NATIONAL SCIENCE FOUNDATION

FY 2010 Budget Request to Congress

May 7, 2009

About the Cover:
Gemini South image of NGC 5426-27 (Arp 271) as imaged by the Gemini Multi-Object Spectrograph. The twin galaxies comprising NGC 5426-27 (Arp 271) are not as peaceful as they look. Separated by only 60,000 light years, they are on a collision course and will end up as a single elliptical galaxy. For more information about NGC 5426-72 (Arp 271) see: www.gemini.edu/node/10979. *(Image courtesy of Gemini Observatory.)*

NSF is the federal steward for ground-based astronomy in the United States. Research support covers a broad array of observational, theoretical, and laboratory research aimed at understanding the origins and characteristics of planets, the Sun, other stars, our galaxy, extragalactic objects, and the structure and origin of the Universe. 2009 is International Year of Astronomy (IYA), as modern astronomy celebrates its quadricentennial and commemorates numerous astronomical and scientific milestones including the 400th anniversary of Galileo's use of a telescope to study the skies and Kepler's publication of *Astronomia Nova*. 2009 is also the anniversary of many other historic events in science, including Huygen's 1659 publication of *Systema Saturnium.* For more information about IYA 2009 see www.nsf.gov/news/news_summ.jsp?cntn_id=113004&org=NSF *and* http://astronomy2009.us/.

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NSF FY 2010 Budget Request to Congress

The National Science Foundation Act of 1950 (Public Law 81-507) sets forth our mission: ***To promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense.***
NSF's Strategic Plan 2006-2011 defines our vision: ***Advancing discovery, innovation, and education beyond the frontiers of current knowledge, and empowering future generations in science and engineering.***

The National Science Foundation is the only federal agency dedicated to the support of basic research and education across all fields of science and engineering. We explore the frontiers of scientific knowledge and extend the reach of engineering by encouraging, identifying, and funding the best ideas and most promising people. The high-risk, potentially transformative investments we make generate important discoveries and new technology, create and train a dynamic workforce, and spark the curiosity and creativity of millions. Our investments in research and education help ensure that our Nation remains globally competitive, prosperous, and secure.

NSF's FY 2010 Budget Request is $7.045 billion, an increase of $555 million (8.5 percent) over the 2009 plan. In addition, since investments in science and technology foster economic growth and create high-tech, high-wage jobs, NSF received a one-time appropriation of $3.0 billion from the American Recovery and Reinvestment Act of 2009, raising its overall FY 2009 appropriation to $9.49 billion.

NSF Funding by Account
(Dollars in Millions)

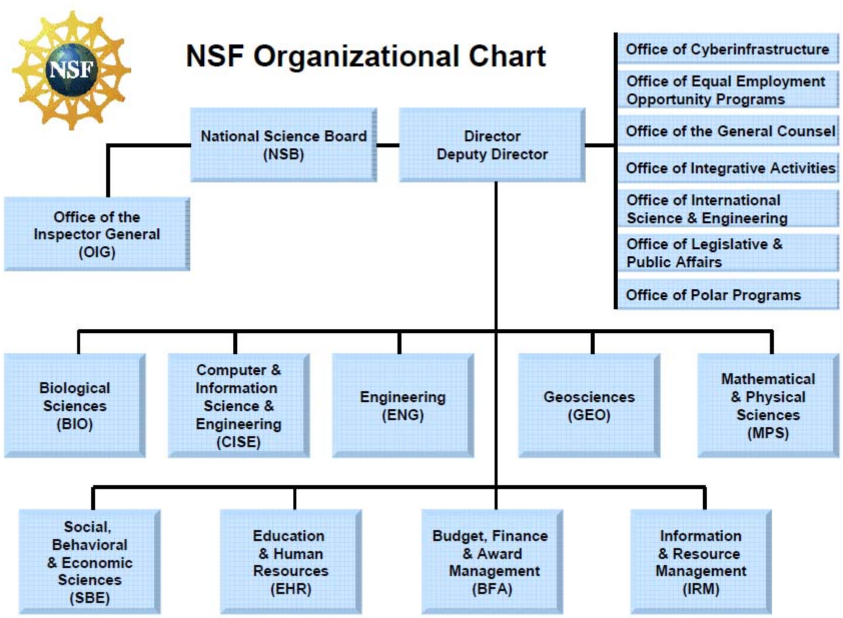
	FY 2008 Actual	FY 2009 Current Plan	FY 2009 Recovery Act	FY 2010 Request	Change over FY 2009 Current Plan	
					Amount	Percent
Research and Related Activities	$4,853.24	$5,183.10	$2,500.00	$5,733.24	$550.14	10.6%
Education and Human Resources	766.26	845.26	100.00	857.76	12.50	1.5%
Major Research Equipment and Facilities Construction	166.85	152.01	400.00	117.29	-34.72	-22.8%
Agency Operations and Award Management	282.04	294.00	-	318.37	24.37	8.3%
National Science Board	3.82	4.03	-	4.34	0.31	7.7%
Office of Inspector General	11.83	12.00	2.00	14.00	2.00	16.7%
Total, NSF	$6,084.04	$6,490.40	$3,002.00	$7,045.00	$554.60	8.5%

Totals may not add due to rounding.

NSF's Organization and Role in the Federal Research Enterprise

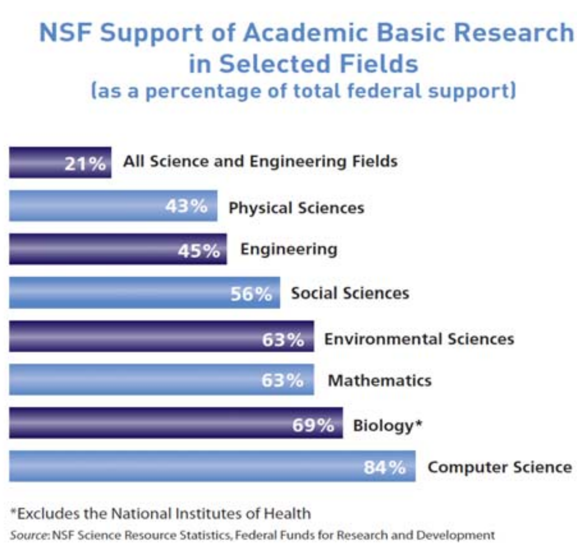
NSF-funded research is characterized by its breadth. NSF prioritizes the integration of education into its research programs, and takes into account the broader societal impacts of the work it funds, such as the training that students and young researchers receive in the research process, and the educational opportunities the work and its people can then provide to the larger community of K-16 students and teachers and the general public.

NSF's comprehensive and flexible support of meritorious projects with broad societal impacts enables the Foundation to identify and foster both fundamental and transformative discoveries within and among fields of inquiry. NSF has the latitude to support emerging fields, high-risk ideas, interdisciplinary collaborations, and research that pushes, and even transforms, the very frontiers of knowledge. In these ways, NSF's discoveries inspire the American public—and the world.



NSF's organization mirrors the major fields of science and engineering. These include biological sciences, computer and information science and engineering, engineering, geosciences, mathematics and physical sciences, and social, behavioral, and economic sciences. NSF also carries out specific responsibilities for education and human resources, cyberinfrastructure, integrative activities, international science and engineering, and polar programs. The 25-member National Science Board sets the overall policies of the Foundation.

NSF's annual budget represents 21 percent of the total federal budget for basic research conducted at America's colleges and universities, and this share increases to 45 percent when medical research supported by the National Institutes of Health is excluded. In many fields NSF is the primary source of federal academic support.



Presidential Initiatives and Major Investments

The President's Budget, "A New Era of Responsibility," will significantly expand three key NSF programs which support students and early-career researchers, and will create a fourth program to help develop the next generation of environmentally engaged scientists and engineers. The Budget also encourages high-risk research and supports critical priorities in global climate change. NSF's FY 2010 budget is an 8.5 percent increase over the FY 2009 level.

Potentially Transformative Research. Transformative research involves ideas, discoveries, or tools that radically change our understanding of existing scientific or engineering concepts or educational practices. Such research is risky but can be high-reward if it leads to breakthroughs or creates new paradigms or fields. NSF explicitly recognizes the critical importance of transformative research in its merit review process. In FY 2010, each research division will set aside a minimum of $2 million ($92 million Foundation-wide) to explore methodologies that help support transformative research.

New Faculty and Young Investigators. (11.6 percent increase to $203.80 million) NSF's Foundation-wide Faculty Early Career Development (CAREER) program supports junior faculty who integrate top-notch education with outstanding research. The five-year awards emphasize exploring new approaches and pursuing potentially transformative activities. (See Overview-4, "Data Centers.")

Graduate Research Fellowship. (6 percent increase to $122.0 million) This prestigious Fellowship is the flagship for the federal government in supporting the broad array of science and engineering disciplines across all fields as well as international research activity. To launch the Presidential initiative of tripling the number of new fellowships awarded annually by FY 2013, the Request supports 1,654 new Fellowships in FY 2010. (See Overview-4, "Supercapacitors.")

Advanced Technological Education (ATE). (24 percent increase to $64.0 million) Focusing on two-year colleges, ATE supports partnerships between academic institutions and employers to improve the education of science and engineering technicians. Career pathways between secondary schools, two-year, and four-year colleges are supported, as are curriculum and professional development activities. FY 2010 is the beginning of a growth trajectory reaching $100.0 million in FY 2013. (See Overview-4, "Wind.")

Climate Change Education Program. ($10.0 million each in FY 2009 and FY 2010) This new program will catalyze activity at the national level and help develop the next generation of environmentally engaged scientists and engineers by supporting awards in the following educational areas: increasing public understanding and engagement; development of resources for learning; informing local and national science, technology, engineering, and mathematics (STEM) education policy; and preparing a climate science professional workforce. (See Overview-10, "Rock," for a similar existing program.)

FY 2010 Presidential Priorities

(Dollars in Millions)

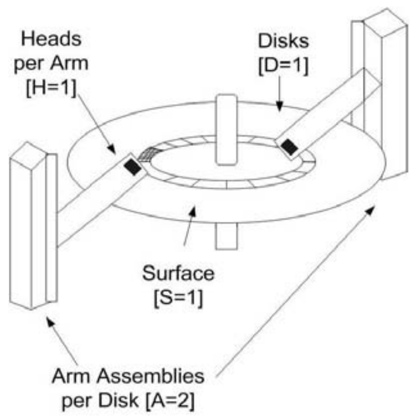
	FY 2008 Actual	FY 2009 Current Plan	FY 2009 Recovery Act	FY 2010 Request	Change over FY 2009 Current Plan: Amount	Change over FY 2009 Current Plan: Percent
Faculty Early Career Development (CAREER)	$203.17	$182.63	$165.00	$203.80	$21.17	11.6%
Graduate Research Fellowships (GRF)	96.02	115.06	45.56	122.00	$6.94	6.0%
Advanced Technology Education (ATE)	51.46	51.62	-	64.00	$12.38	24.0%
Climate Change Education Program		10.00	-	10.00	-	-

Highlights

Credit: Mitch Maxwell

► **Wind Energy Project Trains Turbine Technicians:** An Advanced Technological Education (ATE) program at Laramie County Community College (LCCC) in Wyoming is training and educating technicians to service the more than 25,000 wind turbines operating in the United States today. LCCC's "Wind Energy Technology" program is developing a wind energy technician certification program, mechanic diploma program, and associate of science degree option, and is holding community information seminars and workshops on wind energy technology and related renewable energy topics.

► **A Green Storage Solution for Data Centers:** Data centers, such as those used by Google™, Facebook™, and Youtube™, consumed 61 billion kWh in 2006, and a 2007 Environmental Protection Agency report estimated that they could consume over 100 billion kWh by 2011. In a typical data center, over 37 percent of the power is consumed by storage. NSF CAREER Award winner Sudhanva Gurumurthi, in collaboration with colleague Mircea Stan at the University of Virginia, has developed a new, more compact disk drive architecture that can reduce the energy consumption of data center storage systems by over 60 percent while still achieving high performance.



Intra-disk parallel drives use two sets of arms to improve efficiency. *Credit: Univ. of Virginia*

Credit: John Chmiola

► **Supercapacitors: Keys to a Green Energy Future:** The traditional power sources and batteries essential to our personal electronic devices and automobiles do not store much energy. Supercapacitors are electronic devices with great potential for such uses. Most commonly used in backup power applications because of their indefinite lifespans, short charging times, and reliability in low temperatures, supercapacitors are also finding increased usage in personal electronic devices, mobile phones, and hybrid electric/fuel cell vehicles. John Chmiola, who is funded through NSF's Graduate Research Fellowship and Integrative Graduate Education and Research Traineeship programs, has manipulated supercapacitors at the nanoscale level to increase capacity by 50 percent. This astounding result has direct and potentially far-reaching implications as it could help manufacturers create smaller and cheaper power packs for everything from cameras to cars. Chmiola's discovery was featured in the August 18, 2006, edition of the journal *Science*.

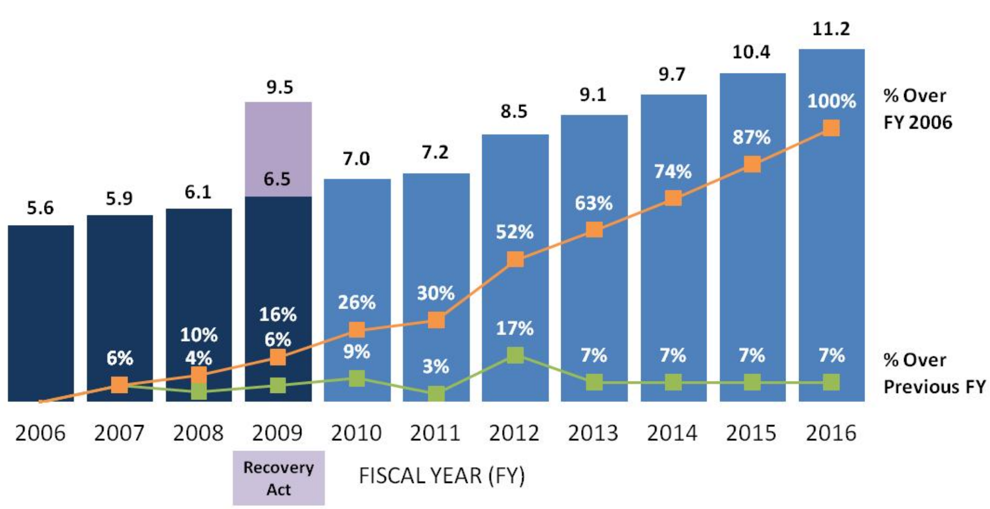
President's Plan for Science and Innovation

In addition to the targeted increases already described, the President's Plan for Science and Innovation aims to double the federal investment in basic research over a 10-year period. Such a commitment will reap dividends for the Nation for decades into the future.

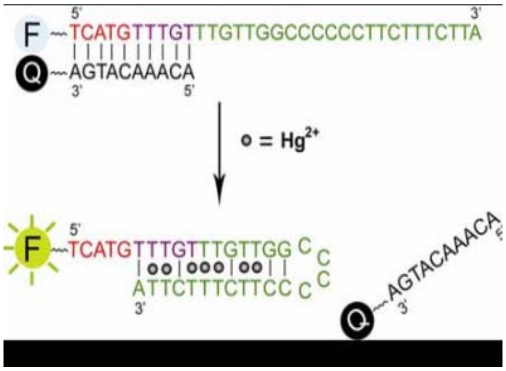
In the process of supporting basic research and education in all science and engineering fields, NSF addresses national challenges such as climate change and maintaining an internationally competitive workforce. Due to its unique role in the scientific enterprise, NSF's funding levels will double relative to 2006 levels under the President's Plan for Science and Innovation. These sustained increases will enable NSF to:

- Support a diversified portfolio of fundamental, high-risk, and transformative research.
- Support researchers at the beginning of their careers, and triple the number of new Graduate Research Fellowships awarded annually.
- Expand the STEM workforce and broaden participation from underrepresented groups and geographical regions.
- Improve the quality and widen the reach of its educational programs, including the expansion of efforts to recruit scientists and engineers to teach math and science in K-12 schools.
- Increase collaboration with other nations, other agencies, and other sectors, encouraging innovation to flourish and addressing grand challenges of the 21st century.
- Sustain the quality of NSF's business processes and development of its human capital.

The President's Plan is designed to sustain the momentum for investing in science and innovation which was generated by the American Recovery and Reinvestment Act of 2009 (Recovery Act). The largest increases occur in the early years of the plan, particularly in FY 2012, to maintain the momentum generated by the Recovery Act.



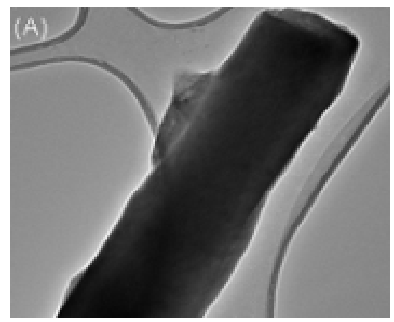
Highlights



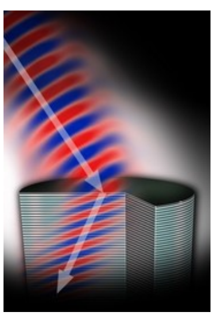
Credit: Yi Lu

► **Fluorescent Mercury Detector:** Sensitive and selective mercury detection in the environment and in the food industry is in high demand, especially in environmental monitoring applications such as mercury detection in drinking water. Professors Mark Shannon and Yi Lu at the University of Illinois at Urbana-Champaign have successfully tested a simple DNA-based "turn-on" fluorescent sensor with high sensitivity and selectivity. The sensing process can be completed onsite in less than five minutes. Its detection limit of 0.6 parts per billion (ppb) is far lower than the EPA limit of approximately two ppb.

► **Nano-Bone:** By mimicking the natural processes of biomineralization, the structure of bone has been reproduced for the first time. The nanocomposites are so similar to natural bone that the cells recognize them as bone tissue and respond accordingly. The composites may provide a commercializable product with orthopedic and dental applications, such as bone graft substitutes to replace or augment the use of autograft or allograft bone tissues, tissue engineering scaffolds, and model systems for the study of bone diseases such as osteogenesis imperfecta.



Credit: Sang Soo Jee, University of Florida


Credit: Claire Gmachl

► **Where are you, Harry Potter?** In nature, light waves and other forms of electromagnetic radiation bend when they pass from one medium into another, but they continue to move forward. Using alternating layers of different semiconductors, Princeton University researchers have created a new optical "metamaterial" that causes light to bend backwards. This behavior has significant potential for optical components such as lenses for magnification and imaging. The metamaterial could help form the basis for higher resolution optical imaging, nanocircuits for high-powered computers, and, to the delight of science-fiction and fantasy buffs, cloaking devices that could render objects invisible to the human eye.

► **Improving the Efficiency of Distributing Critical Supplies in Disasters:** Response to disasters must be timely and focus on delivering only the most needed supplies. An interdisciplinary team of civil engineers and sociologists from Rensselaer Polytechnic Institute and the University of Delaware has determined that enhancing visibility of the response networks is vital to identifying the roles played by each organization within it. This team found three key ways to improve network visibility: identify organizations to serve as information bridges between other organizations or clusters, develop partnerships with community organizations with perspective on needs and resources, and develop technologies to visually represent emergent networks in real time.

Credit: Jose Holguin-Veras

American Recovery and Reinvestment Act of 2009

A primary purpose of the American Recovery and Reinvestment Act of 2009 is to "increase economic efficiency by spurring technological advances in science and health." NSF's role in stimulating the American economy was acknowledged by its inclusion in the Act, which will fund the Nation's best and brightest researchers, train its most deserving graduate students, and develop the advanced scientific tools and infrastructure that the research community needs.

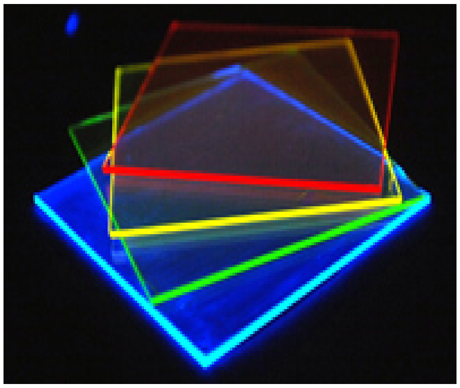
The American Recovery and Reinvestment Act of FY 2009 increases NSF's FY 2009 funding by $3.0 billion for a FY 2009 total appropriation of $9.49 billion. In FY 2009 NSF will maintain its commitment to its established merit review processes and will continue to focus on its current goals and priorities. With Recovery Act funds, NSF will:

- Support highly-rated proposals that would otherwise be declined
- Encourage high-risk, transformative research with the potential to grow the Nation's economy
- Create and sustain research jobs through new awards, graduate research fellows, and early-career researchers
- Train and develop the careers of STEM undergraduates, teachers, and professionals
- Strengthen the Nation's overall cyberinfrastructure and enhance institutional broadband access connectivity
- Meet facilities and infrastructure needs, including deferred maintenance

NSF Activities Funded by the Recovery Act
(in millions)

Research and Related Activities	**$2,500**
• Core research, facilities and infrastructure investments	$2,000
• Major Research Instrumentation	$300
• Academic Research Infrastructure	$200
Education and Human Resources	**$100**
• Robert Noyce Scholarship Program	$60
• Math and Science Partnership Program	$25
• Science Masters' Program	$15
Major Research Equipment and Facilities Construction	**$400**
• Alaska Region Research Vessel	$148
• Advanced Technology Solar Telescope	$146
• Ocean Observatories Initiative	$106
Office of Inspector General	**$2**
TOTAL	**$3,002**

Highlights

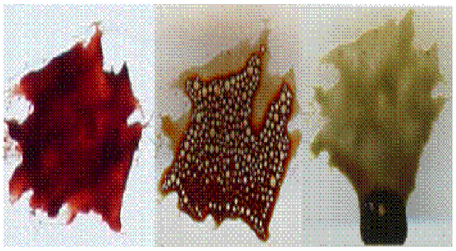


Credit: Donna Coveney, MIT

► **A Colorful Approach to Affordable Solar Energy:** Engineers and graduate students at the Massachusetts Institute of Technology have developed a novel, simple method to turn ordinary pieces of glass into efficient solar concentrators. Dye-coated glass absorbs incoming light and re-emits the energy, which is channeled to solar cells placed along its edges. This technique uses affordable and easily scalable starting materials, and will effectively enable smaller solar cells to harvest the same amount of energy as larger, more costly solar cells. The researchers, who announced their findings in the July 11, 2008, issue of *Science*, believe the technology could soon find its way to the marketplace.

► **"Giant Fossil Frog from Hell" Discovered in Madagascar:** A team of researchers led by Stony Brook University paleontologist David Krause has discovered the remains in Madagascar of what may be the largest frog ever to exist. The 16-inch, 10-pound ancient frog, named *Beelzebufo*, or "devil frog," lived 65 to 70 million years ago. "*Beelzebufo* appears to be a very close relative of a group of South American frogs known as 'ceratophyrines,' or 'Pac-Man' frogs, because of their immense mouths," said Krause.

An artist's depiction. *Credit: David Krause, Stony Brook University*



Credit: David Tyler, Chemistry Department, University of Oregon

► **Light-degradable Plastics:** "Photodegradable" plastics, plastics which degrade or decompose with light, are one way to reduce plastic waste and make plastics more environmentally benign. David Tyler, a NSF-funded Professor of Inorganic Chemistry at the University of Oregon, and his research group have designed a plastic that degrades into a water-soluble liquid after being exposed to sunlight or room light for three days. Photodegradable plastics could have profound consequences for our environment in terms of pollution management as well as the recycling of natural resources.

► **Investors See Green Firms as Less Risky :** NSF-supported research from the University of Oklahoma suggests that a company's decision to go green can result in more willingness by financial markets to invest in them, thereby helping improve their bottom line. The finding is one of several from a study that shows improved green performance benefits corporations in ways previously not considered by economic analysts, running contrary to currently prevailing theories.

Credit: Morguefile

Learning and Workforce Development

The integration of research and education has been a hallmark of NSF since its inception. The Foundation's investments do double duty – generating new knowledge and producing the next generation of scientists, technologists, engineers, mathematicians, and educators. This highly-trained cadre is a vital national asset – forming the "knowledge vectors" that transfer the latest concepts between academe and industry.

Integrative Graduate Education and Research Training (IGERT) (9 percent increase to $68.88 million) awardees prepare doctoral students by integrating research and education in innovative ways that are tailored to the unique requirements of newly emerging interdisciplinary fields and new career options.

Discovery Research K-12 ($108.50 million) develops more effective tools and resources for teachers and students that will support inquiry-based classroom practices and a more intensive scientifically-based assessment of the efficacy of these resources.

Robert Noyce Teacher Scholarship Program ($55.0 million) enables institutions to develop and implement programs to prepare STEM undergraduate majors--and mid-career STEM professionals--to become K-12 science and mathematics teachers.

The Math and Science Partnership (MSP) program (4.6 percent decrease to $58.22 million) links K-12 teachers with their colleagues in higher education. In FY 2010, MSP will continue to build capacity and integrate the work of higher education with that of K-12 to strengthen and reform science and mathematics education.

NSF estimates that in FY 2010 over 215,000 people will be directly involved in NSF programs and activities, receiving salaries, stipends, or participant support. Additionally, NSF programs indirectly impact many millions of people through activities including workshops, public outreach (including online social networking tools), informal science activities such as museums, television, videos, and journals, and dissemination of curricula and other teaching materials.

Number of People Involved in NSF Activities

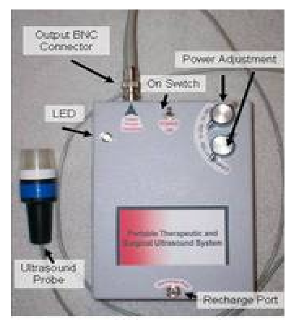
	FY 2008 Estimate	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate
Senior Researchers	43,019	45,290	12,910	48,850
Other Professionals	12,499	13,030	4,160	14,020
Postdoctoral Associates	6,013	6,480	1,990	7,190
Graduate Students	37,308	39,110	12,405	42,780
Undergraduate Students	24,407	25,210	6,275	27,000
K-12 Students	62,375	62,405	1,165	62,465
K-12 Teachers	12,801	12,760	570	12,790
Total, Number of People	198,422	204,285	39,475	215,095

Highlights

Credit: Heather Almquist, University of Montana

► **Finding Dinosaur Fossils by Satellite:** K-12 students and teachers from underserved frontier communities across Montana's vast eastern plains have harnessed the power of geographic information systems (GIS) to explore the region's extraordinary geologic past and wealth of fossil deposits. The technique, designed by Dr. Heather Almquist at The University of Montana, Missoula, led participants to discover fossils of *Tyrannosaurus rex*, *Triceratops*, and the duck-billed *Edmontasaurus*, as well as fossils of many species of reptiles, invertebrates, and plants. This NSF ITEST (Innovative Technology Experiences for Students and Teachers) program, "Project DinoMap," has provided otherwise cost-prohibitive GIS software to all K-12 schools in Montana, awarded graduate credit to 52 teachers to further their careers, trained high school, college and graduate students in science communication, disseminated materials nationally and internationally, and engaged participants from small, isolated communities, including those within the Fort Peck, Fort Belknap, and Rocky Boys Indian reservations.

► **Ultrasound In Your Pocket:** NSF Graduate Research Fellow George Lewis has developed the first pocket-size ultrasound system for commercial, medical, military, and research applications. The novel approach reduces the device's size and cost compared with traditional ultrasonic devices. This transformative research has the potential to replace expensive shoe-box size systems with inexpensive compact cell-phone type devices and make ultrasound technology readily available for students, researchers and ultrasound practitioners.



Credit: George Lewis

Credit: Consortium for Ocean Leadership

► **The School of Rock:** In just three years, 60 U.S. educators have attended professional development programs at the "School of Rock" aboard the ocean drilling vessel JOIDES Resolution and at the Gulf Coast Core Repository at Texas A & M University. This School of Rock (SOR) provides an ocean-going, hands-on experience for the educators, who then go on to share their new knowledge with others. The SOR graduates and staff members have conducted over 100 outreach programs for another 2,000 participants in more than 30 states.

Additional FY 2010 Investments

The following activities are notable for being interdisciplinary, supported by multiple directorates, and/or wide-ranging in their impact on the Foundation. Many aim to have a transformative impact across science and engineering, often in fields where focused research and education can further national priorities. All are integral to the Foundation's mission and vision.

Climate Change Science Program (CCSP). (36.6 percent increase to $299.91 million) This interagency activity is coordinated through the National Science and Technology Council (NSTC). NSF's role is to provide a comprehensive scientific foundation for CCSP through support of a broad and basic research portfolio, which can provide insight into the fundamental processes underlying climate.

Climate Research. ($197.26 million; new NSF-wide focus) This is a new Foundation-wide investment that builds upon CCSP and previous NSF efforts. It focuses on multidisciplinary research that deepens our current understanding of complex interactions that influence climate, through expanded observing capabilities, modeling and simulation, and fundamental research on ways to mitigate and adapt to the impacts of a changing climate. Investments will address smart adaptation and mitigation science, regional and decadal-scale climate modeling, ecosystem vulnerability, the carbon and water cycles, ocean acidification, abrupt climate change, and weather extremes.

Cyber-enabled Discovery and Innovation (CDI). (44.7 percent increase to $102.63 million) CDI supports transformative, multidisciplinary science and engineering research outcomes made possible by innovations and advances in computational concepts, methods, models, algorithms, and tools. CDI breakthroughs advance one or more of the three themes: From Data to Knowledge; Understanding Complexity in Natural, Built, and Social Systems; Building Virtual Organizations.

Cybersecurity. (8.6 percent increase to $126.70 million) The FY 2010 Request includes $126.70 million for cybersecurity research and education, with $40.0 million specifically devoted to research in usability, theoretical foundations, and privacy in support of the Comprehensive National Cybersecurity Initiative.

Experimental Program to Stimulate Competitive Research (EPSCoR). (10.6 percent increase to $147.12 million; $50.0 million from the Recovery Act.) NSF remains a leader in efforts to broaden participation in science and engineering in all states and regions. In response to previous Congressional direction, in FY 2010 EPSCoR will receive the same percentage increase as will the Research and Related Activities Appropriation.

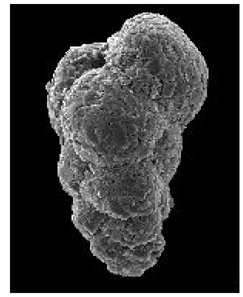
Homeland Security Activities. (2.2 percent increase to $385.50 million) NSF programs apply to homeland security priorities in two areas: protecting critical infrastructure and key assets and defending against catastrophic threats.

Networking and Information Technology R&D. (10.6 percent increase to $1,110.80 million) This interagency activity is coordinated through the NSTC. Major funding increases for FY 2010 are in such areas as large scale networking, high-end computing research, human computer interaction, and research on social, economic, and workforce aspects of advanced computing and communications technologies.

National Nanotechnology Initiative. (6.5 percent increase to $422.96 million) This multiagency initiative seeks systematic understanding, organization, manipulation, and control of atomic, molecular, and supramolecular levels of matter in the size range of 1-100 nanometers. A $2.0 million increase for the Environmental, Health, and Safety area will support decision analysis research.

Highlights

► **Clues to Waterproof Glue Found in Antarctic Creature:** Sam Bowser, a scientist at the New York State Department of Health's Wadsworth Center, studies the calcium carbonate shells of Foraminifera, single-celled marine creatures. Not only do the shells absorb carbon from the water, neutralizing the acidifying effects of dissolved carbon dioxide, but these tiny organisms use an extremely effective underwater adhesive to build their miniscule yet sophisticated shells. Understanding the chemistry of the naturally produced glue could lead to the development of stronger biological adhesives for use in dentistry, neurological surgery, or the development of artificial limbs.

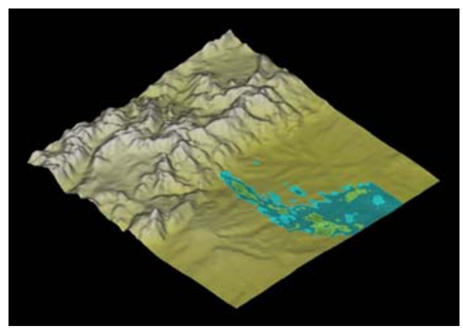


Credit: U.S. Geological Survey

Credit: American Chemical Society

► **Researchers Build Drug-Delivering Backpacks for Cells:** Massachusetts Institute of Technology (MIT) engineers have outfitted cells with tiny polymer "backpacks" that could allow them to deliver drugs, diagnose tumors, or become building blocks for tissue engineering. Using magnetic fields to move the cells around, researchers had immune cells hone in on various tissues in the body, including tumors, infection sites and lymphoid tissues–a trait that could be exploited to achieve targeted drug or vaccine delivery.

► **Scientists Test System to Forecast Flash Floods along Colorado's Front Range:** People living near vulnerable creeks and rivers along Colorado's Front Range may soon get advance notice of potentially deadly floods thanks to a new forecasting system which was tested last summer by the National Center for Atmospheric Research (NCAR) in Boulder, CO. Known as the NCAR Front Range Flash Flood Prediction System, it combines detailed atmospheric conditions with information about stream flows to predict floods along specific streams and catchments.



Credit: U.S. Geological Survey

Credit: AR Science and Technology Authority and AR ASSET Initiative

► **Neural Prosthetic Devices Offer Life-Altering Possibilities:** Project investigators at three universities in Arkansas are collaborating to create neural prosthetic devices from 3-D nanostructures. Neural prosthetic devices do exist, but the excellent biocompatibility of nanowire electrodes could drastically improve reliability and utility. These prosthetics have myriad applications: they could provide deep brain stimulation for Parkinson's or Tourette's patients, restore urinary tract function, or regain control of a paralyzed limb. One aspect of the research involves implantation of networked wireless nanosensors, which would give the patient the freedom to live their life while health-care professionals can monitor them outside of a hospital setting.

Additional FY 2010 Investments, continued

Major Research Equipment and Facilities Construction. ($117.29 million)

- Advanced Laser Interferometer Gravitational Wave Observatory: $46.30 million.
- Atacama Large Millimeter Array: $42.76 million.
- IceCube Neutrino Observatory: $950,000.
- Advanced Technology Solar Telescope: $10.0 million.
- Ocean Observatories Initiative: $14.28 million.
- Judgment Fund: $3.0 million.

Regaining our Energy Science and Engineering Edge (RE-ENERGYSE). This set of investments, part of the President's New Energy for America plan, focuses on preparing students for careers related to research and education on clean energy. NSF, working with the Department of Energy, will leverage existing programs and partnerships to train scientists and technicians, educate K-12 and undergraduate students, and inform the public.

Science and Engineering Beyond Moore's Law. (197.7 percent increase to $46.68 million) In 10 to 20 years, current silicon technology will reach the limits of Moore's Law – the empirical observation that computing power doubles roughly every 18 months. Activities in FY 2010 will encourage transformational activities as well as creating partnering opportunities with the private sector and national laboratories to accelerate innovation.

Science and Technology Centers (STC). (6.2 percent decrease to $57.79 million) STCs integrate cutting-edge research, excellence in education, targeted knowledge transfer, and development of a diverse workforce across all disciplines of science and engineering. STCs conduct research through partnerships among academic institutions, national laboratories, industrial organizations, and/or other public/private entities, and via international collaborations, as appropriate. Up to five new STCs are expected to be funded in FY 2010, for a total of 17.

Stewardship. (8.8 percent increase to $447.66 million) To manage the growing and increasingly complex workload being experienced throughout the Foundation, the Request increases the NSF workforce by 15 to 1,350 FTEs. Investments in Program-Related Technology increase 8 percent to $56.0 million.

FY 2010 Selected Major Investments

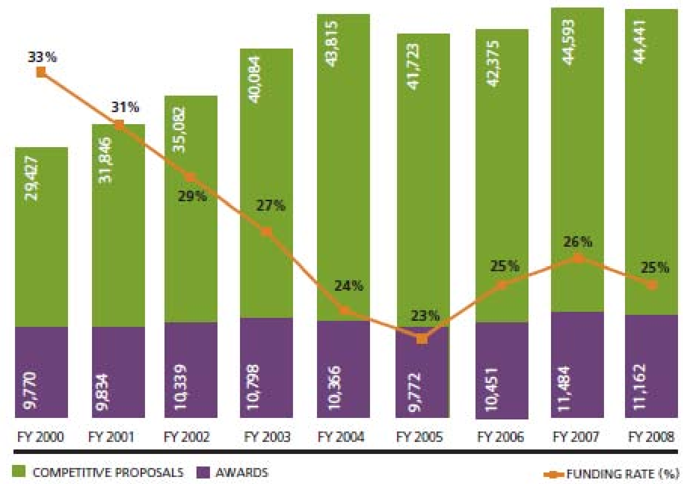
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 Recovery Act	FY 2010 Request	Change over FY 2009 Current Plan	
					Amount	Percent
Climate Change Science Program (CCSP)	$206.70	$219.57	$95.46	$299.91	$80.34	37%
Climate Research	0.00	0.00	0.00	197.26	197.26	N/A
Cyber-enabled Discovery and Innovation (CDI)	53.18	70.94	6.37	102.63	31.69	44.7%
Cybersecurity	106.90	116.70	20.00	126.70	10.00	8.6%
Experimental Program to Stimulate Competitive Research	120.00	133.00	50.00	147.12	14.12	10.6%
Homeland Security Activities	366.09	377.23	29.40	385.50	8.27	2.2%
National Nanotechnology Initiative (NNI)	408.56	397.18	107.81	422.96	25.78	6.5%
Environment, Health, and Safety (EHS)	29.22	27.91	2.69	29.90	1.99	7.1%
Networking and Information Technology R&D (NITRD)	946.54	1,004.28	339.90	1,110.80	106.52	10.6%
Science and Engineering Beyond Moore's Law (SEBML)	8.18	15.68	3.98	46.68	31.00	197.7%

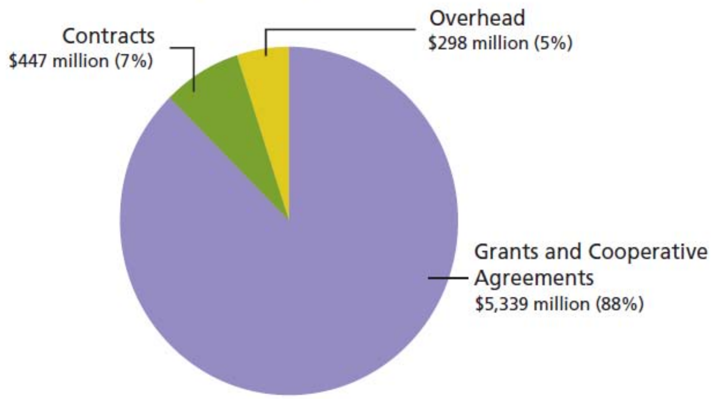
NSF by the Numbers

In FY 2008, the NSF evaluated over 44,400 grant proposals and made 11,162 new awards, a funding rate of 25 percent. The majority were made to individual investigators or small groups of investigators at nearly 1,900 colleges, universities, and other public and private institutions throughout the United States. Ninety percent of NSF's funding was allocated through a merit-based review process that is recognized throughout government as the exemplar for effective and efficient use of public funds. 248,000 proposal reviews were conducted.

NUMBER OF NSF COMPETITIVE PROPOSALS AND AWARDS AND FUNDING RATES



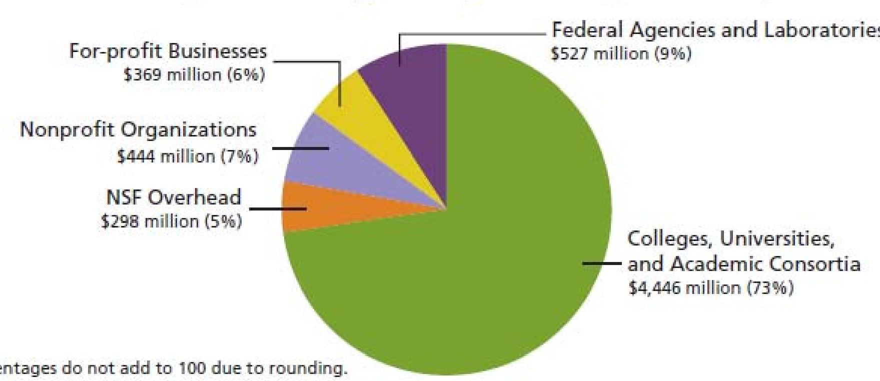
HOW IT'S SPENT: AWARD MECHANISMS
(FY 2008 Budget Obligations—$6,084 million)



Most NSF projects are funded using grants or cooperative agreements. Grants can be funded either as standard awards in which funding for the full duration of the project is provided in a single fiscal year, or as continuing awards, in which funding for a multi-year project is provided in increments. Cooperative agreements are used when the project requires substantial agency involvement during the project performance period (e.g., research centers, multi-user facilities, etc.). Contracts are used to acquire products, services, and studies (e.g., program evaluations) required primarily for NSF or other government use.

Most NSF awards are to academic institutions. Nonprofit organizations include state and local governments and international organizations. For-profit businesses include private and small businesses. Federal agencies and laboratories include funding for Federally Funded R&D Centers.

WHERE IT GOES: INSTITUTIONS FUNDED
(FY 2008 Budget Obligations—$6,084 million)



Percentages do not add to 100 due to rounding.

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National Science Foundation
Summary Tables
FY 2010 Budget Request to Congress

(Dollars in Millions)

NSF by Account	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	FY 2010 Request change over: FY 2008 Actual		FY 2010 Request change over: FY 2009 Current Plan	
					Amount	Percent	Amount	Percent
BIO	$615.62	$655.81	$260.00	$733.00	$117.38	19.1%	$77.19	11.8%
CISE	535.26	573.74	235.00	633.00	97.74	18.3%	59.26	10.3%
ENG *(less SBIR/STTR)*	540.42	574.13	215.00	632.00	91.58	16.9%	57.87	10.1%
SBIR/STTR	109.07	119.21	50.00	132.52	23.45	21.5%	13.31	11.2%
GEO	757.87	807.13	347.00	909.00	151.13	19.9%	101.87	12.6%
MPS	1,171.13	1,255.96	490.00	1,380.00	208.87	17.8%	124.04	9.9%
SBE	227.87	240.30	85.00	257.00	29.13	12.8%	16.70	6.9%
OCI	185.15	199.28	80.00	219.00	33.85	18.3%	19.72	9.9%
OISE	47.77	44.03	14.00	49.00	1.23	2.6%	4.97	11.3%
OPP	447.13	470.67	174.00	516.00	68.87	15.4%	45.33	9.6%
IA	214.48	241.34	550.00	271.12	56.64	26.4%	29.78	12.3%
U.S. Arctic Research Commission	1.47	1.50	-	1.60	0.13	8.8%	0.10	6.7%
Research & Related Activities	**$4,853.25**	**$5,183.10**	**$2,500.00**	**$5,733.24**	**$879.99**	**18.1%**	**$550.14**	**10.6%**
Education & Human Resources	**$766.26**	**$845.26**	**$100.00**	**$857.76**	**$91.50**	**11.9%**	**$12.50**	**1.5%**
Major Research Equipment & Facilities Construction	**$166.85**	**$152.01**	**$400.00**	**$117.29**	**-$49.56**	**-29.7%**	**-$34.72**	**-22.8%**
Agency Operations & Award Management	**$282.04**	**$294.00**	-	**$318.37**	**$36.33**	**12.9%**	**$24.37**	**8.3%**
National Science Board	**$3.82**	**$4.03**	-	**$4.34**	**$0.52**	**13.5%**	**$0.31**	**7.7%**
Office of Inspector General	**$11.83**	**$12.00**	**$2.00**	**$14.00**	**$2.17**	**18.4%**	**$2.00**	**16.7%**
Total, NSF	**$6,084.04**	**$6,490.40**	**$3,002.00**	**$7,045.00**	**$960.96**	**15.8%**	**$554.60**	**8.5%**

* Totals may not add due to rounding.

(Dollars in Millions)

NSF by Strategic Goal	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	FY 2010 Request change over: FY 2008 Actual		FY 2010 Request change over: FY 2009 Plan	
					Amount	Percent	Amount	Percent
Discovery	$3,290.24	$3,509.02	$1,597.32	$3,934.06	$643.82	19.6%	$425.04	12.1%
Learning	848.74	896.71	261.78	962.14	113.40	13.4%	65.43	7.3%
Research Infrastructure	1,583.76	1,673.27	1,140.90	1,701.14	117.38	7.4%	27.87	1.7%
Stewardship	361.31	411.40	2.00	447.66	86.35	23.9%	36.26	8.8%
Total, NSF	**$6,084.04**	**$6,490.40**	**$3,002.00**	**$7,045.00**	**$960.96**	**15.8%**	**$554.60**	**8.5%**

* Totals may not add due to rounding.

National Science Foundation
By Account and Strategic Outcome Goal
FY 2010 Budget Request to Congress

(Dollars in Millions)

NSF Accounts	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request: Discovery	Learning	Research Infrastructure	Stewardship	FY 2010 Request	Change over FY 2008 Actual: Amount	Percent	Change over FY 2009 Plan: Amount	Percent
FY 2008 Total Actual	**$6,084.04**			**$3,290.24**	**$848.74**	**$1,583.76**	**$361.31**					
FY 2009 Current Plan		**$6,490.40**	**$3,002.00**	**$3,509.02**	**$896.71**	**$1,673.27**	**$411.40**					
BIO	$615.62	$655.81	$260.00	$545.85	$50.86	$123.50	$12.79	$733.00	$117.38	19.1%	$77.19	11.8%
CISE	535.26	573.74	235.00	550.07	38.84	30.60	13.49	633.00	97.74	18.3%	59.26	10.3%
ENG *(less SBIR/STTR)*	540.42	574.13	215.00	522.32	62.71	32.83	14.14	632.00	91.58	16.9%	57.87	10.1%
SBIR/STTR	109.07	119.21	50.00	132.52	-	-	-	132.52	23.45	21.5%	13.31	11.2%
GEO	757.87	807.13	347.00	488.07	42.22	362.38	16.33	909.00	151.13	19.9%	101.87	12.6%
MPS	1,171.13	1,255.96	490.00	959.11	67.90	331.51	21.48	1,380.00	208.87	17.8%	124.04	9.9%
SBE	227.87	240.30	85.00	196.14	11.83	43.56	5.47	257.00	29.13	12.8%	16.70	6.9%
OCI	185.15	199.28	80.00	44.93	13.10	156.65	4.32	219.00	33.85	18.3%	19.72	9.9%
OISE	47.77	44.03	14.00	35.24	11.70	0.10	1.96	49.00	1.23	2.6%	4.97	11.3%
OPP	447.13	470.67	174.00	119.63	7.28	383.70	5.39	516.00	68.87	15.4%	45.33	9.6%
IA	214.48	241.34	550.00	159.68	7.56	103.04	0.84	271.12	56.64	26.4%	29.78	12.3%
U.S. Arctic Research Commission	1.47	1.50	-	1.60	-	-	-	1.60	0.13	8.8%	0.10	6.7%
Research & Related Activities	**$4,853.25**	**$5,183.10**	**$2,500.00**	**$3,755.16**	**$314.00**	**$1,567.87**	**$96.21**	**$5,733.24**	**$879.99**	**18.1%**	**$550.14**	**10.6%**
Education & Human Resources	**$766.26**	**$845.26**	**$100.00**	**$178.90**	**$648.14**	**$15.98**	**$14.74**	**$857.76**	**$91.50**	**11.9%**	**$12.50**	**1.5%**
Major Research Equipment & Facilities Construction	**$166.85**	**$152.01**	**$400.00**	-	-	**$117.29**	-	**$117.29**	**-$49.56**	**-29.7%**	**-$34.72**	**-22.8%**
Agency Operations & Award Management	**$282.04**	**$294.00**	-	-	-	-	**$318.37**	**$318.37**	**$36.33**	**12.9%**	**$24.37**	**8.3%**
National Science Board	**$3.82**	**$4.03**	-	-	-	-	**$4.34**	**$4.34**	**$0.52**	**13.5%**	**$0.31**	**7.7%**
Office of Inspector General	**$11.83**	**$12.00**	**$2.00**	-	-	-	**$14.00**	**$14.00**	**$2.17**	**18.4%**	**$2.00**	**16.7%**
Total, National Science Foundation	**$6,084.04**	**$6,490.40**	**$3,002.00**	**$3,934.06**	**$962.14**	**$1,701.14**	**$447.66**	**$7,045.00**	**$960.96**	**15.8%**	**$554.60**	**8.5%**
H-1B Visa Nonimmigrant Petitioner Fees	*$121.12*	*$100.00*						*$100.00*				
Reimbursables	*$102.30*											
Trust Fund	*$49.48*											
Total NSF, Including H-1B Visa, Reimbursables & Trust Fund	*$6,356.94*	*$6,590.40*	*$3,002.00*	*$3,934.06*	*$962.14*	*$1,701.14*	*$447.66*	*$7,145.00*	*$788.06*	*12.4%*	*$554.60*	*8.4%*
Percent Increase over Prior Year, excluding H-1B Visa				**12.1%**	**7.3%**	**1.7%**	**8.8%**					

Totals may not add due to rounding.

National Science Foundation
Research Infrastructure Summary
FY 2010 Budget Request to Congress

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	FY 2010 Request change over: FY 2008 Actual Amount	FY 2008 Actual Percent	FY 2009 Current Plan Amount	FY 2009 Current Plan Percent
Academic Research Fleet	$75.28	$98.68	$18.00	$87.58	$12.30	16.3%	-$11.10	-11.2%
Regional Class Research Vessels	-	*0.10*	-	*2.00*	*2.00*	*N/A*	*1.90*	*1900.0%*
RHOV Construction (R/V Alvin Replacement)	-	-	*3.00*	*5.00*	*5.00*	*N/A*	*5.00*	*N/A*
R/V Langseth Construction (R/V Ewing Replacement)	*1.60*	-	-	-	*-1.60*	*-100.0%*	-	*N/A*
Ship Operations and Upgrades	*73.68*	*98.58*	*15.00*	*80.58*	*6.90*	*9.4%*	*-18.00*	*-18.3%*
Academic Research Infrastructure	-	-	200.00	-	-	N/A	-	N/A
Cornell Electron Storage Ring (CESR)	14.11	10.50	7.80	6.60	-7.51	-53.2%	-3.90	-37.1%
Cornell High Energy Synchrotron Source (CHESS)	5.60	2.51	7.20	6.67	1.07	19.1%	4.16	165.7%
EarthScope: USArray, SAFOD, PBO[/1]	19.21	24.31	4.00	25.05	5.84	30.4%	0.74	3.0%
Gemini Observatory	18.69	18.71	-	19.10	0.41	2.2%	0.39	2.1%
Incorporated Research Institutions for Seismology	11.75	12.00	2.33	12.36	0.61	5.2%	0.36	3.0%
Integrated Ocean Drilling Program[/2]	37.41	43.41	25.00	43.41	6.00	16.1%	-	-
Large Hadron Collider	18.00	18.00	-	18.00	-	-	-	-
Laser Interferometer Gravitational Wave Observatory	29.50	30.30	-	28.50	-1.00	-3.4%	-1.80	-5.9%
Major Research Equipment & Facilities Construction[/3]	192.91	184.78	403.10	145.99	-46.92	-24.3%	-38.79	-21.0%
Major Research Instrumentation	93.87	100.00	300.00	100.00	6.13	6.5%	-	-
National Astronomy & Ionosphere Center	12.75	11.60	3.10	11.40	-1.35	-10.6%	-0.20	-1.7%
National Center for Atmospheric Research	89.07	106.92	13.20	100.00	10.93	12.3%	-6.92	-6.5%
National High Magnetic Field Laboratory	27.75	26.50	20.00	31.95	4.20	15.1%	5.45	20.6%
National Nanotechnology Infrastructure Network (NNIN)	14.13	16.26	10.00	16.26	2.13	15.1%	-	-
National Optical Astronomy Observatories	28.60	29.58	5.60	32.50	3.90	13.7%	2.92	9.9%
National Radio Astronomy Observatories[/4]	52.74	60.79	5.40	67.09	14.35	27.2%	6.30	10.4%
National Stem Education Distributed Learning	15.92	16.50	-	16.25	0.33	2.0%	-0.25	-1.5%
National Solar Observatory	8.21	8.23	1.40	9.10	0.89	10.8%	0.87	10.6%
National Superconducting Cyclotron Laboratory	19.25	20.50	2.00	21.00	1.75	9.1%	0.50	2.4%
Network for Earthquake Engineering Simulation	19.38	21.82	-	22.00	2.62	13.5%	0.18	0.8%
Polar Environment, Health & Safety	5.91	6.29	-	7.20	1.29	21.8%	0.91	14.5%
Polar Facilities and Logistics[/5]	328.94	342.18	22.50	374.35	45.41	13.8%	32.17	9.4%
Research Resources[/6]	257.02	258.68	68.27	298.49	41.47	16.1%	39.81	15.4%
Science and Technology Policy Institute	-	3.04	-	3.04	3.04	N/A	-	-
Science Resources Statistics	28.30	38.15	-	34.22	5.92	20.9%	-3.93	-10.3%
Networking & Computational Resources Infrastructure & Services\7	151.25	157.00	17.00	156.65	5.40	3.6%	-0.35	-0.2%
Other Facilities[/8]	8.45	6.30	5.00	6.65	-1.80	-21.3%	0.35	5.6%
Subtotal, Research Infrastructure Support	**$1,584.01**	**$1,673.54**	**$1,140.90**	**$1,701.41**	**$117.40**	**7.4%**	**$27.87**	**1.7%**
Research Infrastructure Stewardship Offset	**-$0.25**	**-$0.27**	-	**-$0.27**	**-$0.02**	**6.0%**	-	-
RESEARCH INFRASTRUCTURE TOTAL	**$1,583.76**	**$1,673.27**	**$1,140.90**	**$1,701.14**	**$117.38**	**7.4%**	**$27.87**	**1.7%**

Totals may not add due to rounding.

[/1] EarthScope funding includes support provided through the R&RA account for operations and maintenance of the facility. Support provided through the MREFC account for the construction of the project, totaling $4.21 million in FY 2008, is included in the MREFC projects line.

[/2] Funding for the Integrated Ocean Drilling Program (IODP) includes support for the continued phase-out of program and contract activities for the Ocean Drilling Program (ODP), predecessor to the IODP. This line also includes support for the operations and maintenance of the Scientific Ocean Drilling Vessel (SODV). Final MREFC support for the SODV, totaling $24,000 in FY 2008, is included on the MREFC projects line.

[/3] Funding levels for MREFC projects in this table include support for concept and development associated with these projects provided through the R&RA account, specifically for NEON, OOI, and ATST, initial support for operations and maintenance provided through the R&RA account, and implementation support provided through the MREFC account. Final MREFC support for EarthScope, SODV and SPSM is also included in this line.

[/4] Funding for the National Radio Astronomy Observatory (NRAO) includes operation and maintenance support for the Atacama Large Millimeter Array (ALMA). Construction funding for ALMA is included in the MREFC projects line above.

[/5] Polar Facilities and Logistics includes support for the operations and maintenance of the South Pole Station Modernization (SPSM) project. Funds provided through the MREFC account for SPSM, totaling $7.57 million in FY 2008, are included in the MREFC projects line.

[/6] Funding for Research Resources includes support for the operation and maintenance of minor facilities, infrastructure and instrumentation, field stations, museum collections, etc.

[/7] Networking & Computational Resources Infrastructure & Services is the new name for Shared Cyberinfrastructure Tools. Several programs formerly included in Shared Cyberinfrastructure Tools have been reclassified as Disciplinary and Interdisciplinary Research.

[/8] Other Facilities includes support for other physics and materials research facilities.

National Science Foundation
Selected Cross-Cutting Programs
FY 2010 Budget Request to Congress

(Dollars in Millions)

Selected Cross-Cutting Programs		FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	FY 2010 Request change over: FY 2008 Actual		FY 2009 Current Plan	
						Amount	Percent	Amount	Percent
ADVANCE	Research & Related Activities	19.56	19.54	1.00	19.49	-0.07	-0.4%	-0.05	-0.3%
	Education & Human Resources	0.49	1.25	-	1.53	1.04	209.2%	0.28	22.4%
	Total, NSF	**$20.06**	**$20.79**	**$1.00**	**$21.02**	**$0.96**	**4.8%**	**$0.23**	**1.1%**
Climate Change Education Program	Research & Related Activities	-	-	-	4.50	4.50	N/A	4.50	N/A
	Education & Human Resources	-	10.00	-	5.50	5.50	N/A	-4.50	-45.0%
	Total, NSF	-	**$10.00**	-	**$10.00**	**$10.00**	**N/A**	-	-
Faculty Early Career Development - CAREER	Research & Related Activities	203.17	182.63	165.00	203.80	0.63	0.3%	21.17	11.6%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$203.17**	**$182.63**	**$165.00**	**$203.80**	**$0.63**	**0.3%**	**$21.17**	**11.6%**
Graduate Research Fellowships - GRF	Research & Related Activities	8.13	8.06	45.56	19.42	11.29	139.0%	11.36	140.9%
	Education & Human Resources	87.89	107.00	-	102.58	14.69	16.7%	-4.42	-4.1%
	Total, NSF	**$96.02**	**$115.06**	**$45.56**	**$122.00**	**$25.98**	**27.1%**	**$6.94**	**6.0%**
Graduate Teaching Fellowships in K-12 Education - GK-12	Research & Related Activities	8.20	7.86	2.60	5.31	-2.89	-35.3%	-2.55	-32.4%
	Education & Human Resources	46.40	49.50	-	49.00	2.60	5.6%	-0.50	-1.0%
	Total, NSF	**$54.60**	**$57.36**	**$2.60**	**$54.31**	**-$0.29**	**-0.5%**	**-$3.05**	**-5.3%**
Integrative Graduate Education and Research Training - IGERT	Research & Related Activities	39.47	38.20	14.02	39.02	-0.45	-1.1%	0.82	2.1%
	Education & Human Resources	25.29	25.00	-	29.86	4.57	18.1%	4.86	19.4%
	Total, NSF	**$64.76**	**$63.20**	**$14.02**	**$68.88**	**$4.12**	**6.4%**	**$5.68**	**9.0%**
Total, Graduate Fellowships & Traineeships	Research & Related Activities	$55.80	$54.12	$62.18	$63.75	7.95	14.3%	9.63	17.8%
	Education & Human Resources	$159.59	$181.50		$181.44	21.85	13.7%	-0.06	0.0%
	Total, NSF	**$215.39**	**$235.62**	**$62.18**	**$245.19**	**$29.80**	**13.8%**	**$9.57**	**4.1%**
Long-Term Research Sites - LTER	Research & Related Activities	25.34	25.09	-	27.94	2.60	10.3%	2.85	11.4%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$25.34**	**$25.09**	-	**$27.94**	**$2.60**	**10.3%**	**$2.85**	**11.4%**
Research Experience for Teachers - RET	Research & Related Activities	5.59	5.57	1.50	5.67	0.08	1.4%	0.10	1.8%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$5.59**	**$5.57**	**$1.50**	**$5.67**	**$0.08**	**1.4%**	**$0.10**	**1.8%**
Research Experience for Undergraduates - REU	Research & Related Activities	62.67	63.76	18.72	67.70	5.03	8.0%	3.94	6.2%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$62.67**	**$63.76**	**$18.72**	**$67.70**	**$5.03**	**8.0%**	**$3.94**	**6.2%**
Research Experience for Undergraduates - REU - Sites Only	Research & Related Activities	47.19	47.12	18.72	51.01	3.82	8.1%	3.89	8.3%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$47.19**	**$47.12**	**$18.72**	**$51.01**	**$3.82**	**8.1%**	**$3.89**	**8.3%**
Research Experience for Undergraduates - REU - Supplements Only	Research & Related Activities	15.49	16.64	-	16.69	1.20	7.8%	0.05	0.3%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$15.49**	**$16.64**	-	**$16.69**	**$1.20**	**7.8%**	**$0.05**	**0.3%**
Research in Undergraduate Institutions - RUI	Research & Related Activities	32.91	32.86	2.92	35.16	2.25	6.8%	2.30	7.0%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$32.91**	**$32.86**	**$2.92**	**$35.16**	**$2.25**	**6.8%**	**$2.30**	**7.0%**
Science and Technology Centers - STCs	Research & Related Activities	64.73	61.61	-	57.79	-6.94	-10.7%	-3.82	-6.2%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$64.73**	**$61.61**	-	**$57.79**	**-$6.94**	**-10.7%**	**-$3.82**	**-6.2%**

**Totals may not add due to rounding.*

NSF Funding Profile

Approximately half of the awards supported in a particular fiscal year are competitively reviewed in that year through NSF's merit review process. Other awards are continuations of projects that were competitively reviewed in a prior year.

Statistics for Competitive Awards: The Funding Rate is the number of competitive awards made during a year as a percentage of total proposals competitively reviewed. This indicates the probability of receiving an award when submitting proposals to NSF.

Statistics for Research Grants: Research Grants are grants limited to research projects and exclude other categories of awards that fund infrastructure-type activities, which do not require multi-year support, such as equipment and conference awards. Annualized Award Size shows the annual level of research grants provided to awardees by dividing the total dollars of each award by the number of years over which it extends. Both the average and the median annualized award size for competitively reviewed awards are shown. Average Duration is the length of the award in years.

The Quantitative Data Tables, provided under a separate tab in this submission, are based on all proposals and awards, including competitive awards, contracts, cooperative agreements, supplements, and amendments to existing grants and contracts.

NSF Funding Profile

	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate
Statistics for Competitive Awards			
Number of Proposals	44,415	48,400	49,700
Number of Awards	11,145	15,700	12,850
Regular Appropriation	11,145	11,600	12,850
ARRA[1]	-	4,100	-
Funding Rate	25%	32%	26%
Statistics for Research Grants			
Number of Research Grant Proposals	33,100	35,900	37,100
Number of Research Grant Awards	6,900	10,250	8,200
Regular Appropriation	6,900	7,250	8,200
ARRA[1]	-	3,000	-
Funding Rate	21%	29%	22%
Median Annualized Award Size	$114,700	$119,400	$121,200
Average Annualized Award Size	$142,800	$151,650	$154,600
Average Duration (years)	3.0	3.2	3.0

[1] American Recovery and Reinvestment Act of 2009.

National Science Foundation
NSTC Crosscuts Summary
FY 2010 Budget Request to Congress

(Dollars in Millions)

	Climate Change Technology Program				Climate Change Science Programs Includes U.S. Global Change Research Program Climate Change Research Initiative				Networking and Information Technology Research and Development				National Nanotechnology Initiative			
	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request
BIO	-	-	-	-	$15.10	$15.10	$20.00	$46.00	$83.50	$86.15	-	$93.00	$58.73	$56.60	-	$56.60
CISE	-	-	-	-	-	-	-	-	535.26	573.74	$235.00	633.00	14.51	11.00	-	11.00
ENG	$21.50	$23.50	$2.00	$24.75	1.00	1.00	-	1.00	19.20	20.70	-	23.70	144.45	140.02	$35.00	148.00
GEO	-	-	-	-	157.72	163.00	25.00	209.00	15.56	18.98	-	22.98	10.29	6.33	-	6.33
MPS	-	-	-	-	6.90	6.69	2.67	7.13	76.03	78.93	21.90	86.82	173.73	178.06	72.81	195.86
SBE	-	-	-	-	15.48	15.48	3.00	18.48	22.84	17.00	3.00	22.80	2.25	1.67	-	1.67
OCI	-	-	-	-	-	-	-	-	185.15	199.28	80.00	219.00	-	-	-	-
OISE	-	-	-	-	-	-	-	-	-	-	-	-	0.50	-	-	-
OPP	-	-	-	-	10.50	18.30	44.79	18.30	-	-	-	-	-	-	-	-
IA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R&RA	**$21.50**	**$23.50**	**$2.00**	**$24.75**	**$206.70**	**$219.57**	**$95.46**	**$299.91**	**$937.54**	**$994.78**	**$339.90**	**$1,101.30**	**$404.46**	**$393.68**	**$107.81**	**$419.46**
EHR	-	-	-	-	-	-	-	-	**$9.00**	**$9.50**	-	**$9.50**	**$4.10**	**$3.50**	-	**$3.50**
NSF Total	**$21.50**	**$23.50**	**$2.00**	**$24.75**	**$206.70**	**$219.57**	**$95.46**	**$299.91**	**$946.54**	**$1,004.28**	**$339.90**	**$1,110.80**	**$408.56**	**$397.18**	**$107.81**	**$422.96**

National Science Foundation
Homeland Security Activities Summary
FY 2010 Budget Request to Congress

(Dollars in Millions)

	BIO	CISE	ENG	GEO	MPS	SBE	OPP	IA	R&RA	EHR	AOAM	Total, NSF
FY 2008 Actual	**$15.00**	**$159.80**	**$159.50**	**-**	**$8.57**	**$4.50**	**$3.05**	**$2.00**	**$352.42**	**$11.37**	**$2.30**	**$366.09**
Protecting Critical Infrastructure & Key Assets	-	**159.80**	**159.50**	-	**8.57**	**4.50**	**3.05**	**2.00**	**$337.42**	**$11.37**	**$2.30**	**$351.09**
Antarctic Security	-	-	-	-	-	-	0.30	-	0.30	-	-	0.30
Counterterrorism	-	27.00	-	-	-	-	-	-	27.00	-	-	27.00
Cybersecurity	-	103.50	3.20	-	0.20	-	-	-	106.90	-	-	106.90
Electronic Commerce	-	4.50	3.50	-	-	-	-	-	8.00	-	-	8.00
Emergency Planning & Response	-	24.80	26.00	-	5.52	-	-	-	56.32	-	-	56.32
Energy Supply Assurance	-	-	29.00	-	1.30	-	-	-	30.30	-	-	30.30
IT Security	-	-	-	-	-	-	2.75	2.00	4.75	-	2.30	7.05
Resilient Infrastructure (Risk Mgmt, Modeling, Simul)	-	-	97.80	-	1.55	4.50	-	-	103.85	-	-	103.85
Scholarships for Service / Cybercorps	-	-	-	-	-	-	-	-	-	11.37	-	11.37
Defending Against Catastrophic Threats	**$15.00**	-	-	-	-	-	-	-	**$15.00**	-	-	**$15.00**
Research to Combat Bioterrorism	15.00	-	-	-	-	-	-	-	15.00	-	-	15.00
Microbial Genomics, Analysis & Modeling	*15.00*	-	-	-	-	-	-	-	*15.00*	-	-	*15.00*
FY 2009 Current Plan	**$15.00**	**$169.80**	**$160.00**	**-**	**$6.00**	**$4.50**	**$2.68**	**-**	**$357.98**	**$15.00**	**$4.25**	**$377.23**
Protecting Critical Infrastructure & Key Assets	-	**169.80**	**160.00**	-	**6.00**	**4.50**	**2.68**	-	**$342.98**	**$15.00**	**$4.25**	**$362.23**
Antarctic Security	-	-	-	-	-	-	0.28	-	0.28	-	-	0.28
Counterterrorism	-	27.00	-	-	-	-	-	-	27.00	-	-	27.00
Cybersecurity	-	113.50	3.20	-	-	-	-	-	116.70	-	-	116.70
Electronic Commerce	-	4.50	3.50	-	-	-	-	-	8.00	-	-	8.00
Emergency Planning & Response	-	24.80	26.00	-	3.60	-	-	-	54.40	-	-	54.40
Energy Supply Assurance	-	-	29.00	-	1.00	-	-	-	30.00	-	-	30.00
IT Security	-	-	-	-	-	-	2.40	-	2.40	-	4.25	6.65
Resilient Infrastructure (Risk Mgmt, Modeling, Simul)	-	-	98.30	-	1.40	4.50	-	-	104.20	-	-	104.20
Scholarships for Service / Cybercorps	-	-	-	-	-	-	-	-	-	15.00	-	15.00
Defending Against Catastrophic Threats	**$15.00**	-	-	-	-	-	-	-	**$15.00**	-	-	**$15.00**
Research to Combat Bioterrorism	15.00	-	-	-	-	-	-	-	15.00	-	-	15.00
Microbial Genomics, Analysis & Modeling	*15.00*	-	-	-	-	-	-	-	*15.00*	-	-	*15.00*
FY 2009 ARRA Estimate	**-**	**$20.00**	**$7.00**	**-**	**$2.40**	**-**	**-**	**-**	**$29.40**	**-**	**-**	**$29.40**
Protecting Critical Infrastructure & Key Assets	-	**20.00**	**7.00**	-	**2.40**	-	-	-	**$29.40**	-	-	**$29.40**
Cybersecurity	-	20.00	-	-	-	-	-	-	20.00	-	-	20.00
Emergency Planning & Response	-	-	1.00	-	1.50	-	-	-	2.50	-	-	2.50
Energy Supply Assurance	-	-	1.00	-	0.50	-	-	-	1.50	-	-	1.50
Resilient Infrastructure (Risk Mgmt, Modeling, Simul)	-	-	5.00	-	0.40	-	-	-	5.40	-	-	5.40
Increment from FY 2009 Current Plan to FY 2010 Request	**-**	**$10.00**	**$0.50**	**-**	**-$2.73**	**-**	**-**	**-**	**$7.77**	**-**	**$0.50**	**$8.27**
Protecting Critical Infrastructure & Key Assets	-	**10.00**	**0.50**	-	**-2.73**	-	-	-	**$7.77**	-	**0.50**	**$8.27**
Antarctic Security	-	-	-	-	-	-	-	-	-	-	-	-
Counterterrorism	-	-	-	-	-	-	-	-	-	-	-	-
Cybersecurity	-	10.00	-	-	-	-	-	-	10.00	-	-	10.00
Electronic Commerce	-	-	-	-	-	-	-	-	-	-	-	-
Emergency Planning & Response	-	-	0.30	-	-0.33	-	-	-	-0.03	-	-	-0.03
Energy Supply Assurance	-	-	-	-	-1.00	-	-	-	-1.00	-	-	-1.00
IT Security	-	-	-	-	-	-	-	-	-	-	0.50	0.50
Resilient Infrastructure (Risk Mgmt, Modeling, Simul)	-	-	0.20	-	-1.40	-	-	-	-1.20	-	-	-1.20
Scholarships for Service / Cybercorps	-	-	-	-	-	-	-	-	-	-	-	-
Defending Against Catastrophic Threats	-	-	-	-	-	-	-	-	-	-	-	-
Research to Combat Bioterrorism	-	-	-	-	-	-	-	-	-	-	-	-
Microbial Genomics, Analysis & Modeling	-	-	-	-	-	-	-	-	-	-	-	-
FY 2010 Request	**$15.00**	**$179.80**	**$160.50**	**-**	**$3.27**	**$4.50**	**$2.68**	**-**	**$365.75**	**$15.00**	**$4.75**	**$385.50**
Protecting Critical Infrastructure & Key Assets	-	**179.80**	**160.50**	-	**3.27**	**4.50**	**2.68**	-	**$350.75**	**$15.00**	**$4.75**	**$370.50**
Antarctic Security	-	-	-	-	-	-	0.28	-	0.28	-	-	0.28
Counterterrorism	-	27.00	-	-	-	-	-	-	27.00	-	-	27.00
Cybersecurity	-	123.50	3.20	-	-	-	-	-	126.70	-	-	126.70
Electronic Commerce	-	4.50	3.50	-	-	-	-	-	8.00	-	-	8.00
Emergency Planning & Response	-	24.80	26.30	-	3.27	-	-	-	54.37	-	-	54.37
Energy Supply Assurance	-	-	29.00	-	-	-	-	-	29.00	-	-	29.00
IT Security	-	-	-	-	-	-	2.40	-	2.40	-	4.75	7.15
Resilient Infrastructure (Risk Mgmt, Modeling, Simul)	-	-	98.50	-	-	4.50	-	-	103.00	-	-	103.00
Scholarships for Service / Cybercorps	-	-	-	-	-	-	-	-	-	15.00	-	15.00
Defending Against Catastrophic Threats	**$15.00**	-	-	-	-	-	-	-	**$15.00**	-	-	**$15.00**
Research to Combat Bioterrorism	15.00	-	-	-	-	-	-	-	15.00	-	-	15.00
Microbial Genomics, Analysis & Modeling	*15.00*	-	-	-	-	-	-	-	*15.00*	-	-	*15.00*

NSF Programs to Broaden Participation
FY 2010 Budget Request to Congress

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	FY 2010 Request change over: FY 2008 Amount	FY 2008 Percent	FY 2009 Amount	FY 2009 Percent
ADVANCE	$20.06	$20.79	$1.00	$21.02	$0.96	4.8%	$0.23	1.1%
ADVANCE - R&RA	*19.56*	*19.54*	*1.00*	*19.49*	*-0.07*	*-0.4%*	*-0.05*	*-0.3%*
ADVANCE - EHR	*0.49*	*1.25*	-	*1.53*	*1.04*	*209.2%*	*0.28*	*22.4%*
Advanced Technology Education (ATE)	51.46	51.62	-	64.00	12.54	24.4%	12.38	24.0%
Alliances for Graduate Education and the Professoriate (AGEP)	15.85	16.75	-	16.75	0.90	5.7%	-	-
Broadening Participation in Computing (BPC)	14.00	14.00	-	14.00	-	-	-	-
Broadening Participation in the Biological Sciences - BIO	4.77	5.20	-	5.20	0.43	8.9%	-	-
Centers of Research Excellence in Science and Technology (CREST)	24.95	30.53	5.00	30.53	5.58	22.3%	-	-
CREST - R&RA	-	-	*5.00*	-	-	*N/A*	-	*N/A*
CREST - EHR	*24.95*	*30.53*	-	*30.53*	*5.58*	*22.3%*	-	-
Cyberinfrastructure Training, Education, Advancement and Mentoring (CI-TEAM)	9.90	-	-	7.00	-2.90	-29.3%	7.00	N/A
Experimental Program to Stimulate Competitive Research (EPSCoR)	120.00	133.00	50.00	147.12	27.12	22.6%	14.12	10.6%
GEO LSAMP Linkages	1.00	1.00	-	1.00	0.00	0.0%	-	-
Graduate Research Diversity (GRD) - ENG	-	0.75	-	1.50	1.50		0.75	100.0%
Graduate Research Fellowships - Women in Engineering and Computer Science	8.13	13.80	7.94	14.00	5.87	72.3%	0.20	1.4%
H-1B Nonimmigrant Petitioner Fee programs	121.12	100.00	-	100.00	-21.12	-17.4%	-	-
Historically-Black Colleges and Universities-Undergraduate Program (HBCU-UP)	29.74	31.50	-	32.00	2.26	7.6%	0.50	1.6%
Informal Science Education (ISE)	64.45	66.00	-	66.00	1.55	2.4%	-	-
Integrating Research & Education in Cyberinfrastucture (IREC)	-	2.00	-	2.00	*2.00*	*N/A*	-	-
Louis Stokes Alliances for Minority Participation (LSAMP)	40.47	42.50	-	44.75	4.28	10.6%	2.25	5.3%
Math and Science Partnership (MSP)	47.87	61.00	25.00	58.22	10.35	21.6%	-2.78	-4.6%
Mentoring in Biology	5.09	5.00	3.00	15.00	9.91	194.4%	10.00	200.0%
Minority Post-Docs	3.62	3.50	3.00	3.50	-0.12	-3.3%	-	-
BIO Minority Post-Docs	*3.08*	*2.50*	*3.00*	*2.50*	*-0.58*	*-18.8%*	-	-
SBE Minority Post-Docs	*0.54*	*1.00*	-	*1.00*	*0.46*	*85.2%*	-	-
Next Generation Workforce (NGW) - SBE	1.00	1.00	-	1.00	0.00	0.0%	-	-
Noyce Scholarships	55.05	55.00	60.00	55.00	-0.05	-0.1%	-	-
OISE Broadening Participation	-	1.00	0.50	1.00	1.00		-	-
Opportunities to Enhance Diversity in the Geosciences (OEDG)	4.57	4.60	7.00	4.60	0.03	0.7%	-	-
Partnerships for Innovation (PFI)	9.19	9.19	-	9.19	0.00	0.0%	-	-
Partnerships for Research and Education in Materials (PREM) - MPS	5.08	7.00	11.00	5.70	0.62	12.2%	-1.30	-18.6%
Research in Disabilities Education (RDE)	5.93	6.50	-	6.50	0.57	9.6%	-	-
Research on Gender in Science and Engineering (GSE)	10.13	11.50	-	11.50	1.37	13.5%	-	-
Research Partnerships for Diversity (RPD) - MPS	1.00	1.00	-	1.00	-	-	-	-
Science, Technology, Engineering and Math Talent Expansion Program (STEP)	29.48	29.70	-	32.53	3.05	10.4%	2.83	9.5%
STEP - R&RA	-	-	-	*1.00*	*1.00*	*N/A*	*1.00*	*N/A*
STEP - EHR	*29.48*	*29.70*	-	*31.53*	*2.05*	*7.0%*	*1.83*	*6.2%*
Significant Opportunities in Atmospheric Research and Science (SOARS) - GEO	0.51	0.51	-	0.60	0.09	17.6%	0.09	17.6%
Tribal Colleges and Universities Program (TCUP)	12.80	13.50	-	13.35	0.55	4.3%	-0.15	-1.1%
Undergraduate Research Collaboratives (URC) - MPS	2.63	2.16	-	1.00	-1.63	-61.9%	-1.16	-53.7%
Subtotal, R&RA	**$210.05**	**$224.25**	**$88.44**	**$254.90**	**$44.85**	**21.4%**	**$30.65**	**13.7%**
Subtotal, EHR	**$418.15**	**$447.05**	**$85.00**	**$464.19**	**$46.04**	**11.0%**	**$17.14**	**3.8%**
Subtotal, H-1B Nonimmigrant Petitioner Fees	**$121.12**	**$100.00**	-	**$100.00**	**-$21.12**	**-17.4%**	-	-
TOTAL, NSF	**$749.32**	**$771.30**	**$173.44**	**$819.09**	**$69.77**	**9.3%**	**$47.79**	**6.2%**

Please note that this table displays a subset of the overall Broadening Participation portfolio. This list comprises the standard set of programs that have been historically tracked as Broadening Participation for budget purposes.

National Science Foundation
Learning Funding by Level of Education
FY 2010 Budget Request to Congress

(Dollars in Millions)

					FY 2010 Request change over:			
					FY 2008 Actual		FY 2009 Plan	
	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Amount	Percent	Amount	Percent
K-12 Programs	$47.47	$60.13	$25.00	$57.29	$9.82	20.7%	-$2.84	-4.7%
Undergraduate Programs	348.27	369.74	94.47	399.20	50.93	14.6%	29.46	8.0%
Graduate & Professional Programs	302.04	315.83	107.42	335.37	33.33	11.0%	19.54	6.2%
Multi-level and Other Programs	150.96	151.01	34.89	170.28	19.32	12.8%	19.27	12.8%
TOTAL, NSF	**$848.74**	**$896.71**	**$261.78**	**$962.14**	**$113.40**	**13.4%**	**$65.43**	**7.3%**

Number of People Involved in NSF Activities

Estimates are that in FY 2010 over 215,000 people will be directly involved in NSF programs and activities, receiving salaries, stipends, or participant support. Also, NSF programs indirectly impact millions of people. These programs reach K-12 students and teachers, the general public, and researchers through activities including workshops; informal science activities such as museums, television, videos, and journals; outreach efforts; and dissemination of improved curriculum and teaching methods.

Number of People Involved in NSF Activities

	FY 2008 Estimate	FY 2009 Estimate	FY 2009 ARRA[1] Estimate	FY 2010 Estimate
Senior Researchers	43,019	45,290	12,910	48,850
Other Professionals	12,499	13,030	4,160	14,020
Postdoctoral Associates	6,013	6,480	1,990	7,190
Graduate Students	37,308	39,110	12,405	42,780
Undergraduate Students	24,407	25,210	6,275	27,000
K-12 Teachers	62,375	62,405	1,165	62,465
K-12 Students	12,801	12,760	570	12,790
Total, Number of People	198,422	204,285	39,475	215,095

[1] American Recovery and Reinvestment Act of 2009.

Senior Researchers include scientists, mathematicians, engineers, and educators receiving funding through NSF awards. These include both researchers who are principal or co-principal investigators on research and education projects, and researchers working at NSF-supported centers and facilities.

Other Professionals are individuals who may or may not hold a doctoral degree or its equivalent, are considered professionals but are not reported as senior researchers, postdoctoral associates, or students. Examples are technicians, systems experts, etc.

Postdoctoral Associates are individuals who have received Ph.D., M.D., D.Sc., or equivalent and are not faculty members of the performing institution. About 98 percent are supported through funds included in research projects, centers, or facilities awards. Others are recipients of postdoctoral fellowships.

Graduate Students include those compensated from NSF grant funds. About 12 percent receive support through programs such as NSF Graduate Research Fellowships and NSF Graduate STEM Fellowships in K-12 Education. The balance assists senior researchers or postdoctoral associates in performing research and are supported through funds included in research projects, centers, or facilities awards. NSF provides support for about five percent of the science and engineering graduate students in the U.S.

Undergraduate Students include students enrolled in technical colleges or baccalaureate programs compensated from NSF grant funds. They may be assisting senior researchers or postdoctoral associates in performing research, or participating in NSF programs aimed at undergraduate students, such as Research Experiences for Undergraduates and the Louis Stokes Alliances for Minority Participation.

K-12 Students are those attending elementary, middle, and secondary schools. They are supported through program components that directly engage students in science and mathematics experiences.

K-12 Teachers include teachers at elementary, middle, and secondary schools. These individuals actively participate in intensive professional development experiences in the sciences and mathematics.

NSF By Account

(Actual Dollars in Millions - Current Dollars)

Fiscal Year	Research & Related Activities	Education & Human Resources	Academic Research Infrastructure[1]	Major Research Equipment & Facilities Construction	Agency Operations & Award Management	Office of Inspector General	National Science Board	NSF
1951	0.03	-	-	-	0.13	-	-	0.15
1952	1.40	1.54	-	-	0.53	-	-	3.47
1953	2.14	1.41	-	-	0.88	-	-	4.43
1954	4.52	1.89	-	-	1.55	-	-	7.96
1955	8.86	2.08	-	-	1.55	-	-	12.49
1956	10.79	3.52	-	-	1.68	-	-	15.99
1957	21.98	14.30	-	-	2.35	-	-	38.63
1958	27.37	19.21	-	-	2.93	-	-	49.51
1959	66.33	61.29	-	-	5.26	-	-	132.88
1960	88.35	63.74	-	-	6.51	-	-	158.60
1961	103.98	63.44	-	-	7.57	-	-	174.99
1962	173.26	78.58	-	-	8.98	-	-	260.82
1963	218.90	90.99	-	-	10.87	-	-	320.75
1964	239.95	102.58	-	-	12.05	-	-	354.58
1965	282.44	120.41	-	-	13.12	-	-	415.97
1966	328.63	124.31	-	-	13.09	-	-	466.02
1967	327.70	123.36	-	-	14.04	-	-	465.10
1968	350.20	134.71	-	-	15.38	-	-	500.29
1969	292.90	123.11	-	-	16.49	-	-	432.50
1970	316.41	126.41	-	-	19.68	-	-	462.49
1971	369.37	105.00	-	-	21.77	-	-	496.14
1972	482.43	93.73	-	-	24.56	-	-	600.72
1973	519.42	62.23	-	-	28.62	-	-	610.27
1974	533.29	80.71	-	-	31.66	-	-	645.65
1975	581.23	74.03	-	-	37.87	-	-	693.13
1976	619.72	62.48	-	-	42.23	-	-	724.42
1977	671.98	74.26	-	-	45.53	-	-	791.77
1978	734.69	73.86	-	-	48.70	-	-	857.25
1979	791.76	80.41	-	-	54.77	-	-	926.93
1980	836.83	80.06	-	-	58.24	-	-	975.13
1981	900.36	75.70	-	-	59.21	-	-	1,035.27
1982	909.75	26.20	-	-	63.18	-	-	999.14
1983	1,013.02	22.98	-	-	65.70	-	-	1,101.69
1984	1,177.70	62.97	-	-	66.26	-	-	1,306.92
1985	1,344.56	90.56	-	-	71.95	-	-	1,507.07
1986	1,329.64	91.69	-	-	71.84	-	-	1,493.17
1987	1,439.97	109.88	-	-	77.77	-	-	1,627.62
1988	1,481.31	156.79	-	-	84.47	-	-	1,722.57
1989	1,600.53	194.06	-	-	91.29	-	-	1,885.88
1990	1,696.56	230.41	0.41	-	96.35	2.33	-	2,026.06
1991	1,868.45	331.91	39.02	-	101.23	2.89	-	2,343.49
1992	1,940.48	459.44	33.36	-	109.99	3.86	-	2,547.13
1993	2,046.31	505.06	49.75	34.07	110.84	3.69	-	2,749.73
1994	2,168.36	569.03	105.38	17.04	123.49	3.92	-	2,987.21
1995	2,281.46	611.88	117.46	126.00	129.01	4.46	-	3,270.27
1996	2,327.80	601.16	70.89	70.00	132.50	3.98	-	3,206.33
1997	2,433.93	619.14	30.02	76.13	134.27	5.33	-	3,298.82
1998	2,572.62	633.16	-	78.21	136.95	4.80	-	3,425.73
1999	2,821.61	662.48	-	56.71	144.08	5.41	-	3,690.28
2000	2,979.90	683.58	-	105.00	149.28	5.60	-	3,923.36
2001	3,372.30	795.42	-	119.24	166.33	6.58	-	4,459.87
2002	3,615.97	866.11	-	115.35	169.93	6.70	-	4,774.06
2003	4,054.43	934.88	-	179.03	189.42	8.70	2.88	5,369.34
2004	4,293.34	944.10	-	183.96	218.92	9.47	2.22	5,652.01
2005	4,234.82	843.54	-	165.14	223.45	10.17	3.65	5,480.77
2006	4,351.03	798.48	-	233.81	247.06	11.47	3.94	5,645.79
2007	4,656.33	797.76	-	166.21	248.49	11.92	3.65	5,884.37
2008	4,853.25	766.26	-	166.85	282.04	11.83	3.82	6,084.04
2009 Current Plan	5,183.10	845.26	-	152.01	294.00	12.00	4.03	6,490.40
2009 ARRA	2,500.00	100.00	*[200.00]*	400.00	-	2.00	-	3,002.00
2010 Request	5,733.24	857.76	-	117.29	318.37	14.00	4.34	7,045.00

[1] Funding for the Academic Research Infrastructure program is included in the Research and Related Activities account for the American Recovery and Reinvestment Act of 2009.

NSF By Account

(FY Actuals - FY 2009 Constant Dollars in Millions)

Fiscal Year	Research & Related Activities	Education & Human Resources	Academic Research Infrastructure[1]	Major Research Equipment & Facilities Construction	Agency Operations & Award Management	Office of Inspector General	National Science Board	NSF
1951	0.19	-	-	-	0.90	-	-	1.09
1952	9.74	10.69	-	-	3.68	-	-	24.11
1953	14.58	9.61	-	-	5.97	-	-	30.16
1954	30.45	12.73	-	-	10.41	-	-	53.59
1955	59.17	13.89	-	-	10.32	-	-	83.38
1956	70.21	22.90	-	-	10.93	-	-	104.05
1957	137.83	89.67	-	-	14.74	-	-	242.25
1958	166.62	116.89	-	-	17.85	-	-	301.36
1959	397.51	367.30	-	-	31.52	-	-	796.33
1960	523.16	377.43	-	-	38.54	-	-	939.13
1961	607.01	370.36	-	-	44.19	-	-	1,021.57
1962	1,000.25	453.64	-	-	51.83	-	-	1,505.72
1963	1,248.05	518.76	-	-	61.95	-	-	1,828.77
1964	1,351.96	577.97	-	-	67.91	-	-	1,997.84
1965	1,564.41	666.95	-	-	72.66	-	-	2,304.02
1966	1,782.14	674.14	-	-	70.98	-	-	2,527.26
1967	1,721.56	648.07	-	-	73.78	-	-	2,443.41
1968	1,776.72	683.44	-	-	78.02	-	-	2,538.18
1969	1,421.07	597.30	-	-	80.01	-	-	2,098.38
1970	1,455.62	581.54	-	-	90.52	-	-	2,127.68
1971	1,618.42	460.07	-	-	95.38	-	-	2,173.87
1972	2,018.51	392.17	-	-	102.77	-	-	2,513.45
1973	2,081.51	249.38	-	-	114.69	-	-	2,445.58
1974	1,993.21	301.66	-	-	118.32	-	-	2,413.20
1975	1,967.76	250.63	-	-	128.20	-	-	2,346.59
1976	1,956.87	197.29	-	-	133.34	-	-	2,287.50
1977	1,974.03	218.15	-	-	133.75	-	-	2,325.93
1978	2,022.11	203.30	-	-	134.02	-	-	2,359.43
1979	2,016.70	204.80	-	-	139.50	-	-	2,361.00
1980	1,959.70	187.49	-	-	136.39	-	-	2,283.57
1981	1,920.42	161.46	-	-	126.28	-	-	2,208.16
1982	1,816.15	52.31	-	-	126.13	-	-	1,994.58
1983	1,936.79	43.93	-	-	125.61	-	-	2,106.33
1984	2,171.51	116.10	-	-	122.17	-	-	2,409.77
1985	2,401.21	161.72	-	-	128.49	-	-	2,691.43
1986	2,320.57	160.02	-	-	125.37	-	-	2,605.97
1987	2,449.19	186.89	-	-	132.27	-	-	2,768.35
1988	2,442.66	258.55	-	-	139.28	-	-	2,840.49
1989	2,540.54	308.03	-	-	144.90	-	-	2,993.47
1990	2,596.52	352.63	0.63	-	147.46	3.56	-	3,100.80
1991	2,756.13	489.59	57.56	-	149.32	4.26	-	3,456.85
1992	2,792.16	661.09	48.00	-	158.27	5.55	-	3,665.07
1993	2,879.15	710.62	70.00	47.94	155.95	5.19	-	3,868.84
1994	2,986.65	783.78	145.14	23.47	170.09	5.39	-	4,114.53
1995	3,077.67	825.42	158.45	169.97	174.04	6.02	-	4,411.57
1996	3,081.02	795.68	93.83	92.65	175.37	5.26	-	4,243.82
1997	3,166.22	805.42	39.05	99.04	174.67	6.93	-	4,291.33
1998	3,306.52	813.78	-	100.52	176.01	6.17	-	4,402.99
1999	3,579.54	840.43	-	71.94	182.78	6.86	-	4,681.56
2000	3,705.51	850.03	-	130.57	185.63	6.96	-	4,878.70
2001	4,096.77	966.30	-	144.86	202.06	7.99	-	5,417.98
2002	4,310.26	1,032.41	-	137.50	202.56	7.99	-	5,690.71
2003	4,737.09	1,092.29	-	209.17	221.31	10.16	3.36	6,273.39
2004	4,888.98	1,075.08	-	209.48	249.29	10.78	2.53	6,436.15
2005	4,672.58	930.74	-	182.21	246.55	11.22	4.03	6,047.33
2006	4,643.41	852.14	-	249.52	263.66	12.24	4.20	6,025.18
2007	4,836.81	828.69	-	172.65	258.12	12.38	3.79	6,112.45
2008	4,924.12	777.45	-	169.28	286.16	12.00	3.88	6,172.90
2009 Current Plan	5,183.10	845.26	-	152.01	294.00	12.00	4.03	6,490.40
2009 ARRA	2,500.00	100.00	*[200.00]*	400.00	-	2.00	-	3,002.00
2010 Request	5,676.18	849.22	-	116.12	315.20	13.86	4.30	6,974.89

[1] Funding for the Academic Research Infrastructure program is included in the Research and Related Activities account for the American Recovery and Reinvestment Act of 2009.

NSF AUTHORIZATIONS

NSF FY 2010 Current Authorizations……….…………………………………......…NSF Authorizations – 3

Report Required by Sec. 1008(c), P.L. 110-69……...………………...……...…….NSF Authorizations – 5

National Science Foundation Current Authorizations

LEGISLATION	FY 2008 Actual	Authorization Levels FY 2008	FY 2009	FY 2010	FY 2009 Enacted
			(Dollars in Millions)		
National Science Foundation Act of 1950 (P.L.81-507)[1]					
Scholarships and Graduate Fellowships		*within limits of funds made available for this purpose*			
General Authority		*within the limits of available appropriations*			
Administering Provisions		*to make such expenditures as may be necessary*			
International Cooperation and Coordination with Foreign Policy		*within the limit of appropriated funds*			
Contract Arrangements		*utilize appropriations available*			
America COMPETES Act (P.L.110-69)[2]	**$6,084.04**	**$6,600.00**	**$7,326.00**	**$8,132.00**	**$6,490.40**
Account and Program Specific					
Research and Related Activities	**$4,853.25**	**$5,156.00**	**$5,742.30**	**$6,401.00**	**$5,183.10**
Experimental Program to Stimulate Competitive Research	*$120.00*	*$120.00*	*$133.20*	*$147.80*	*$133.00*
Faculty Early Career Development (CAREER) Program	*$203.17*	*$165.40*	*$183.60*	*$203.80*	*$182.63*
Graduate Research Fellowship Program	*$8.13*	*$9.00*	*$10.00*	*$11.10*	*$8.06*
Integrative Graduate Education and Research Traineeship Program	*$39.47*	*$47.30*	*$52.50*	*$58.30*	*$38.20*
Major Research Instrumentation	*$93.87*	*$115.00*	*$123.10*	*$131.70*	*$100.00*
Professional Science Master's Degree Program	-	*$10.00*	*$12.00*	*$15.00*	-
Research Experiences for Undergraduates	*$62.68*	*$61.60*	*$68.40*	*$75.90*	*$63.76*
Education and Human Resources	**$766.26**	**$896.00**	**$995.00**	**$1,104.00**	**$845.26**
Advanced Technology Education	*$51.46*	*$52.00*	*$57.70*	*$64.00*	*$51.62*
Graduate Research Fellowship Program	*$87.89*	*$96.60*	*$107.20*	*$119.00*	*$107.00*
Integrative Graduate Education and Research Traineeship Program	*$25.29*	*$27.10*	*$30.10*	*$33.40*	*$25.00*
Mathematics and Science Education Partnerships	*$47.87*	*$100.00*	*$111.00*	*$123.20*	*$61.00*
Science, Mathematics, Engineering, and Technology Talent Expansion Program	*$29.48*	*$40.00*	*$50.00*	*$55.00*	*$29.70*
Robert Noyce Scholarship Program	*$55.05*	*$89.80*	*$115.00*	*$140.50*	*$55.00*
Major Research Equipment and Facilities Construction	**$166.85**	**$245.00**	**$262.00**	**$280.00**	**$152.01**
Agency Operations and Award Management	**$282.04**	**$285.60**	**$309.76**	**$329.45**	**$294.00**
National Science Board	**$3.83**	**$4.05**	**$4.19**	**$4.34**	**$4.03**
Office of the Inspector General	**$11.83**	**$12.35**	**$12.75**	**$13.21**	**$12.00**

LEGISLATION (cont.)	FY 2008 Actual	Authorization Levels FY 2008	FY 2009	FY 2010	FY 2009 Enacted
21st Century Nanotechnology Research and Development Act (P.L.108-153)					
Nanoscale Science and Engineering	**$408.56**	**$476.00**			
National Earthquake Hazards Reduction Program Reauthorization Act of 2003 (P.L.108-360)	**$53.60**	**$41.52**	**$42.77**		**$55.00**
National Windstorm Impact Reduction Act of 2004 (P.L.108-360)	**$16.60**	**$9.40**			*****
Consolidated Appropriations Act, 2001 (P.L.106-554); Small Business Technology Transfer Program Reauthorization Act of 2001 (P.L.107-50)					
Small Business Innovation Research (SBIR) Program [3]	*$97.51*	*2.5% of research funds (SBIR)*			*$106.59*
Small Business Technology Transfer (STTR) Program [4]	*$11.56*	*0.3% of research funds (STTR)*			*$12.62*

[1] Organic language establishing NSF, authorization and appropriation language may not correspond to current accounts and programs.
[2] Authorizes agency funding for FYs 2008-10; authorizes agency, account, and various program levels.
[3] SBIR is authorized through July 31st, 2009.
[4] STTR is authorized through September 31, 2009.
* Actual amounts will be reported after awards are completed.

REPORT REQUIRED BY SEC. 1008(c), P.L. 110-69: HIGH-RISK, HIGH-REWARD BASIC RESEARCH

This is a report on the National Science Foundation's (NSF's) support of basic research that can be considered high-risk, high reward that: meets fundamental technological or scientific challenges, involves multidisciplinary work, and involves a high degree of novelty.

Given that the Foundation's vision is "*Advancing discovery, innovation and education beyond the frontiers of current knowledge, and empowering future generations in science and engineering*" (NSF FY 2006-2011 Strategic Plan), support for such research is an integral component of NSF's programs. High-risk, high reward research or potentially transformative research (PTR) is central to the vision of the National Science Foundation (NSF). Congress, the National Science Board, and the scientific community all want to ensure NSF's support for PTR remains strong.

The FY 2010 Budget Request includes approximately $92.0 million to leverage activities across the research directorates and offices aimed at increasing support for transformative research. Examples of potential foci for these investments include innovative processes for identifying potentially transformative research, special solicitations and competitions, increased use of specialized funding mechanisms, notably NSF's EAGER (EArly-concept Grants for Exploratory Research), establishing collaboratories, employing sandpits (a process that couples novel/high-risk research project development with real-time peer review), and exploring novel processes for problem solving.

NSF's previous Sec. 1008(c) submission noted that NSF has: modified the intellectual merit review criterion to include potentially transformative concepts; established the NSF-wide Facilitating Transformative and Interdisciplinary Research (FacTIR) working group; and established an operational definition of transformative research. Since then, NSF has implemented an additional funding mechanism, EAGER, to support PTR and is providing training to new program officers on the importance of supporting PTR as part of a balanced awards portfolio. The EAGER mechanism is contained in the January 2009 version of the NSF Grant Proposal Guide (GPG). NSF is monitoring the implementation of this new funding mechanism closely and will make modifications as indicated by use data. Specifically, the GPG states:

> *The EAGER funding mechanism may be used to support exploratory work in its early stages on untested, but potentially transformative, research ideas or approaches. This work may be considered especially "high risk-high payoff" in the sense that it, for example, involves radically different approaches, applies new expertise, or engages novel disciplinary or interdisciplinary perspectives. These exploratory proposals may also be submitted directly to an NSF program, but the EAGER mechanism should not be used for projects that are appropriate for submission as "regular" (i.e., non-EAGER) NSF proposals. PI(s) must contact the NSF program officer(s) whose expertise is most germane to the proposal topic prior to submission of an EAGER proposal. This will aid in determining the appropriateness of the work for consideration under the EAGER mechanism; this suitability must be assessed early in the process.*
>
> - *The Project Description is expected to be brief (five to eight pages) and include clear statements as to why this project is appropriate for EAGER funding, including why it does not "fit" into existing programs and why it is a "good fit" for EAGER. Note this proposal preparation instruction deviates from the standard proposal preparation instructions contained in this Guide; EAGER proposals must otherwise be compliant with the GPG.*
> - *The box for "EAGER" must be checked on the Cover Sheet.*

- *Only internal merit review is required for EAGER proposals. Under rare circumstances, program officers may elect to obtain external reviews to inform their decision. If external review is to be obtained, then the PI will be so informed in the interest of maintaining the transparency of the review and recommendation process. The two standard NSB-approved merit review criteria will apply.*
- *Requests may be for up to $300,000 and of up to two years duration. The award size, however, will be consistent with the project scope and of a size comparable to grants in similar areas.*
- *No-cost extensions, and requests for supplemental funding, will be processed in accordance with standard NSF policies and procedures.*
- *Renewed funding of EAGER awards may be requested only through submission of a proposal that will be subject to full external merit review. Such proposals would be designated as "EAGER renewals."*

High risk, high reward proposals that are multi-disciplinary and involve a high degree of novelty are encouraged and supported through core funding programs. These factors are also expressly considered through NSF's intellectual merit component of our merit review criteria. Additionally, the Foundation provides numerous targeted funding opportunities specifically designed to foster innovation and welcomes such proposals (e.g., Cyber-enabled Discovery and Innovation, Solar Energy Initiative, Emerging Frontiers in Research and Innovation, and Science and Technology Centers).

The Foundation is committed to the support of highly innovative research proposals that have the potential to transform the frontiers of science and engineering. Only by supporting such proposals, can we realize the vision articulated in the Foundation's strategic plan.

RESEARCH AND RELATED ACTIVITIES $5,733,240,000

+$550.14 / 10.6%

The FY 2010 Budget Request for the Research and Related Activities (R&RA) Appropriation is $5,733.24 million, an increase of $550.14 million, or 10.6 percent, above the FY 2009 Current Plan of $5,183.10 million. Support from the R&RA Appropriation enables U.S. leadership and progress across the frontiers of scientific and engineering research and education.

Sustained, targeted investment by NSF in fundamental science and engineering advances discovery and learning and spurs innovation. Such transformational work holds great promise for meeting the myriad social, economic, and environmental challenges faced by both the Nation and the world.

In FY 2010, funding within the broad and flexible R&RA portfolio underscores the President's priorities for science and innovation with a focus on high-risk, potentially transformative research; new faculty and young investigator support; graduate research fellowships; and support for research priorities in global climate change.

Research and Related Activities Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Biological Sciences[1]	$615.62	$655.81	260.00	$733.00	$77.19	11.8%
Computer & Information Science & Engineering[1]	535.26	573.74	235.00	633.00	59.26	10.3%
Engineering[1]	649.49	693.34	265.00	764.52	71.18	10.3%
Geosciences	757.87	807.13	347.00	909.00	101.87	12.6%
Mathematical & Physical Sciences	1,171.13	1,255.96	490.00	1,380.00	124.04	9.9%
Social, Behavioral & Economic Sciences[1]	227.87	240.30	85.00	257.00	16.70	6.9%
Office of Cyberinfrastructure	185.15	199.28	80.00	219.00	19.72	9.9%
Office of International Science & Engineering[2]	47.77	44.03	14.00	49.00	4.97	11.3%
Office of Polar Programs	447.13	470.67	174.00	516.00	45.33	9.6%
Integrative Activities	214.48	241.34	550.00	271.12	29.78	12.3%
U.S. Arctic Research Commission	1.47	1.50	-	1.60	0.10	6.7%
Total, Research & Related Activities	$4,853.24	$5,183.10	$2,500.00	$5,733.24	$550.14	10.6%

Totals may not add due to rounding.

[1] In FY 2010, Science of Learning Centers (SLC) funding is transferred from the Office of Integrative Activities to BIO, CISE, ENG, and SBE. SLC funding is shown in these directorates for all years for comparability.

[2] OISE FY 2008 Actual includes $5.46 million provided to NSF by the U.S. Department of State for an award to the U.S. Civilian Research and Development Foundation. The transfer occurred in FY 2007 and funds were obligated in FY 2008.

RESEARCH AND RELATED ACTIVITIES

Appropriation Language

For necessary expenses in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), and the Act to establish a National Medal of Science (42 U.S.C. 1880-1881); services as authorized by 5 U.S.C. 3109; maintenance and operation of aircraft and purchase of flight services for research support; acquisition of aircraft; and authorized travel; ~~$5,183,100,000~~*$5,733,240,000*, to remain available until September 30, ~~2010,~~*2011*, of which not to exceed ~~$540,000,000~~*$570,000,000* shall remain available until expended for polar research and operations support, and for reimbursement to other Federal agencies for operational and science support and logistical and other related activities for the United States Antarctic program*: Provided* That, from funds specified in the fiscal year ~~2009~~*2010* budget request for icebreaking services, up to $54,000,000 shall be available for the procurement of polar icebreaking services: *Provided further*, That the National Science Foundation shall only reimburse the Coast Guard for such sums as are agreed to according to the existing memorandum of agreement*: Provided further*, That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation~~: *Provided further*, That not less than $133,000,000 shall be available for activities authorized by section 7002(b)(2)(A)(iv) of Public Law 110-69~~.

Research and Related Activities
FY 2010 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Supplemental	Carryover/ Recoveries	Transfers[1]	Rescission	Expired	Total Resources	Obligations Incurred/ Est.
FY 2008 Approp.	$4,821.47	$22.50	$29.67	-$2.24	-$17.17	-0.42	$4,853.81	$4,853.25
FY 2009 Current Plan (CP)	5,183.10	-	0.56	-	-	-	5,183.66	5,183.66
FY 2009 ARRA	2,500.00	-	-	-	-	-	2,500.00	2,500.00
FY 2010 Request	5,733.24	-	-	-	-	-	5,733.24	5,733.24
$ Change from FY 2009 CP								$549.58
% Change from FY 2009 CP								10.6%

Totals may not add due to rounding.
[1]Transferred to the Office of Science Technology Policy (OSTP) for the Science and Technology Policy Institute (STPI).

Explanation of Carryover

Within the **Research and Related Activities (R&RA)** appropriation, $556,677 was carried forward into FY 2009. This amount is from several awards/contracts from various programs that were not ready for obligation in FY 2008.

RESEARCH AND RELATED ACTIVITIES
FY 2010 Performance Highlights

The table below shows the strategic planning and evaluation framework for activities funded through the R&RA appropriation. This framework was established in the NSF Strategic Plan for FY 2006-2011. NSF's strategic outcome goals are assessed annually by the Advisory Committee for GPRA Performance Assessment. Additional details are available in the Performance Information section of this document.

Research and Related Activities
By Strategic Outcome Goal
(Dollars in Millions)

	FY 2008 Actuals	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Discovery	$3,126.65	$3,330.95	$1,597.32	$3,755.16	$424.21	12.7%
Learning	269.20	259.60	161.78	314.00	54.40	21.0%
Research Infrastructure	1,401.24	1,505.03	740.90	1,567.87	62.84	4.2%
Stewardship	56.15	87.52	-	96.21	8.69	9.9%
Total, NSF	$4,853.24	$5,183.10	$2,500.00	$5,733.24	$550.14	10.6%

Totals may not add due to rounding.

BIOLOGICAL SCIENCES

$733,000,000
+$77,190,000 / 11.8%

Biological Sciences Funding
(Dollars in Millions)

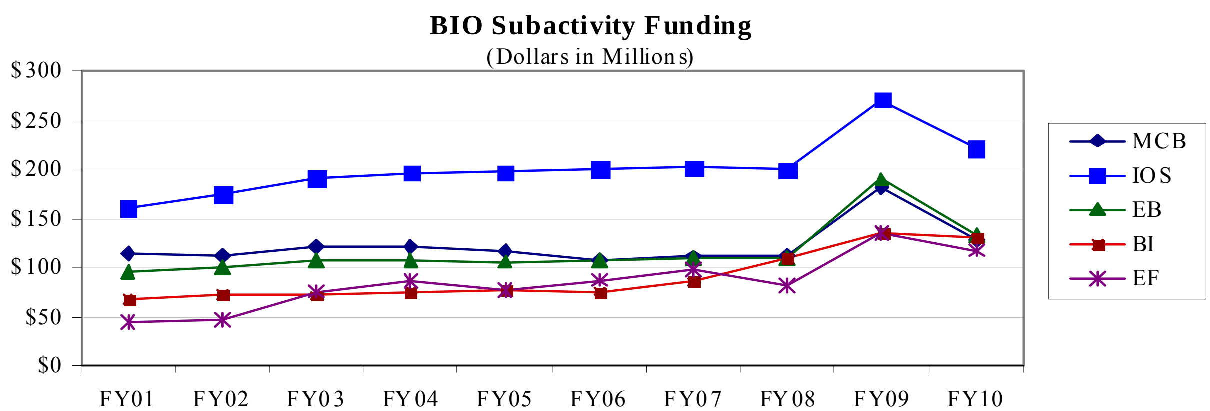
	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Molecular and Cellular Biosciences	$112.28	$121.26	$60.00	$128.83	7.57	6.2%
Integrative Organismal Systems	200.04	211.62	60.00	221.84	10.22	4.8%
Environmental Biology	110.71	120.38	70.00	133.92	13.54	11.2%
Biological Infrastructure [1]	109.86	116.80	20.00	130.14	13.34	11.4%
Emerging Frontiers [2]	82.73	85.75	50.00	118.27	32.52	37.9%
Total, BIO	**$615.62**	**$655.81**	**$260.00**	**$733.00**	**$77.19**	**11.8%**
Major Components:						
Research and Education Grants	491.78	523.99	245.00	590.11	66.12	12.6%
Instrumentation/Research Resources	99.80	104.00	15.00	110.00	6.00	5.8%
Centers Programs	24.04	27.82	-	32.89	5.07	18.2%

Totals may not add due to rounding.

[1/] Funding for the Science of Learning Center (SLC) within the Division for Biological Infrastructure is included for all years for comparability. SLC will be cofunded with the Directorate for Social, Behavioral and Economic Sciences beginning in FY 2010.

[2/] In FY 2010, all centers are shifted from Emerging Frontiers to Biological Infrastructure. Funding is included in Biological Infrastructure for all years for comparability.

The mission of the Directorate for Biological Sciences (BIO) is to enable discoveries for understanding life. Through its investments in innovative and transformative research, BIO advances the frontiers of knowledge in the life sciences by increasing our understanding of complex living systems. BIO supported projects also provide the theoretical basis for advancing the growing body of research being done by other sciences and engineering fields that involves applying biological principles or employing biological systems or processes.



BIO in Context

BIO provides about 69 percent of federal funding for non-medical, basic research at academic institutions in the life sciences including environmental biology, a critical research area needed to answer questions related to climate change.

In FY 2010, BIO's investments will focus on understanding the changing dynamics of the biosphere, research on the fundamental characteristics of biological energy systems, and efforts to enhance education and broaden participation. An example is the Basic Research to Enable Agricultural Development, (BREAD) program begun in FY 2009 in partnership with the Bill and Melinda Gates Foundation. This program supports basic research to test innovative hypotheses and novel approaches and technologies for sustainable, science-based solutions to problems of agriculture in developing countries. In FY 2008, over 13,000 individuals were supported through BIO funding.

The FY 2010 Request for BIO includes $20.0 million to leverage activities across the directorate aimed at increasing support for transformative research. Examples of potential foci for these investments include: stimulating interdisciplinary research; establishing collaboratories; capitalizing on developing priorities; employing sandpits, a process that couples novel/high risk research project development with real-time peer review; and exploring novel processes for problem solving.

Directorate-wide Changes and Priorities

Climate Research (+$46.0 million for a total of $46.0 million).

In FY 2010, BIO will make a major investment in NSF's new Climate Research effort. NSF proposes an integrated approach that includes: modeling of basic natural and human processes; fundamental research to support paradigm development and predictive understanding; environmental observation; inquiry-based studies of integrated natural and human systems; and research on the environmental significance of adaptation and mitigation strategies. Specific emphases include:

- Modeling: Enhance scalability of climate and ecosystem models to move climate modeling from the global to the regional scale; move ecological modeling from the local to the regional scale; and improve predictability at multiple scales to inform decision makers;
- Fundamental Research: Support a broad research portfolio in carbon cycling, biodiversity, and ecological systems and expand the Nation's workforce trained to address complex environmental challenges;
- Observation: Improve, upgrade and deploy critical environmental observing platforms and systems (Long Term Ecological Research and the National Ecological Observatory Network) and partner with the USDA to establish a set of Urban Long Term Research Areas.

The long-term goal of this program is to assert U.S. leadership in providing and communicating the fundamental knowledge base on climate change.

Disciplinary Research/Division Research (+$38.0 million, to a total of $512.96 million).

Increasing support for basic research in biology will yield insights that can be used to produce the next generation of nano-, bio-, and information technologies. BIO investments support integrative fundamental research across the biological scales, from intracellular macromolecules to the biosphere and results in the discoveries and new knowledge needed to address issues of national importance. Enhanced attention will be placed on developing areas of research such as: life in transition; energy, information, and novel products; and closing the loop of theory, observation, experimentation and technology.

Research Resources & Centers in the Biological Sciences (+$20.0 million, to a total of $142.54 million). Funds will be used to continue efforts, to digitize and network U.S. specimen-based research collections. These collections provide proper validation of species including a wealth of ancillary data such as DNA samples and environment/habitat information. These data provide the baseline from which to begin further biodiversity studies and provide critical information about the existing gaps in our knowledge of life on earth. Filling these gaps is crucial to a complete understanding of the biodiversity of the planet, both in space and time, and the history of climate change. The Interagency Working Group on Scientific Collections developed a comprehensive report on the current status of federally owned collections; NSF, as part of that working group, surveyed federally supported collections. Both reports emphasized the digitization of collections to leverage past investments by making them available and searchable online to researchers worldwide.

In addition, support will be enhanced for research resources to include increased funding for Advances in Biological Informatics (ABI) and Instrument Development for Biological Research (IDBR), two vitally important research resource programs.

The centers supported by BIO will be managed as a cohort within DBI in order to promote synthesis across the complete range of biological research, integrate and streamline the resources required by the individual centers, promote education and outreach activities among the centers, and integrate other center-like activities requiring similar management practices.

National Ecological Observatory Network (+$200,000 million for a total of $13.50 million). Increased investment in project planning for the National Ecological Observatory Network (NEON) will sustain project design and development activities until completion of the preliminary and final design reviews scheduled for completion in early FY 2010. Confirmation of baseline estimates for construction will inform the FY 2011 budget request.

Education and Learning Activities (+$11.5 million for a total of $50.86 million). In partnership with EHR, GEO, and OPP, BIO will support innovative formal and informal education activities centered on the general theme of climate science.

Additional funding will build upon activities in the BIO/EHR partnership that have included 'conversations' with undergraduate educators and researchers, co-funding of innovative education awards and networking grants, and a planned July 2009 *Vision and Change in Undergraduate Biology Education* conference co-sponsored by BIO and EHR. FY 2010 funding will support Research Coordination Networks that join biology and education researchers and practitioners to enhance the exchange of ideas and innovative practices. New this year will be a set of incubation grants to build upon themes of the Vision and Change conference, and expand and complement the Howard Hughes Medical Institute (HHMI) Experiments in Undergraduate Science Education competition.

Program Evaluation and Performance Improvement

The Performance Information chapter describes the Foundation's performance evaluation framework, which is built upon the four strategic outcome goals in NSF's Strategic Plan: *Discovery, Learning, Research Infrastructure*, and *Stewardship*. Performance evaluation is conducted at all levels within the Foundation, using both qualitative and quantitative measures – including an agency-wide annual review of research and education outcomes by an external expert committee and periodic reviews of programs and portfolios of programs by external Committees of Visitors (COVs) and directorate Advisory

Committees. Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are also factored into the assessment process.

In FY 2008, BIO held two COVs in June 2008 for the Molecular and Cellular Bioscience and for the Integrative Organismal Systems. The Directorate Advisory Committee met twice in FY 2008, in October 2007 and later in April 2008.

In FY 2009, BIO Committee of Visitors (COV) reviews took place for the Emerging Frontiers and the Division of Environmental Biology. All BIO divisions are responding to and implementing recommendations from recent COVs. COVs for the Division of Biological Infrastructure are scheduled for 2010. In addition, the National Research Council of the National Academy of Sciences is currently preparing a report on "The Role of the Life Sciences in Transforming America's Future." Funded by NSF and NIH, the Committee on a New Biology for the 21st Century held a workshop on December 3, 2008. The Committee expects to release a final report in August 2009.

Number of People Involved in BIO Activities

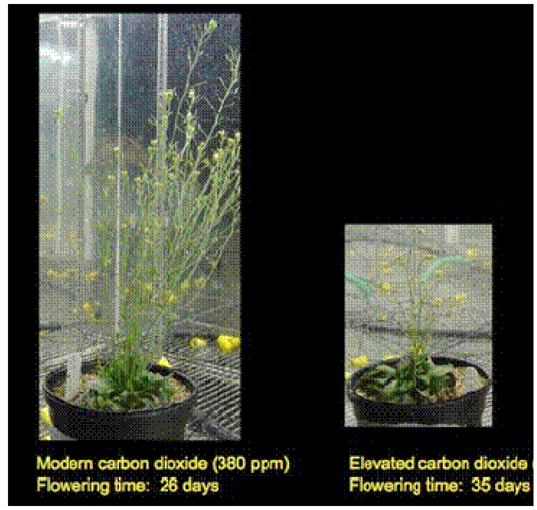
	FY 2008 Estimate	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate
Senior Researchers	3,942	4,021	1,100	4,600
Other Professionals	1,545	1,576	450	1,800
Postdoctorates	1,364	1,391	390	1,600
Graduate Students	2,745	2,800	785	3,200
Undergraduate Students	3,524	3,595	1,000	4,100
Total Number of People	13,120	13,383	3,725	15,300

BIO Funding Profile

	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate
Statistics for Competitive Awards:			
Number of Proposals	6,599	6,764	7,500
Number of New Awards	1,293	1,844	1,500
Regular Appropriation	1,293	1,319	1,500
ARRA		525	
Funding Rate	20%	27%	20%
Statistics for Research Grants:			
Number of Research Grant Proposals	5,473	5,585	6,200
Number of Research Grants	898	1,366	1,040
Regular Appropriation	898	916	1,040
ARRA		450	
Funding Rate	16%	24%	17%
Median Annualized Award Size	149,347	157,300	168,300
Average Annualized Award Size	179,267	188,900	202,000
Average Award Duration, in years	3.2	3.0	3.0

Recent Research Highlights

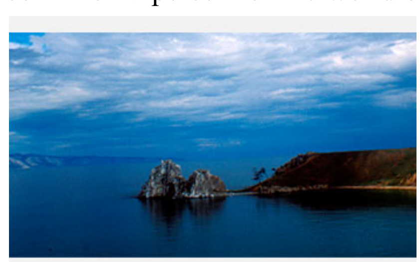
► **Is There a Relationship between Global Climate Change and Flowering?:** From a survey of past studies, researchers at the University of Kansas knew that rising CO2 exerts a strong effect on flowering time in the majority of plant species, although the mechanisms for this response are not yet well understood. Using *Arabidopsis thaliana*, a small flowering plant with a relatively short life cycle, the researchers for the first time demonstrated that elevated CO2 can influence the expression of genes involved in the initiation of flowering. More specifically, they found that the gene *Flowering locus C* plays a large role in determining delayed flowering in plants grown at elevated carbon dioxide. By describing these specific mechanisms, scientists are in a better position to predict the future responses of plants to a changing environment, and from this, they can determine the best approaches for improving crop responses to increasing carbon dioxide concentrations of the future.



This image shows Arabidopsis thaliana plants of the same age that were grown at future (elevated) and modern carbon dioxide concentrations. Notice that the plant grown at elevated carbon dioxide (right) exhibits delayed flowering relative to the plant grown at the modern carbon dioxide value (left). Although it cannot be seen in this photo, the elevated carbon dioxide-grown plant is as large as the modern carbon dioxide-grown plant, but substantial amounts of plant tissue remain underground at this earlier stage of development. *Credit: Justin Graham.*

► **Sugary Tropical Maize Shows Promise for Biofuel:** Scientists at the University of Illinois report that certain tropical varieties of maize, when grown in the Midwest, can accumulate sugars in their stalks at levels comparable to those of sugarcane grown in Brazil. The tropical maize could have a dramatic impact on U.S. ethanol production for biofuel because it requires less nitrogen fertilizer than conventional corn. It is also a more desirable biofuel crop for farmers because it can be integrated easily into current crop rotations. Because of its high sugar content, tropical maize can be processed without the additional treatments required by current biofuel crops, such as switchgrass and corn stover, to convert cellulose or starch into the sugars that are then fermented into ethanol.

► **Global Warming Affects World's Largest Freshwater Lake:** Scientists from Wellesley College and Russian colleagues report the rising temperature of the world's largest lake, located in frigid Siberia, shows the region is responding strongly to global warming. The lake contains 20 percent of the world's fresh water and is large enough to hold all the water in the United States' Great Lakes. At 25 million years old, Lake Baikal predates the emergence of humans. The researchers' conclusions rely on a 60-year data set, collected on Lake Baikal by three generations of a single family of Siberian scientists. Data collection continued through every season, in an environment where winter temperatures drop to -50 degrees Fahrenheit. Lake Baikal was expected to be among those most resistant to climate change due to its tremendous volume and unique water circulation, but the lake now joins other large lakes, including Superior, Tanganyika and Tahoe, in showing effects of climate change from warming of its vast waters to changes in the microscopic plants and animals that inhabit it.

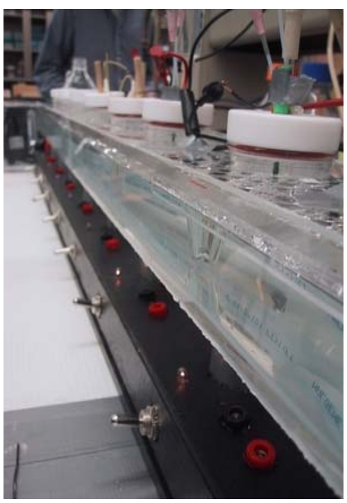


This well-known landmark, Shaman Rock on Lake Baikal in Russia, stands guard over an ancient lake whose pristine condition is changing quickly. *Credit: Nicholas Rodenhouse.*

► **New Maze Puts Maize Mutants on Display:** The Maize-10-Maze Project is a collaborative outreach effort between Florida State University and Florida A&M University. The project, part of the Forestry and Conservation Education Summer Program, was designed to be a living field map of the maize genome with each of the 10 rows of plants representing the ten chromosomes of corn. About 100 naturally occurring mutants, such as albino or six-inch-high dwarf mutants, were used to illustrate the genetic control of plant growth and development. The maze field was open to the public with the goal of educating people of all ages about maize genetics, mutants, and how mutations affect plants. The program's goal is to broaden participation by encouraging underrepresented minority high school students to consider plant science as a future career.

Students learn about maize genetics as part of the Maize-10-Maze outreach project, directed by Dr. H. W. Bass (right) of Florida State University in partnership with Dr. O. Onokpise (left) of Florida A&M University. FACE is a three-week summer program designed to expose minorities to forestry, natural-resource conservation, and plant genetics. Here, area high school students collect pollen to carry out genetic crosses in preparation for the upcoming public field day, held at the FAMU Research Farm. *Credit: Courtesy H. W. Bass, Florida State, Tallahassee, FL.*

► **Harnessing the Energy Produced by Bacteria:** Researchers at the University of Minnesota-Twin Cities are creating miniaturized microbial fuel cells and sensors to harness the energy produced by certain bacteria. The bacteria appear to have a remarkable property – electrons from metabolism are transferred outside of the cell. One reason this occurs, they believe, is because the metals these bacteria use as their energy source in nature are insoluble. This means that some bacteria, when attached to a conductive surface, can produce an electrical current. This capability has been harnessed in so-called "microbial fuel cells" that use bacteria to convert wastewater organic compounds into electricity. The team has shown that the same phenomenon can be harnessed for use in biosensors and with other surfaces engineered to convert organic molecules into electricity. With the heightened interest in bio-energy, these bacteria have taken center stage as keys to new kinds of bio-electrical devices.



This photo shows a bank of eight electrochemical chambers containing glassy carbon or microfabricated gold electrodes, which are used to culture biofilms of anaerobic electricity-producing bacteria such as Geobacter sulfurreducens. Each 3-electrode chamber is connected to a potentiostat, allowing routine application of multiple voltammetry techniques able to detect electron transfer from bacteria to electrodes. *Credit: Daniel R. Bond, University of Minnesota*.

► **All Eyes and Ears on the Corn Genome:** A consortium of researchers led by the Genome Sequencing Center at Washington University in St. Louis has completed a draft sequence of the corn genome. This groundbreaking project was funded by NSF under the auspices of the National Plant Genome Initiative. Corn has one of the most complex genomes of any known organism and is one of the most challenging genomes sequenced to date. At 2.5 billion base pairs covering 10 chromosomes, this genome's size is comparable to that of the human genome. The draft sequence will be a valuable tool allowing researchers to uncover the functional components of individual genes and develop a picture of the genome organization. Scientists will be able to develop new varieties of corn that increase crop yields and resist drought and disease. Information gleaned from the corn genome is likely to be applicable to other grains, such as rice, wheat, and barley.

In 2005, NSF, DOE, and USDA funded the sequencing of the corn genome. *Credit: © 2008 Jupiter Images Corp.*

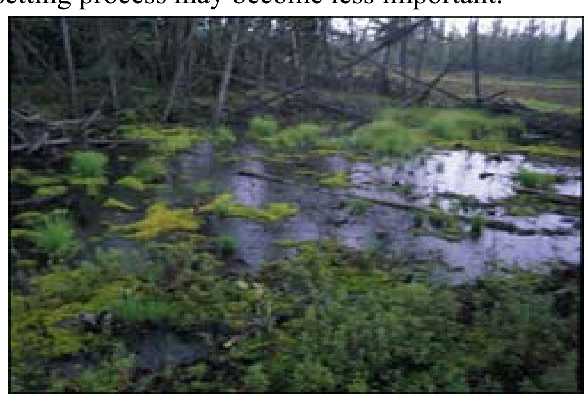
► **Gatekeepers Protect Plants from Ozone Damage:** Photosynthesis requires that plants exchange CO2, water, and other gasses with the atmosphere through stomatal pores. These "breathing" pores have guard cells on either side to help the plant control gas exchange, mostly to prevent water loss from plants when the pores are open. Recently, NSF-funded scientists from the University of California at San Diego, working with European collaborators, showed that the gene SLAC1 controls the amount of ozone, an atmospheric toxin, allowed into the plant by causing the guard cells to deflate shutting stomatal pores. This protects vulnerable internal tissues and slows photosynthetic activity until atmospheric ozone concentrations drop. Plants lose more than 90 percent of their water through evaporation from stomatal pores. Thus, understanding the basic genetic and biochemical mechanisms that control the guard cell regulation of the stomatal pores will contribute to breeding crops and other plants capable of withstanding severe droughts.

How the SLAC1 Anion Channel mediates stomatal closing. *Credit: Image courtesy Julian Schroeder, UCSD.*

Two guard cells surround this stomatal pore, allowing CO2 for photosynthesis into the plant. If atmospheric ozone concentrations would increase, the guard cells would swell, closing the stomatal pore. *Credit: Julian Schroeder, UCSD.*

► **What Happens When Permafrost Thaws?**: Recent findings from an NSF-supported study suggest that rising temperatures in boreal peatlands may not always increase the greenhouse gases responsible for global warming. Scientists predict that as rising atmospheric temperatures accelerate rates of permafrost thawing, organic matter stored in frozen peatland soil will decompose and release even more greenhouse gases into the atmosphere. A Villanova University team found that while warming leads to permafrost thawing, it also increases the growth of mosses that take up carbon from the atmosphere. Soil cores, which tell the climatic and ecological history of the peatland ecosystem, suggest that as the permafrost continues to degrade and the peatland begins to dry, slower-growing plants replace the water-loving, fast-growing mosses. Thus, while current rates of carbon uptake due to moss growth may compensate for greenhouse gas releases, over the long term, this offsetting process may become less important.

An example of permafrost collapse in peatlands, resulting in the slumping of the soil surface and flooding. This will be followed by a complete change in vegetation, soil structure, and many other important aspects of these ecosystems. *Credit: Dale H. Vitt, Southern Illinois University Carbondale.*



Thawing permafrost in the peatlands of boreal forests in North America. *Credit: Dale H. Vitt, Southern Illinois University Carbondale.*

MOLECULAR AND CELLULAR BIOSCIENCES $128,830,000 +$7,570,000 / 6.2%

Molecular and Cellular Biosciences Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, MCB	**$112.28**	**$121.26**	**$60.00**	**$128.83**	**$7.57**	**6.2%**
Major Components:						
Research and Education Grants	112.28	121.26	60.00	128.83	7.57	6.24%

Totals may not add due to rounding.

Molecular and Cellular Biosciences Division (MCB) (+$7.57 million, to a total of $128.83 million). MCB supports fundamental research and related activities to understand the dynamic underpinnings of complex living systems at the molecular, subcellular, and cellular levels. Priorities include projects that address questions related to the origin, organization, and properties of macromolecular structures, and/or subcellular and cellular components, as well as those that address the nature and operation of basic life processes.

In general, 33 percent of the MCB budget is available for new research grants. The remaining 67 percent funds continuing grants made in previous years.

The FY 2010 request includes:

- Support for additional innovative and potentially transformative disciplinary projects to advance our understanding of the molecular underpinnings of complex living systems. Central to this endeavor is building collaborations with the physical sciences to strengthen the theoretical, computational, and mathematical approaches that are critical for advances in this area. Also within the disciplinary increase is support to fund research on the transfer of energy and information between and among molecules, cells, organisms, and/or populations; traits that not only confer many of the unique properties of life such as robustness and resilience but also could form the basis for new energy sources and systems.

- Continued emphasis will be placed on the integration of research and education by increasing the number of CAREER awards.

INTEGRATIVE ORGANISMAL SYSTEMS $221,840,000

+$10,220,000 / 4.8%

Integrative Organismal Systems Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
IOS Project Support	$102.59	$110.40	$60.00	$117.58	$7.18	6.5%
Plant Genome Research Program	97.45	101.22	0.00	104.26	3.04	3.0%
Total, IOS	**$200.04**	**$211.62**	**$60.00**	**$221.84**	**$10.22**	**4.8%**
Major Components:						
Research and Education Grants	159.59	170.62	60.00	180.84	10.22	6.0%
Instrumentation	40.45	41.00	-	41.00	-	-

Totals may not add due to rounding.

Integrative Organismal Systems Division (IOS) (+$10.22 million, to a total of $221.84 million). IOS supports research and education aimed at understanding plants, animals and microorganisms as complex systems by focusing on the structures and processes that affect organismal development, structure, performance, and interactions under varying environmental conditions. In general, 49 percent of the IOS Project Support budget and 31 percent of the Plant Genome Research Program budget are available for new research grants. The remaining 51 and 69 percent, respectively, primarily fund continuing grants made in previous years.

IOS Project Support (+$7.18 million for a total of $117.58 million in FY 2010) will give highest priority to projects that focus on:

- Understanding the mechanisms and principles that allow organisms to survive, adapt to, and transform their environment. A greater understanding of such principles will enhance our ability to predict organisms' responses to climate and environmental change and suggest mitigation and adaptation strategies.

The Plant Genome Research Program (+$3.04 million for a total of $104.26 million in FY 2010) will emphasize:

- Support of genome-scale research that capitalizes on previous investments to accelerate basic discoveries of potential application in crop improvement and/or adaptation to global climate change.
- The Basic Research to Enable Agricultural Development (BREAD) Program will support basic research to test innovative hypotheses, approaches, and technologies for sustainable, science-based solutions to problems of agriculture in developing countries. BREAD is supported by the National Science Foundation (NSF) and the Bill and Melinda Gates Foundation through funding provided to NSF.

IOS will also continue to place a high priority on the integration of research and education by increasing the number of CAREER awards.

ENVIRONMENTAL BIOLOGY $133,920,000 +$13,540,000 / 11.2%

Environmental Biology Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, DEB	**$110.71**	**$120.38**	**$70.00**	**$133.92**	**$13.54**	**11.2%**
Major Components:						
Research and Education Grants	110.71	120.38	70.00	133.92	13.54	11.2%

Totals may not add due to rounding.

Environmental Biology Division (DEB) (+$13.54 million, to a total of $133.92 million).
DEB supports fundamental research on the past, current, and future biosphere. Foci include the origin, extent and maintenance of biological diversity; impacts and feedbacks associated with climate change; and how populations and communities survive, adapt to, and transform their environment. In general, 41 percent of the DEB budget is available for new research grants. The remaining 59 percent primarily funds continuing grants made in previous years.

The FY 2010 request includes:

- Enhanced support for innovative disciplinary projects, especially in climate change and the dimensions of biodiversity. Advances in genomics as well as other biological advances coupled with developments in digitization and high performance computing make it feasible to establish the goal of determining the dimensions of Earth's biodiversity within a decade.
- The Long Term Ecological Research (LTER) program will be augmented by $2.0 million in FY 2010 to improve critical observing systems so that LTER sites can collaborate with NEON and other NSF environmental observatories.
- DEB will enhance its support for activities that integrate research and education by increasing the number of CAREER awards.

BIOLOGICAL INFRASTRUCTURE

$130,140,000
+$13,340,000 / 11.4%

Biological Infrastructure Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, DBI	**$109.86**	**$116.80**	**$20.00**	**$130.14**	**$13.34**	**11.4%**
Major Components:						
Research and Education Grants	35.78	39.36	20.00	41.00	1.64	4.2%
Instrumentation/Research Resources	47.87	47.61	-	56.25	8.64	18.1%
Centers [1]	26.21	29.83	-	32.89	3.06	10.3%
National Center for Ecological Analysis and Synthesis	*3.89*	*3.71*	-	*3.70*	*-0.01*	*-0.3%*
National Evolutionary Synthesis Center	*2.89*	*2.55*	-	*5.77*	*3.22*	*126.3%*
National Institute for Mathematical and Biological Synthesis	*0.35*	*1.85*	-	*2.35*	*0.50*	*27.0%*
Plant Science Cyberinfrastructure Collaborative (iPlant)	*6.63*	*9.11*	-	*10.97*	*1.86*	*20.4%*
Centers for Environmental Implications of Nanotechnology	*3.10*	*4.10*	-	*4.10*	*-0.00*	*-0.0%*
Center for Behavioral Neuroscience	*3.15*	*2.51*	-	-	*-2.51*	*-100.0%*
Center for Microbial Oceanography Research and Education	*4.00*	*4.00*	-	*4.00*	-	-
Science of Learning Center [2]	*2.20*	*2.00*	-	*2.00*	-	-

Totals may not add due to rounding.

[1] In FY 2010, all centers are shifted from Emerging Frontiers to Biological Infrastructure. Funding is included in Biological Infrastructure for all years for comparability.

[2] Funding for the Science of Learning Center (SLC) is added for all years for comparability. SLC will be cofunded with the Directorate for Social, Behavioral and Economic Sciences beginning in FY 2010.

Biological Infrastructure Division (DBI) (+$13.34 million, to a total of $130.14 million).
DBI supports research resources that include the development of research tools, acquisition of instrumentation, and infrastructure improvements; human resource activities; and centers. Approximately 49 percent of the DBI budget is available for new awards each year with approximately 22 percent available for new research grants. The remainder supports continuing grants made in previous years.

Research and Education Grants (+$1.64 million for a total of $41.0 million in FY 2010):
- In collaboration with EHR, OPP, and GEO, will support the planning and establishment of a Climate Change Education program.

Instrumentation/Research Resources (+$8.64 million for a total of $56.25 million in FY 2010):
- Enhanced support will be provided for research resources such as biological informatics and instrument development.

Centers (+3.06 million for a total of $32.89 million in FY 2010):
- A shift of the centers from EF to DBI will promote cross-center synthesis, as well as education and outreach activities among the centers. In addition, the shift will integrate and

streamline the resources required by individual centers and coordinate other center-like activities that require similar management practices. An increase of $3.22 million is due to the renewal of the National Evolutionary Synthesis Center (NESCent).

EMERGING FRONTIERS

$118,270,000
+$32,520,000 / 37.9%

Emerging Frontiers Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Percent
Total, EF	**$82.73**	**$85.75**	**$50.00**	**$118.27**	**$32.52**	**37.9%**
Major Components:						
Research and Education Grants	68.90	72.45	35.00	104.77	32.32	44.6%
Instrumentation/Research Resources			15.00			
Centers [1]	-	-	-	-	-	N/A
Facilities	13.83	13.30	-	13.50	0.20	1.5%
National Ecological Observatory Network	*13.83*	*13.30*	-	*13.50*	*0.20*	*0.02*

Totals may not add due to rounding.

[1] In FY 2010, all centers are shifted from Emerging Frontiers to Biological Infrastructure. Funding for all years is included in Biological Infrastructure for comparability.

Emerging Frontiers Division (EF) (+$32.52 million, to a total of $118.27 million).
EF identifies, incubates, and supports research areas or infrastructure that transcends scientific disciplines and/or advances the conceptual foundations of biology. EF develops and implements new forms of merit review, and mechanisms to support transformative research and stimulate creativity. These goals are accomplished by promoting cultural change within and across scientific disciplines to increase the frequency of multidisciplinary collaborations, by encouraging curiosity and exploration through novel mechanisms and investments, and by facilitating support of research areas relevant to all of biology by targeted co-funding throughout the directorate. In general, 50 percent of the EF budget is available for new research grants. The remaining 50 percent is used primarily to fund continuing grants made in previous years.

The FY 2010 request includes:

- The transfer of centers to DBI to enhance cross center synthesis and coordination and promote the sharing of best practices with other large DBI projects.
- Support for developing priorities (+$15.5 million) such as research to enhance our understanding of complex biological systems, especially those that will yield new knowledge about global change.
- A partnership with EHR (+10.0 million) to develop and support activities identified after a two year planning process to improve undergraduate biology education through new mentoring, curriculum and research experiences for students, and faculty development.
- Continued support for NEON as it finalizes project planning and review.
- Leveraging activities across the directorate to increase support for transformative research, Emerging Frontiers will establish an innovation fund (+$8.0 million) that will co-fund with other BIO divisions using innovative mechanisms for identifying and reviewing innovative research projects.

COMPUTER AND INFORMATION SCIENCE AND ENGINEERING — $633,000,000 +$59,260,000 / 10.3%

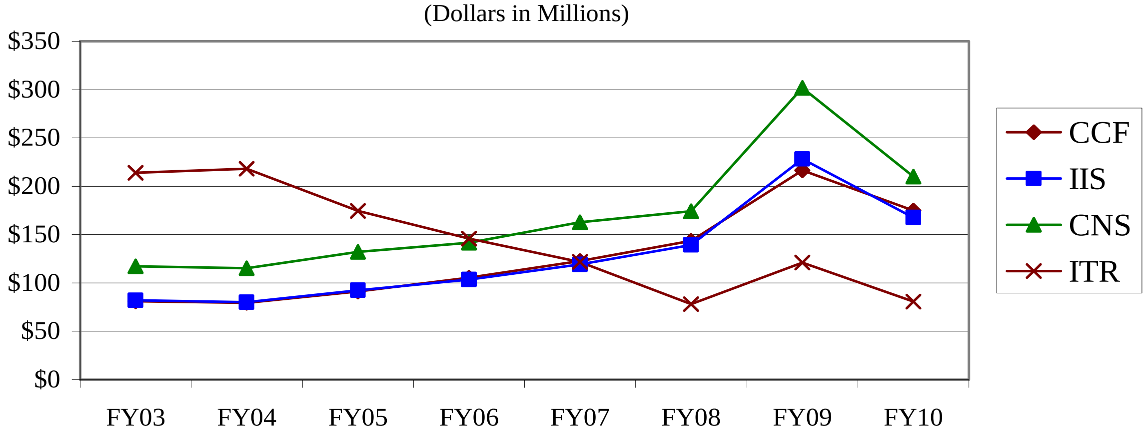
Computer and Information Science and Engineering Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Computing and Communication Foundations (CCF)	$143.63	$156.93	$41.50	$174.83	$17.90	11.4%
Computer and Network Systems (CNS)	174.16	188.31	92.57	209.87	21.56	11.4%
Information and Intelligent Systems (IIS)	139.33	150.26	60.50	167.56	17.30	11.5%
Information Technology Research (ITR)	78.14	78.24	40.43	80.74	2.50	3.2%
Total, CISE	**$535.26**	**$573.74**	**$235.00**	**$633.00**	**$59.26**	**10.3%**
Major Components:						
Research and Education Grants	499.75	539.74	203.00	592.50	52.76	9.8%
Centers Programs	8.00	8.00	-	10.50	2.50	31.3%
Computing Research Resources	27.51	26.00	32.00	30.00	4.00	15.4%

Totals may not add due to rounding.

CISE's mission is to enable the U.S. to uphold a position of world leadership in computer and information science and engineering; to promote understanding of the principles and uses of advanced computer, communications, and information systems in service to society; and to contribute to universal, transparent, and affordable participation in an information-based society. CISE supports ambitious, long-term research projects within and across the many sub-fields of computing, contributes to the education and training of computing professionals and, more broadly, informs the preparation of a U.S. workforce with computing competencies essential to success in an increasingly competitive, global market. CISE-supported fundamental research outcomes in computing and information technology inform the development and deployment of cyberinfrastructure supported by the agency in service to all fields of science and engineering.

CISE Subactivity Funding
(Dollars in Millions)



CISE in Context

NSF is the principal source of federal funding for university-based basic research in computer science, providing the vast majority – 84 percent – of total federal support in this area. In recent years, basic research investments in computing have provided unsurpassed value-added to the U.S. economy. Since 1995, networking and information technology industries have accounted for 25 percent of the Nation's economic growth, although they represent only three percent of the gross domestic product.[1]

Essentially all practical applications of IT are based on ideas and concepts that emerged from basic research investments. These fundamental ideas and concepts have enabled innovative product and application developments that now permeate all areas of modern life. IT not only forms a sizeable portion of the economy in its own right, but drives discovery and innovation in many other areas, including advanced scientific research, healthcare, national and homeland security, organizational effectiveness, and governmental efficiency. Innovation in IT will remain an essential and vital force in productivity gains and economic growth in both the manufacturing and service sectors for many years to come, positioning NSF and CISE as central and essential actors in improving the nation's economic outlook and advancing a highly trained, technologically astute workforce.

The CISE Directorate continues to play a leadership role in the multi-agency subcommittee on Networking and Information Technology Research and Development (NITRD), which is co-chaired by the CISE Assistant Director. All projects supported by CISE investments, including all research, education, and cyberinfrastructure (computing research infrastructure), enrich the agency's NITRD portfolio. In FY 2010 CISE will continue to explore the computing frontier, stimulating research advances in new foundations and systems – all enabling applications yet to be imagined. CISE will continue to strengthen the intellectual foundations of computing, supporting research in algorithms and theoretical computer science, computer architecture, cryptography, information theory, network and communication theory, parallel computing, programming languages, semantics and logics, software engineering, and in emerging models and substrates of computation; As computing systems provide richer functionalities and faster performance, as they become more ubiquitous and pervasive, and as user expectations of and demands on them increase, CISE investments in the fundamental research essential to systems design for properties such as privacy, security, reliability, and usability become increasingly important. As we seek to better understand human intelligence and to use computing to enhance our quality of life, CISE will also continue to invest in artificial intelligence, computer vision, graphics, machine learning, natural language processing, robotics, speech, search, information retrieval, and technologies for collaboration. CISE contributions to the National Nanotechnology Initiative will permit exploratory and interdisciplinary work on novel quantum and bio-inspired device and systems technologies, as well as related programming models, languages and tools that promise to form the basis of the revolutionary new computing systems of the future.

NSF is the principal source of federal support for strengthening science, technology, engineering and mathematics (STEM) education across all levels and is uniquely positioned to lead the Nation in STEM education due to its focus on STEM education research. Two programs in particular, CISE Pathways to Revitalized Undergraduate Computing Education (CPATH) and Broadening Participation in Computing (BPC), aim to increase American competitiveness in the global economy and support NSF's underlying strategy of integration of research and education.

The FY 2010 Request for CISE includes $8.0 million to leverage activities across the directorate aimed at

[1] *Leadership under Challenge: IT R&D in a Competitive World*, President's Council of Advisors in Science and Technology (PCAST) 2007.

increasing support for transformative research. Examples of potential foci for these investments include CISE's Expeditions in Computing program, which supports large multi-disciplinary awards targeted to compelling, transformative research agendas that promise disruptive innovations in computing and information for many years to come.

Directorate-wide Changes and Priorities

Computing Fundamentals (+$13.05 million, to a total of $458.37 million)..

CISE will increase investment in disciplinary and emerging areas of computer and information science and engineering in research programs that emphasize transformative work and cross-cutting areas. These areas include: the exploration of revolutionary computational models, languages, and tools, and hardware and software architectures that will serve as the primary catalysts for future innovations in information technology; transformative research on trustworthy software and networked systems that simultaneously explore the technological challenges as well as the equally important organizational, sociological, economic, legal, and psychological factors impeding progress in securing cyberspace; and exploration of human-centered computing and information and intelligent systems that promise value to a diverse range of individuals and to society at large. CISE will increasingly focus on programs and projects that identify plausible but high-risk opportunities with potential to result in significant, enduring impact in societal applications.

As part of CISE's $123.50 million investment in cybersecurity research and education, the directorate will devote $40.0 million to research in usability; theoretical foundations; and privacy to support the Comprehensive National Cybersecurity Initiative.

Cyber-enabled Discovery and Innovation (CDI) (+$16.37 million, to a total of $50.0 million).

The CDI program, NSF-wide and begun in FY 2008, recognizes that "computational thinking," i.e., computational methods, concepts, models, algorithms, and tools, will transform how all science and engineering will be conducted in the 21st Century. It will be the computational abstractions, as much as the high-speed computers and high-bandwidth networks that will enable scientists and engineers to make new discoveries – by changing the very questions they ask. Research in Cyber-Physical Systems (CPS) is a major component of CDI. Cyber-physical systems (e.g., autonomous cars, intelligent energy-efficient buildings, embedded medical devices, assistive technology for the aged, quality-of-life robots) are already penetrating every sector of our daily lives: transportation (e.g., automotive, aerospace), infrastructure (e.g., bridges, buildings), and healthcare (e.g., pacemakers, MRI technology), to name a few. Research in data-intensive computing also is an important component of CDI. To transform an abundance of digital data into new knowledge, CISE researchers will: explore new fundamental mathematical and computational abstractions to represent and manage data; participate in multidisciplinary projects that explore data mining, data federation, and extraction strategies in demanding science and engineering applications; and develop the underpinnings essential to the development of sophisticated data visualization and delivery tools. CISE will also invest in an emerging data-intensive computing paradigm ("cloud computing") where systems are designed, programmed, and operated on massively large server clusters.

Science and Engineering Beyond Moore's Law (SEBML) (+$11.0 million, to a total of $15.0 million).

In SEBML, CISE researchers will explore radically new systems based on revolutionary technologies such as organic molecules, carbon nanotubes, optical switches, and superconductors, among others. New programming models will also be explored, along with the languages and compilers that support them. To optimize computing power, new algorithms that exploit highly parallel hardware and architecture characteristics in contemporary silicon-based technologies, such as multi-cores and communication and memory latencies, will also be examined.

Climate Research (CR) (+$10.0 million, to a total of $10.0 million).
CISE will play an important role in CR. Research in fundamental new algorithms, data structures, and software capabilities will enable development of computational models of our planet so that climate prediction can be done on a regional and decadal scale. Research in smart sensor and smart sensor networking technologies will enable state-of-the-art observatories in the sky, ocean, ice, land, and in living systems, including humans. Research in advanced machine learning, data mining, visualization, and other information-extraction techniques will enable real-time processing of multiple and disparate data streams and intelligent decision-making.

Program Evaluation and Performance Improvement

The Performance Information chapter describes the Foundation's performance evaluation framework, which is built upon the four strategic outcome goals in NSF's Strategic Plan: *Discovery, Learning, Research Infrastructure*, and *Stewardship*. Performance evaluation is conducted at all levels within the Foundation, using both qualitative and quantitative measures – including an agency-wide annual review of research and education outcomes by an external expert committee and periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. During FY 2009, CISE will hold three Committees of Visitors, one for each division other than ITR. Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are also factored into the performance assessment process.

Number of People Involved in CISE Activities

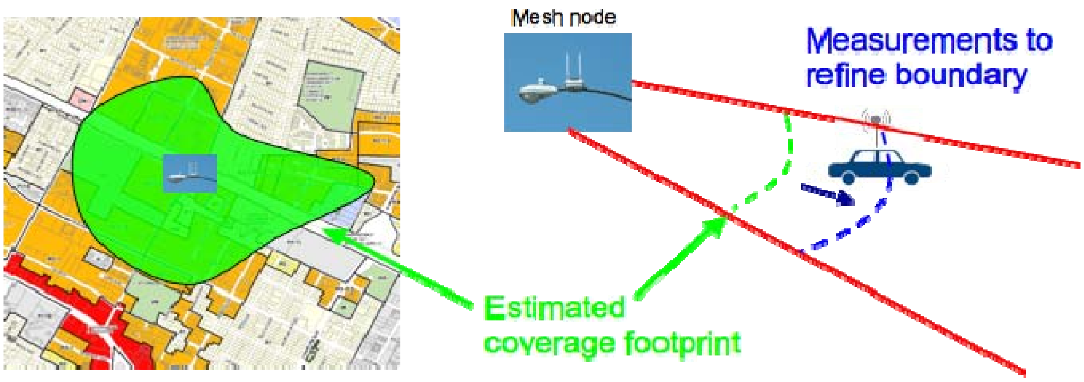
	FY 2008 Estimate	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate
Senior Researchers	6,462	6,915	2,840	7,605
Other Professionals	522	560	230	615
Postdoctorates	274	290	220	320
Graduate Students	5,594	5,985	2,450	6,585
Undergraduate Students	1,752	1,875	770	2,065
Total Number of People	14,604	15,625	6,510	17,190

CISE Funding Profile

	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate
Statistics for Competitive Awards:			
Number of Proposals	5,566	6,500	6,100
Number of New Awards	1,352	1,950	1,580
Regular Appropriation	1,352	1,420	1,580
ARRA	-	530	-
Funding Rate	24%	30%	26%
Statistics for Research Grants:			
Number of Research Grant Proposals	5,182	6,050	5,700
Number of Research Grants	1,046	1,500	1,220
Regular Appropriation	1,046	1,100	1,220
ARRA	-	400	-
Funding Rate	20%	25%	21%
Median Annualized Award Size	116,667	120,000	120,000
Average Annualized Award Size	164,212	170,000	170,000
Average Award Duration, in years	3.1	3.5	3.0

Recent Research Highlights

► **Broadband Wireless Networks:** Wireless access networks have the potential to expand broadband access throughout the United States. NSF-funded researchers have not only developed a set of design blueprints to guide the deployment of low-cost, broadband wireless access networks, but they also demonstrated the value of their designs in a wireless network deployed in an under-resourced neighborhood in Houston, Texas. Research innovations include new algorithms used to decide where to install wireless access points to minimize network dead zones and to determine where to install cables or fiber to ensure sufficient broadband connectivity is available throughout the network. The research team also developed an algorithm to detect dead spots following network deployment, without needing to take measurements at every place in the network. These research innovations provide network operators with a valuable toolkit, allowing them to build high performance broadband networks at lower cost.



An illustration of the technique for determining the coverage footprint of a mesh access point using coverage estimation (left) and a small number of measurements for refinement (right). This technique won the prestigious ACM MobiCom 2008 Best Paper Award. *Credit: City of Mountain View, CA and Joshua Robinson, Rice University.*

► **New Technology Helps Data Centers Conserve Energy:** The nation's rapidly growing information-based economy relies on power-hungry computing facilities called data centers. When computer programs run, computer systems consume electricity and generate heat, which needs to be removed from the data center room by the cooling installation. In a typical data center, jobs are submitted, executed, and finished at different times, thus creating various usage patterns, or layouts, of the center. Researchers at Arizona State University report they have devised a model of heat recirculation and an algorithm that uses the model to find the most energy-efficient task schedules. Simulations of the technology predict up to 30 percent energy savings in a moderately busy data center. This research enables the data center to monitor itself and self-adjust its behavior automatically to increase efficiency and avoid critical situations of overheating.

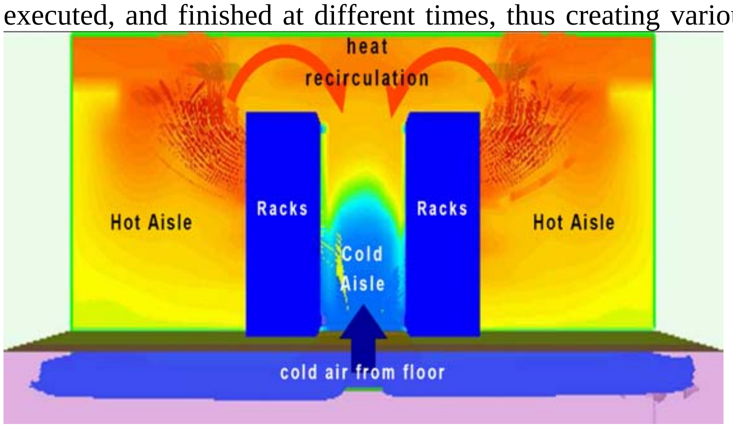


Figure shows the heat recirculation effect in a typical data center using a cold aisle – hot aisle configuration. *Credit: Image generated in the Arizona State University Impact lab using the Flovent Computation Fluid Dynamics (CFD) software.*

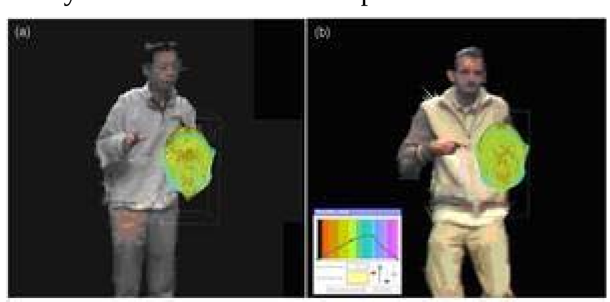
► **Error Correction in Digital Information Reaches Best Case Scenario:** Today, reliable, correct transmission and storage of digital information is of paramount importance. Despite the errors inherent in all communication channels and storage media, reliability can be achieved through the application of error-correcting codes, which were first conceived by Claude Shannon about 60 years ago. Recent advances made by NSF-funded scientists have led to error-correcting codes with the best possible trade-off between error-correction capability and efficiency. This new discovery yields an improvement by a factor of two over conventional error-correction algorithms currently used in most computing devices today. It remains to be seen whether we will all be using these new codes whenever we play a CD or access a computer hard disk in the years to come. But it is clear that these researchers have achieved an elusive milestone that has been sought ever since the birth of this field 60 years ago.

Error-correcting codes are all around us. *Credits (left to right): http://commons.wikimedia.org/wiki/File:Storhaugen_p%C3%A5_Fitjar.JPG, NASA, http://commons.wikimedia.org/wiki/File:Harddisk-head.jpg.*

► **Human-Robots Provide Post-Stroke Rehabilitation:** In the United States, about 730,000 people are victims of strokes each year, often resulting in some form of permanent disability. Yet rehabilitation is a scarce health-care service. To provide more patients with extended care, researchers at the University of Southern California have developed an integrated system composed of humanoid robots, software, and sensors. Together, they provide affordable monitoring, motivating, and coaching of rehabilitation exercises for people recovering from strokes. Low-cost, wearable sensors enable the robot to understand what the patient is doing and to decide what appropriate coaching and encouragement should be given. The robot uses a learning algorithm that enables it to adjust its personality and coaching style to match that of the patient's, resulting in rehabilitation exercise improvements. This project has the potential to create more affordable means of extended supervised rehabilitation, increasing the health and quality of life for many stroke survivors.

Wearable wristwatch-sized sensor used for robot-assisted stroke rehabilitation. *Credit: Dr. Eric Wade.*

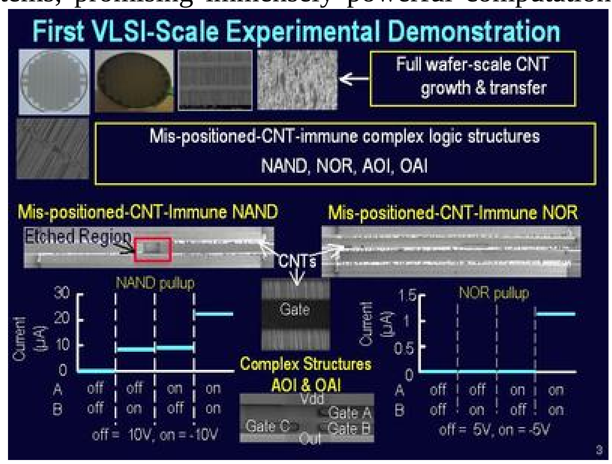
► **Improving Human Social Interaction in Multi-Site 3D Tele-Immersive Environments:** Many remote collaboration technologies failed because they have been unable to reproduce the richness of human social interaction. Typically, non-colocated users, for example those participating in videoconferencing, are unable to see the eye gaze or gestures of other participants, decreasing social cues and potential for appropriate social interaction. NSF-funded researchers have developed a teleimmersive system that fully immerses users in a common virtual space where normal social interactions can take place. To explore whether full human interaction is possible, a number of teleimmersive applications have been developed, including 3D



Two remote users rendered in the teleimmersive virtual environment with MRI data of human brain. The two screenshots show user A's and user B's perspective of the meeting. *Credit: Diana Kaljian.*

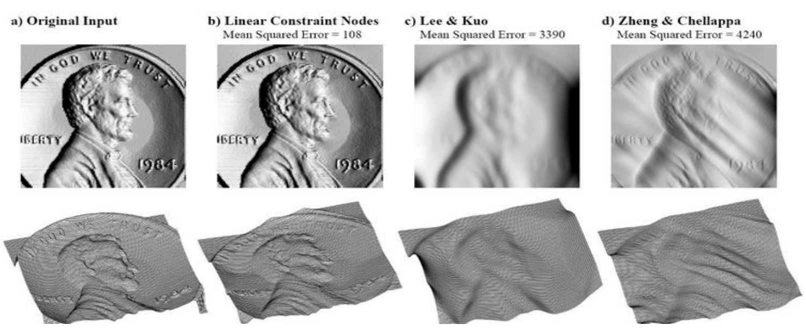
video conferencing, collaborative work on 3D MRI data sets , remote training in military scenarios, and remote teaching of dance performance. The researchers found that in contrast to existing 2-D videoconferencing or text-based collaboration technologies, teleimmersion humanizes remote communication. Progress is being made toward creating a low-cost, portable version of this system for use in the home or office.

► **Computing with Carbon Nanotubes:** Carbon nanotubes are strong candidates to replace silicon-based electronic building blocks in computing systems, promising immensely powerful computational capabilities in systems the size of pinheads. Unfortunately however, the precise fabrication of carbon nanotube devices and circuits has eluded scientists and engineers for many years, due to the difficulty of adequately controlling the positioning and material characteristics of carbon nanotubes at very large integration scales. Using mathematical principles, NSF-funded computer scientists recently devised a new algorithm that allowed them to design carbon nanotube circuits that are immune to such fabrication imperfections, resulting in the first experimental demonstration of carbon nanotube circuits in complex digital logic structures. The impact of these advances is significant, as it brings us closer to harvesting the great promise of nanotechnology.



VLSI Demonstration of Carbon Nanotube Circuits. *Credit: S.Mitra, Stanford University.*

► **Improving Computer Vision:** Inferring three-dimensional structures of objects based on their two-dimensional images is a central problem in biological and computer vision. Solving this problem is important for a large variety of civilian and military applications, particularly for automatic vehicle and robot navigation, scene understanding, and object tracking and manipulation. Computer scientists at Carnegie Mellon are investigating how neurons in the primate visual cortex encode prior knowledge about the natural environment and how neurons cooperate – as a group – to quickly resolve current ambiguities using that information. The researchers developed algorithms based on efficient belief propagation that have already yielded state-of-the-art results in 3-D shape inference, and which are generally useful for solving a large class of complex probabilistic inference problems. Solving real and difficult vision problems provides them with insights to guide their physiological studies of the visual cortex. This project represents a fruitful synergy between computational and neuroscience research.



State-of-the-art results on inferring 3D surface information from a single image of a U.S. penny provided by our efficient belief propagation algorithms. (a) The input image to the system (top row) and the underlying 3D ground-truth of the penny (second row). (b) The result from our algorithm, showing the image reconstructed (top) based on the inferred 3D map (bottom) are much more superior than current state-of-the-art results (c) and (d). *Credit: Tai Sing Lee, Carnegie Mellon University.*

COMPUTING AND COMMUNICATION FOUNDATIONS $174,830,000
+$17,900,000 / 11.4%

Computing and Communication Foundations Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, CCF	**$143.63**	**$156.93**	**$41.50**	**$174.83**	**$17.90**	**11.4%**
Major Components:						
Research and Education Grants	135.63	148.93	41.50	166.83	17.90	12.0%
Centers	8.00	8.00	-	8.00	-	-
STC for Embedded Networked Sensing	*4.00*	*4.00*	-	*4.00*	-	-
STC for Ubiquitous Secure Technology	*4.00*	*4.00*	-	*4.00*	-	-

Summary of FY 2010 Request

Computing and Communications Foundation Division (CCF) (+$17.90 million, to a total of $174.83 million). CCF supports research and education on: algorithmic foundations to help us understand the fundamental limits of resource-bounded computation and to obtain optimal solutions within those limits; algorithms that are applicable to areas both within and outside computer science; the theoretical underpinnings and current and future enabling technologies for information acquisition, transmission, and processing in communication and information networks; the foundational aspects of hardware and software, i.e., the reasoning, comparing and establishing properties of existing and newly-conceived software and hardware components, systems, and other artifacts, which are essential to advance the capability of computing systems; and the design of new computing devices based on nanotechnology, biotechnology, or quantum physics.
In general, 60 percent of the CCF portfolio is available for new research grants with 40 percent used primarily to fund continuing grants from prior years.

In FY 2010, CCF will continue to support two Science and Technology Centers: the Center for Embedded Networked Sensing (CENS) at the University of California at Los Angeles, which is exploring embedded networked sensing systems, which are large-scale, distributed systems composed of smart sensors and actuators embedded in the physical world; and the Center for Ubiquitous Secure Technology at the University of California at Berkeley (TRUST). TRUST is addressing a parallel and accelerating trend of the past decade - the integration of secure, robust computing and communications capabilities across critical infrastructures, in areas such as telecommunications, finance, energy distribution, and transportation.

CCF will continue to explore concepts, methods, technologies and tools foundational to the computing disciplines in FY 2010, assuring the Nation's leadership in computing for the long-term. CCF will place renewed emphasis on processes and tools for the design, development, and deployment of reliable software and hardware systems. The division will also make new investments in research and education at the interface of computer science and other fields of science and engineering. For example, new investments at the interface between computer science and economics will enable a better understanding of trust and risk in our financial markets, how to design emerging online markets to satisfy global goals, the use of network theory to understand economic systems in the developing world, and numerous other applications. Further, CCF will continue to support the design and analysis of algorithms, optimization methods, and software to facilitate research advances in the natural sciences, social sciences, and engineering.

In FY 2010, CCF will continue its emphasis on Cyber-enabled Discovery and Innovation (CDI). By applying algorithmic insights broadly across science, engineering, and areas of societal importance, CDI will spark a new revolution in our understanding of the world and in our productivity. As part of CDI, CCF will increase its investments in Cyber-Physical Systems (e.g., autonomous cars, intelligent energy-efficient buildings, embedded medical devices, assistive technology for the aged, quality-of-life robots) by $4.0 million in FY 2010. CCF-enabled advances in Cyber-Physical Systems will establish the scientific foundations and engineering principles to help conceptualize, design, analyze, implement, and certify cyber-physical systems Further, to realize the full potential of data-intensive computing CCF will support innovative research in algorithms, programming languages, programming models, resource management, and system design to fully capitalize on the potential of data-intensive systems to transform application areas from science and engineering to healthcare, environmental monitoring and the humanities.

CCF is increasing support in Science and Engineering Beyond Moore's Law (SEBML) by $11.0 million to a level of $15.0 million in FY 2010. As performance gains forecast by Moore's Law continue to level out, multicore processors that incorporate thousands of cores on a single chip promise a new means by which to realize system performance gains. CCF-supported research will address all the hardware and software challenges associated with exploiting multicore technology, including capitalizing on the energy efficiencies it promises. In addition, CCF will support fundamental research to identify promising, radically new technologies for computing, including, for example, the use of molecules or biomolecules as basic logic elements, the use of nanowires for gates or interconnections, and the exploitation of quantum phenomena to perform parallel computations.

All three CISE disciplinary divisions will play important roles in the NSF-wide program on Climate Research. CCF will provide $3.30 million in FY 2010, supporting research on fundamental new algorithms, data structures, and software capabilities to enable development of computational models of our planet so that climate prediction can be done on regional and decadal scales.

COMPUTER AND NETWORK SYSTEMS

$209,870,000
+$21,560,000 / 11.4%

Computer and Network Systems Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, CNS	**$174.16**	**$188.31**	**$92.57**	**$209.87**	**$21.56**	**11.4%**
Major Components:						
Research and Education Grants	146.65	162.31	60.57	179.87	17.56	10.8%
Computing Research Resources	27.51	26.00	32.00	30.00	4.00	15.4%

Summary of FY 2010 Request

Computer and Network Systems Division (CNS) (+$21.56 million, to a total of $209.87 million). CNS supports research and education activities that advance our understanding of the fundamental properties of computer systems and networks and their complexity, explore new ways to address the limitations of existing computer and networked systems to make better use of these technologies, and develop better paradigms, abstractions and tools for designing, analyzing and building next generation computer and networked systems that are robust, secure and trustworthy.

CNS investments in computer systems research focus on: distributed, mobile, and embedded systems; sensing and control systems; dynamically configured, multiple-component systems; and parallel systems. CNS investments in fundamental network research create new insights into the dynamics of complex networks, and explore new architectures for future-generation networks and services. CNS provides scientific leadership in trustworthy computing, supporting research and education activities that will ensure that society's increasingly ubiquitous and distributed computing and communication systems deliver the quality of service they are designed to achieve, without disruption, while enabling and preserving privacy, security and trust.

CNS also plays a leadership role in coordinating CISE investments in research infrastructure resources and in the development of the computing workforce of the future. Through the Computing Research Infrastructure program, CNS supports the acquisition, enhancement, and operation of state-of-the-art infrastructures and facilities that enable high-quality computing research and education in a diverse range of institutions and projects. CNS supports the Broadening Participation in Computing (BPC) program to significantly increase the number and diversity of U.S. citizens and permanent residents receiving post secondary degrees in the computing disciplines, and the CISE Pathways to Revitalized Education in Computing (CPATH) program to identify and define the core computing concepts, methods, technologies and tools to be integrated into promising new undergraduate education models.

In general, 47 percent of the CNS portfolio is available for new grants. The remaining 53 percent is used primarily to fund continuing grants made in previous years.

In FY 2010, CNS will increase its investments in Trustworthy Computing by $10.0 million, emphasizing foundational cybersecurity research, as well as research in areas such as privacy and usability. CNS will also continue its emphasis on Cyber-enabled Discovery and Innovation (CDI), supporting research leading to a better understanding of how complex systems and networks behave at scale and evolve over time. As part of CDI, CNS will increase investments in Cyber-Physical Systems (CPS) by $2.0 million to enable the development of methods, tools, components, and architectures that promise significant impact in application domains ranging from transportation and automotive to healthcare and the environment.

Along with CCF and IIS, CNS will play an important role in the NSF-wide program on Climate Research. CNS will provide $3.40 million in FY 2010, supporting research on smart sensor and smart sensor networking technologies that will enable state-of-the-art observatories in the sky, ocean, ice, land, and in living systems, including humans.

INFORMATION AND INTELLIGENT SYSTEMS $167,560,000

+$17,300,000 / 11.5%

Information and Intelligent Systems Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, IIS	**$139.33**	**$150.26**	**$60.50**	**$167.56**	**$17.30**	**11.5%**
Major Component:						
Research and Education Grants	139.33	150.26	60.50	167.56	17.30	11.5%

Summary of FY 2010 Request

Information and Intelligent Systems Division (IIS) (+$17.30 million, to a total of $167.56 million). IIS supports research and education that: develops new knowledge to support people in the design and use of information technology; enhances the capabilities of people and machines to create, discover and reason with knowledge by advancing the ability to represent, collect, store, organize, visualize and communicate data and information; and advances knowledge about how computational systems can perform tasks autonomously, robustly, and flexibly.

IIS research investments support the exploration of novel theories and innovative technologies that advance our understanding of the complex and increasingly coupled relationships between people and computing. Investments in information integration and informatics focus on the processes and technologies involved in creating, managing, visualizing, and understanding diverse digital content as it relates to individuals, groups, organizations, and societies, and as it is hosted on engineered systems ranging from individual devices to globally-distributed systems. IIS also invests in the research traditions of artificial intelligence, computer vision, human language research, robotics, machine learning, computational neuroscience, cognitive science, and related areas leading to the computational understanding and modeling of intelligence in complex, realistic contexts.

In general, 55 percent of IIS funding is available for new research grants. The remaining 45 percent is used primarily to fund continuing grants made in previous years.

In FY 2010, IIS will increase investments in disciplinary areas, reflecting the continuing and growing importance of topics such as: designing and developing innovative technologies that support the reuse, repurposing, integration, and protection of diverse and heterogeneous sources of digital content; building creative systems that exhibit the broad competencies and robust behaviors exhibited by humans and other biological organisms; and understanding the fundamental capabilities and limitations of people and computers networked together as social and intelligent systems. With an investment of $5.0 million, IIS will spearhead a new multidisciplinary program focused on socially intelligent computing, in collaboration with colleagues in the human sciences. By better characterizing, understanding, and designing for desired behaviors arising from computationally mediated groups of people at all scales, new forms of knowledge creation, new models of computation, new forms of culture, and new types of interaction will result.

IIS will continue its emphasis on Cyber-enabled Discovery and Innovation (CDI) in FY 2010, targeting new data technologies that scale to the quantities, speed, dimensionality, and complexity of data that challenges innovation in scientific and engineering. To address CDI's thrust on virtual organizations, IIS will support research that enables large-scale collaboration across scientific and engineering domains, with emphasis placed on building and applying more principled understanding of virtual organization design. Virtual organizations will also be explored as primary vehicles for supporting inquiry-based STEM education, with the potential to reach students at all levels and the public at large.

Along with CCF and CNS, IIS will play important roles in the NSF-wide program on Climate Research. IIS will provide $3.30 million in FY 2010, supporting research to develop data technologies and intelligent decision-making techniques that can enable real-time processing of the numerous and highly disparate sources of data that are crucial to understanding climate.

INFORMATION TECHNOLOGY RESEARCH $80,740,000

+$2,500,000 / 3.2%

Information Technology Research Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, ITR	**$78.14**	**$78.24**	**$40.43**	**$80.74**	**$2.50**	**3.2%**
Major Components:						
Research and Education Grants	78.14	78.24	40.43	78.24	-	-
Science of Learning Centers	-	-	-	2.50	2.50	N/A

Summary of FY 2010 Request

Information Technology Research Division (ITR) ($+2.50 million, to a total of $80.74 million). The ITR subactivity provides support for transformative explorations in computer and information science and engineering research and related education activities, emphasizing the funding of high-risk, multi-investigator, often multidisciplinary projects.

In general, 70 percent of the ITR portfolio is available to make new awards. The remaining 30 percent is used primarily to fund continuing grants made in previous years.

In FY 2009 and FY 2010, funds from the ITR subactivity will be used to target CISE-wide IT research and education priorities.

Continued support will be provided for the Expeditions in Computing program. In planning and implementing *Expeditions*, researchers are encouraged to come together within or across departments or institutions in the identification of compelling, transformative research agendas that promise disruptive innovations in computing and information for many years to come. Funded at levels up to $10 million, *Expeditions* projects represent some of the largest single investments currently made by CISE. Together with the Science and Technology Centers and the Science of Learning Center CISE supports, *Expeditions* form the centerpiece of the directorate's award portfolio.

In FY 2010, ITR will provide support to the Pittsburgh Science of Learning Center (SLC) for Robust Learning.

ENGINEERING

$764,520,000
+$71,180,000 / 10.3%

Engineering Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Chemical, Bioengineering, and Transport Systems (CBET)	$132.81	$146.02	$60.40	$160.11	$14.09	9.6%
Civil, Mechanical, and Manufacturing Innovation (CMMI)	161.11	174.84	57.76	191.66	16.82	9.6%
Electrical, Communications, and Cyber Systems (ECCS)	83.60	87.35	45.84	95.75	8.40	9.6%
Industrial Innovation and Partnerships (IIP)[1/]	130.72	141.23	55.00	156.00	14.77	10.5%
SBIR/STTR	*109.07*	*119.21*	*50.00*	*132.52*	*13.31*	*11.2%*
Engineering Education and Centers (EEC)[2/]	116.02	117.45	32.00	132.00	14.55	12.4%
Emerging Frontiers in Research and Innovation (EFRI)	25.23	26.45	14.00	29.00	2.55	9.6%
Total, ENG	**$649.49**	**$693.34**	**$265.00**	**$764.52**	**$71.18**	**10.3%**
Major Components:						
Research and Education Grants	528.36	568.86	234.00	629.71	60.85	10.7%
Centers Programs	92.07	92.06	21.00	102.00	9.94	10.8%
Facilities O&M	29.06	32.42	10.00	32.81	0.39	1.2%

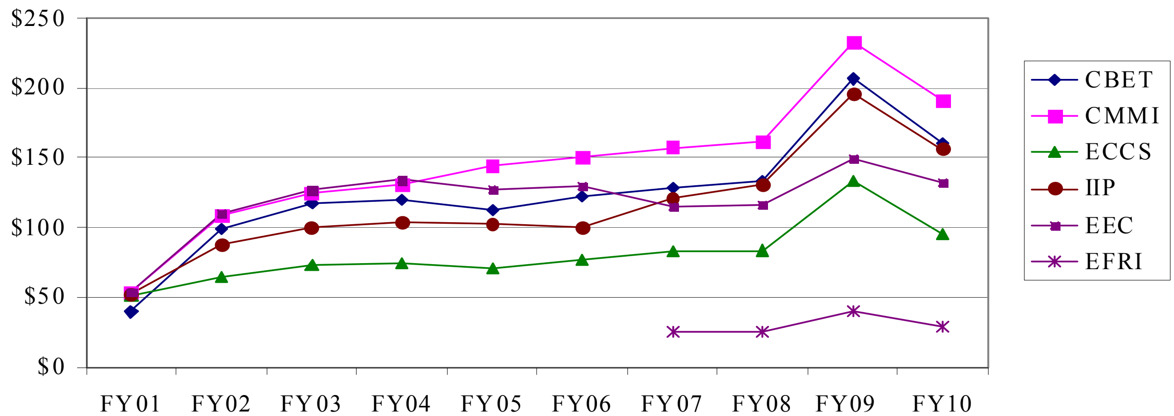
Totals may not add due to rounding.

[1/] Funding for Partnerships for Innovation (PFI) will be transferred in FY 2010 from Integrative Activities (IA) to the Directorate for Engineering, which manages the program. Funding for PFI is shown for all years for comparability.

[2/] Funding for the Science of Learning Center (SLC) within the Division for Engineering Education and Centers is included for all years for comparability. SLC will be cofunded with the Directorate for Social, Behavioral and Economic Sciences beginning in FY 2010.

The NSF Directorate for Engineering (ENG) provides critical support for the Nation's engineering research activities and is a driving force behind the training and development of the U.S. engineering workforce. ENG supports fundamental research, the creation of cutting-edge facilities and tools, and broad interdisciplinary collaborations. ENG also enhances the competitiveness of U.S. companies through its centers, partnerships, and small business programs.

ENG Subactivity Funding
(Dollars in Millions)



Engineering in Context

ENG provides approximately 45 percent of the total federal support for university-based, fundamental engineering research. The directorate's work impacts students and the research community, the business community, and the Nation as a whole. By making education an essential element of its grants and centers, and by supporting research experiences for teachers, undergraduates, graduate students, and new faculty, ENG helps prepare the future engineering workforce to innovate and compete in the global economy. By emphasizing interdisciplinary, high-risk, and potentially transformative engineering research, the directorate encourages the research community to advance the frontiers of knowledge and tackle increasingly complex problems. Through its centers and the Small Business Innovation Research program, the directorate speeds the translation of promising fundamental research into innovations that can be commercialized.

ENG has supported a wide range of critical breakthroughs essential to the Nation's prosperity, security, quality of life, and economic competitiveness. These include creative ways to make the Nation's physical infrastructure more sustainable and resilient; revolutionary advances in sensor technologies; catalytic methods for creating biofuels; new techniques for medical diagnostics and treatments; commercial-scale production of high-quality nanomaterials; novel methods for monitoring and treating drinking water supplies; and a host of others in a portfolio generated by thousands of grantees.

To identify new opportunities and challenges for transformative engineering research, the directorate supports workshops and projects each year. Examples of past workshops are:

- the annual Frontiers of Engineering Symposia (National Academy of Engineering, www.nae.edu/frontiers),
- the Simulation-Based Engineering and Science Workshop (World Technology Evaluation Center, www.wtec.org or www.wtec.org/sbes/workshop/FinalWS-20080425/SBES-allpresentations-30Apr08-lowres.pdf),
- Grand Challenges for Engineering (National Academy of Engineering, www.engineeringchallenges.org).

The FY 2010 Request for ENG includes $35.0 million to leverage activities across the directorate aimed at increasing support for transformative research. Examples of potential foci for these investments include innovative processes for identifying potentially transformative research, special solicitations and competitions, and increased use of specialized funding mechanisms, notably NSF's EAGER (EArly-concept Grants for Exploratory Research).

Directorate-wide Changes and Priorities

Disciplinary and Interdisciplinary Research (+$39.05 million, to a total of $369.64 million).

ENG will continue to build on its strong system of merit review and investigator-initiated proposals, which advance the frontiers of knowledge and innovation by working across traditional boundaries and encouraging multidisciplinary, cutting-edge, and high-impact research. ENG represents a broad and synergistic convergence of fields, disciplines, and frontier opportunities. This supports both newly emerging fields and long-standing challenges that are poised for major advancement. The Office of Emerging Frontiers in Research and Innovation will continue to identify, prioritize, and fund emerging areas in engineering research, innovation, and education.

Engineering Research Centers (ERC) (+$9.65 million, to a total of $63.20 million).
Increased funding will support three new Generation-3 centers and the planned growth of the FY 2008 class of ERCs.

Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) (+$13.31 million, to a total of $132.52 million).
This funding increase meets the mandated agency spending target of 2.8 percent of the agency's extramural research budget.

Science and Engineering Beyond Moore's Law (+$7.0 million, to a total of $10.00 million).
Engineering contributions are fundamental to advances in this area. For example, research in nanomanufacturing, photonics, and micro- and nanoelectronics will result in the new materials and devices—such as silicon microelectronics that exploit properties at the quantum level—required to realize computing capacity beyond the limits suggested by Moore's Law.

CAREER (+$4.85 million, to a total of $50.70 million).
The CAREER program remains the primary mechanism for jump-starting junior faculty toward independent careers in research and education. ENG provides a portion of its research investment each year towards CAREER. The increased funding in FY 2010 will fund at least twelve additional CAREER grants.

Cyber-enabled Discovery and Innovation (CDI) (+$3.00 million, to a total of $14.00 million).
Investment in CDI seeks to infuse computational thinking into all areas of engineering, bringing computational capabilities into the traditional experimentation-observation-analysis-theory research paradigm. ENG supports CDI with contributions from the CBET, CMMI, and EEC divisions. The ENG investment in CDI will focus on the development of the next generation of computationally-based discovery concepts and tools to deal with data-rich and interacting systems.

Industry/University Cooperative Research Centers (+$750,000, to a total of $7.85 million).
Engineering support provided to each center will increase by approximately $10,000 per center. The NSF investment in this program leverages investment of approximately $65.0 million annually from industry, university, state, and other federal partners.

Program Evaluation and Performance Improvement

The Performance Information chapter describes the Foundation's performance evaluation framework, which is built upon the four strategic outcome goals in NSF's Strategic Plan: *Discovery, Learning, Research Infrastructure*, and *Stewardship*. Performance evaluation is conducted at all levels within the Foundation, using both qualitative and quantitative measures—including an agency-wide annual review of research and education outcomes by an external expert committee and periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are also factored into the performance assessment process.

ENG convenes Committees of Visitors, composed of qualified external evaluators, to review each division every three years. These experts assess the integrity and efficiency of the processes for proposal review and provide a retrospective assessment of the quality of results of NSF's investments. The Chemical, Bioengineering, Environmental, and Transport Systems (CBET) and Civil, Mechanical, and Manufacturing Innovation (CMMI) division will be reviewed in FY 2009, and the Industrial Innovation and Partnerships (IIP) division and the Office of Emerging Frontiers in Research and Innovation (EFRI) will be reviewed in FY 2010.

Number of People Involved in ENG Activities

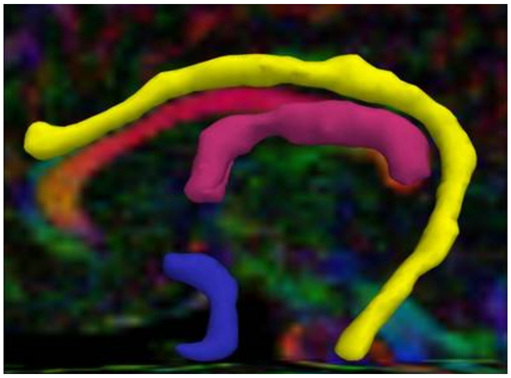
	FY 2008 Estimate	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate
Senior Researchers	6,809	7,252	2,860	7,868
Other Professionals	1,337	1,424	548	1,545
Postdoctorates	331	353	136	383
Graduate Students	6,327	6,738	2,594	7,310
Undergraduate Students	2,819	3,002	1,156	3,257
Total Number of People	17,623	18,769	7,294	20,363

ENG Funding Profile

	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate
Statistics for Competitive Awards:			
Number of Proposals	9,644	10,770	11,170
Number of New Awards	1,967	2,789	2,470
Regular Appropriation	1,967	2,040	2,470
ARRA	-	749	-
Funding Rate	20%	26%	22%
Statistics for Research Grants:			
Number of Research Grant Proposals	7,220	8,303	8,610
Number of Research Grants	1,159	1,775	1,540
Regular Appropriation	1,159	1,300	1,540
ARRA	-	475	-
Funding Rate	16%	21%	18%
Median Annualized Award Size	$100,000	$101,000	$101,500
Average Annualized Award Size	$112,540	$113,500	$114,000
Average Award Duration, in years	3.1	3.0	3.0

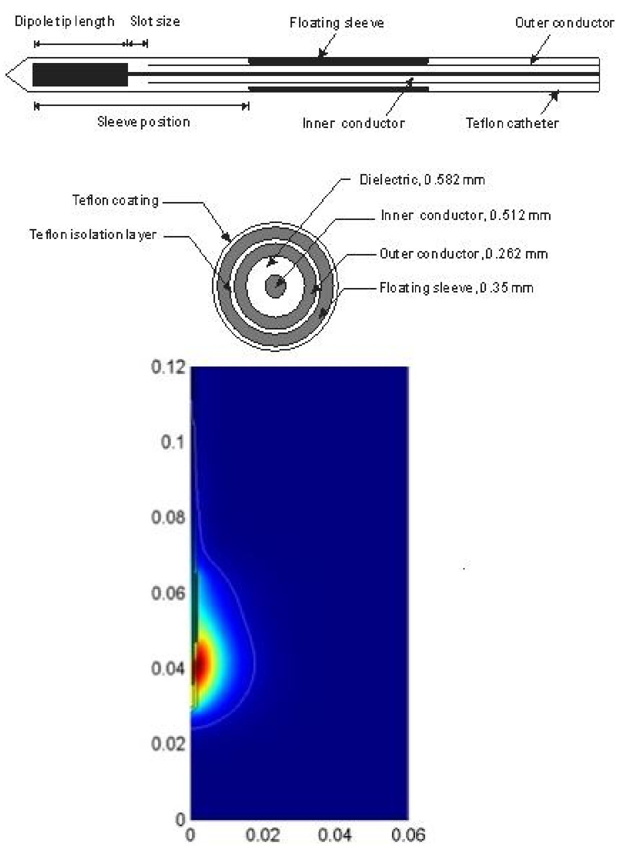
Recent Research Highlights

► **Medical Images Benefit from Algorithm:** A new technique to improve the usefulness of brain scans could be a boon to medicine. The approach combines systems and control, computer vision, and image processing to track objects in dynamically changing environments. For the first time, the technique allows researchers to robustly and efficiently extract key brain structures, such as major neural connections known as "fiber tracts," which impact just about every aspect of brain imaging. This technique can aid image-guided therapy, assist image-guided surgery and treatment, and detect diseases such as schizophrenia. The same technique can be applied to novel virtual colonoscopy as a minimally invasive method to identify suspicious polyps in screening for colon cancer.



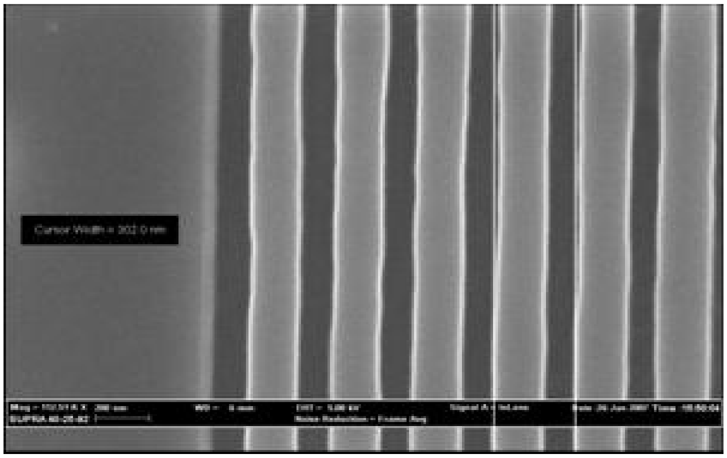
Three key neural fiber bundles are located in a human brain using the shape-based tractography technique on diffusion tensor magnetic resonance imagery. *Credit: Georgia Institute of Technology.*

► **Simulation Techniques That Improve Cancer Treatment:** What do microwave antennas have to do with cancer treatment? By inserting a thin coaxial cable into cancerous tissue to transmit the microwave power, the heat from microwaves can be used to shrink or eliminate tumors. Designing the antenna's radiation pattern is critical to achieving a heating pattern that removes only the cancerous tissue. To assess and design new antennas for treatment, researchers at the University of Wisconsin and Georgia Institute of Technology combined clinical knowledge with state-of-the-art computer simulation models. Their new designs will ablate the cancerous tissue without seriously damaging the healthy tissue and will limit radiation exposure. Using their modeling scheme, the researchers determined that the resulting antenna would provide a 27 percent improvement over the standard design used in clinical treatment. They also developed a modeling scheme that considers individual tissue variation so that treatment can be tailored to each patient's needs.



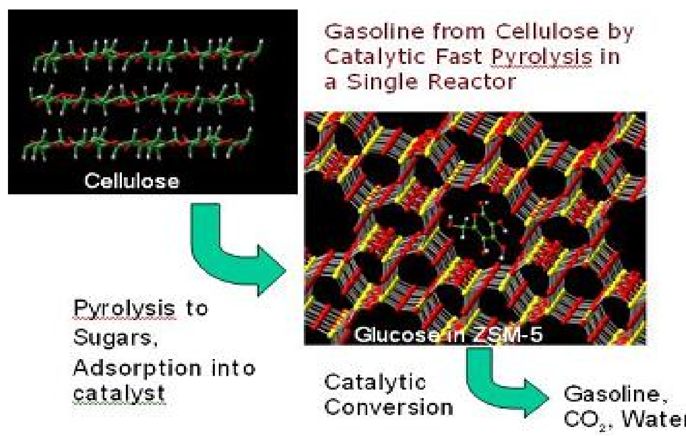
By optimizing microwave antenna design, University of Wisconsin researchers demonstrated it is possible to ablate cancerous tumors without causing severe damage to surrounding noncancerous tissue. *Credit: Michael Ferris, Univ. of Wisconsin.*

► **A Better Light Trap Improves Efficiency of Solar Cells:** Development of a thin film with almost complete light absorption will make it possible to create solar cells with unprecedented efficiency. To achieve high efficiency, it is essential to trap light in a way that increases the absorption path length in the thin film. A research team at the Massachusetts Institute of Technology has developed a new light-trapping scheme using a novel photonic crystal backside reflector. The reflector increases the optical path length more than 104 times the thin film's thickness for almost complete light absorption. This optimized back reflector will significantly increase thin film Si solar cell efficiency; for a 2-mm thick (silicon) thin-film solar cell, the relative efficiency enhancement is expected to be as high as 53 percent. The researchers fabricated the design at the University of New Mexico node of the National Nanotechnology Infrastructure Network using a process that can be scaled up at low cost.



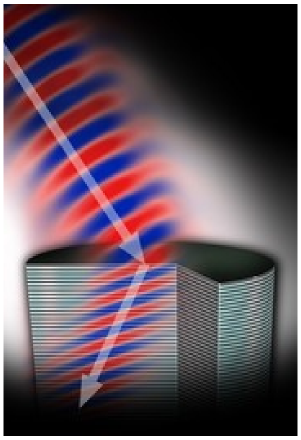
Scanning electron microscope image of a thin film patterned with interference lithography tool. *Credit: University of New Mexico.*

► **A One-Step Process to Convert Cellulose into Gasoline:** Biofuels from plant sources such as switchgrass and forest waste are becoming vital as our society moves away from petroleum-derived resources. The current roadblock to producing these new biofuels is the lack of economical processes to convert the plant matter into liquids. The ideal process would selectively produce a liquid biofuel from solid biomass in a single, small reactor. A group of researchers at the University of Massachusetts at Amherst recently demonstrated that gasoline range aromatics and olefins can be produced from solid biomass quickly and in high yields in a single reactor over zeolite-based catalysts. The process, named "catalytic fast pyrolysis," addresses the needs of the recently passed Energy Independence and Security Act of 2007, which mandates increased production of renewable fuels.



In one reactor, cellulose is broken up into sugar fragments that interact with a catalyst to become aromatic compounds used for gasoline. *Credit: George Huber, University of Massachusetts at Amherst.*

► **Bending Light Backwards:** In nature, light waves and other forms of electromagnetic radiation bend when they pass from one medium into another, but they continue to move forward. Using alternating layers of different semiconductors, Princeton University researchers have created a new optical "metamaterial" that causes light to bend backwards. This behavior has significant potential for optical components such as lenses for magnification and imaging. Princeton's invention is the first three-dimensional metamaterial that bends light backwards and is composed of semiconductors for ease in manufacturing. The metamaterial has relatively low optical loss and functions over a very wide range of mid-infrared wavelengths. With these features, the metamaterial has tremendous potential to be used in devices such as chemical threat sensors, communications equipment, and medical diagnostics tools. For science fiction fans, it means cloaking devices like those featured in Star Trek and Harry Potter are one step closer to reality.



Light bends backwards in a new optical metamaterial with a negative index of refraction. The material is crafted from alternating layers of semiconductors (indium-gallium-arsenic and aluminum-indium-arsenic). *Credit: Claire Gmachl.*

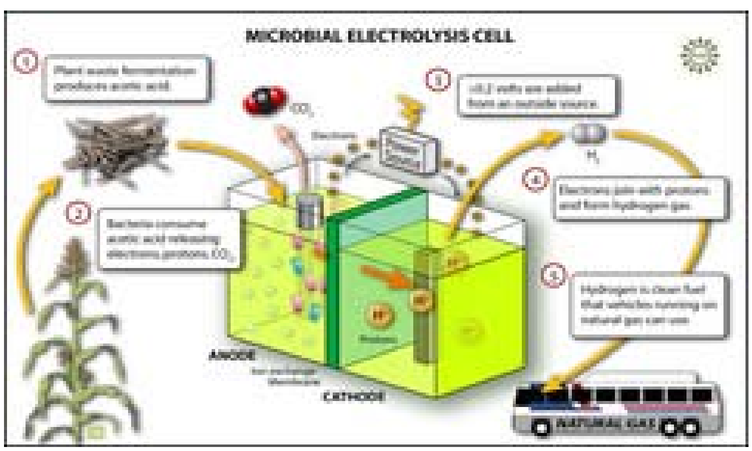
► **Bridges Get All Shook Up:** Researchers at the University of Nevada-Reno are testing the performance of entire four-span bridges and individual bridge components by subjecting them to simulated earthquake ground motion. This is the first system that can examine the interactions between components and assess the performance of the entire bridge system. In light of recent events such as the Minneapolis Interstate 35W bridge collapse and earthquake-related failures, such research to ensure a strong and resilient national infrastructure is critical. In the laboratory in Reno, researchers are building and testing large-scale models of existing bridges and innovative infrastructure with seismic-resistant design. Researchers from the University of California at San Diego and Florida International University, as well as Japan's Tokyo Institute of Technology, are collaborating in the testing. This project, which uses the George E. Brown, Jr., Network for Earthquake Engineering Simulation (NEES) infrastructure, will advance fundamental understanding and will help to improve the design criteria and seismic codes to ensure better bridge performance in future earthquakes.

Model bridge tested at the University of Nevada at Reno. *Credit: M. Saiidi, University of Nevada, Reno.*

► **Touch Robot Mimics Human Arm:** NSF-funded research by Western Robotics of Kirtland, Ohio, has created a Touch Robot with low inertia links, low friction joints, and totally smooth actuation – in short, a robot with dynamics similar to the human arm. This breakthrough means it can be made to work the way humans do, by using force and tension, rather than by repeating positions like conventional robots. When a robot interacts compliantly with its environment, just like a person, it can sense, react, and adjust to variations and imprecision. NSF-funded work at the University of Michigan combines the Touch Robot technology with Michigan's noncontact precision inspection technology. The goal is to close the loop between inspection and product manufacture, making manufacturing equipment that works intelligently and ensures every part is made correctly. The work is initially focused on smoothing and shaping jet engine turbine blades, a difficult, injurious manufacturing process that has resisted automation. Ultimately, this technology may allow robots to perform a variety of strenuous and hazardous tasks in manufacturing.

Mockup of integrated inspection and robotic turbine blade finishing system. *Credit: Western Robotics.*

► **Microbes Churn out Hydrogen at Record Rate:** Starting from raw materials that can include waste streams, a team of researchers at Pennsylvania State University reports progress toward practical generation of electric power or hydrogen by microbial fuel cells. The team recently announced they have increased hydrogen yield to a new record for this type of system, with the addition of a small jolt of electricity. Yields as high as 91 percent from vinegar and 68 percent from cellulose were achieved. Incorporating all energy inputs and outputs, the overall efficiency of the vinegar-fueled system is better than 80 percent, far better than the efficiency for generating ethanol. The researchers note that microbial fuel cells can be used to generate electric power if the objective is not to produce hydrogen.



Researchers designed a microbial electrolysis cell in which bacteria break up acetic acid (a product of plant waste fermentation) to produce hydrogen gas with a very small electric input from an outside source. Hydrogen can then be used for fuel cells or as a fuel additive in vehicles that now run on natural gas. *Credit: Zina Deretsky, National Science Foundation.*

CHEMICAL, BIOENGINEERING, ENVIRONMENTAL, AND TRANSPORT SYSTEMS — $160,110,000 +$14,090,000 / 9.6%

Chemical, Bioengineering, Environmental, and Transport Systems Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, CBET	**$132.81**	**$146.02**	**$60.40**	**$160.11**	**$14.09**	**9.6%**
Major Components:						
Research and Education Grants	119.88	132.37	57.00	146.46	14.09	10.6%
Centers	9.63	9.95	-	9.95	-	-
Nanoscale Science and Engineering Centers	*5.63*	*5.95*	-	*5.95*	-	-
STC: Ctr. for Advanced Materials for Water Purification	*4.00*	*4.00*	-	*4.00*	-	-
Facilities	3.30	3.70	3.40	3.70	-	-
National Nanotechnology Infrastructure Network	*3.30*	*3.70*	*3.40*	*3.70*	-	-

The Chemical, Bioengineering, Environmental, and Transport Systems division (CBET) supports research to enhance and protect U.S. national health, energy, environment, and security. Through CBET, the physical, life, and social sciences are merged in engineering research and education, resulting in advances in the rapidly evolving fields of bioengineering and environmental engineering, and in areas that involve the transformation and/or transport of matter and energy by chemical, thermal, or mechanical means. CBET investments contribute significantly to the knowledge base and to the development of the workforce for major components of the U.S. economy, including chemicals, pharmaceuticals, medical devices, forest products, metals, petroleum, food, textiles, utilities, and microelectronics. CBET supports research in biotechnology and the chemical, environmental, biomedical, mechanical, civil, and aerospace engineering disciplines.

To achieve synergy across disciplinary boundaries, CBET is organized into four program clusters: Chemical, Biochemical, and Biotechnology Systems; Biomedical Engineering and Engineering Healthcare; Environmental Engineering and Sustainability; and Transport and Thermal Fluids Phenomena.

In general, 65 percent of the CBET portfolio is available for new research grants. The remaining 35 percent is used primarily to fund continuing grants made in previous years.

FY 2010 Funding

CBET will continue to allocate the majority of its budget to research and education grants. The current balance emphasizing new over continuing grants provides the division with the opportunity to support the most cutting-edge research and educational programs. In addition, CBET will continue to participate in major NSF-wide investments, such as Cyber-enabled Discovery and Innovation (CDI), Science and Engineering Beyond Moore’s Law (SEBML), and to support Nanoscale Science and Engineering Centers (NSEC), the National Nanotechnology Infrastructure Network (NNIN), and a Science and Technology Center (STC) in the area of water purification.

Funding for research and education grants supports work in areas at the intersection of engineering and the physical, life, and social sciences, such as catalysis, chemical process design, environmental engineering, advanced materials, fuel cells, fluid flow, combustion, heat transfer, and particulate processes. These investments contribute to advances that are important for energy, the environment, transportation, information technologies, health-related products, and other national priorities that both impact our daily lives and sustain and enhance U.S. competitiveness.

Current high-emphasis areas include multi-disciplinary research funded through programs across the division and with support from outside the division. This cross-disciplinary research leads to improved biosensors, biomaterials, controlled drug release, improved medical devices and instrumentation, artificial organs, therapeutic agent bioprocessing, bioremediation, water and waste treatment, and food engineering.

Changes by Activity/Cluster

CBET Research and Education Grants (+$14.09 million, to a total of $146.46 million).
Research and Education Grants from CBET's programs support interdisciplinary, frontier research in many national priority areas. CBET will increase funding for these grants in order to raise the division's funding rate, particularly in the areas of energy, environment, and sustainability; nanoscale science and engineering; and complex engineered and natural systems. Within this larger investment, funding will also support the following cross-Foundation investments:

- *Science and Engineering Beyond Moore's Law (+$2.0 million, to a total of $2.70 million).* This increase from CMMI reflects the priority this research takes within the division and the engineering community, and the importance of the innovations that will come from these investigations. Support will focus on research exploiting quantum states and interactions, new connection architectures, and new algorithms that will significantly advance computations ability. Frontier research areas included: new materials, new control principles, massive parallelism and designed asynchronicity and interdeterminacy.

- *Cyber-enabled Discovery and Innovation (CDI) (+$1.10 million, to a total of $5.23 million).* The academic communities funded by CBET rely on high-performance computing for multi-scale modeling of biomedical, biological, and behavioral systems. Investment in CDI builds capacity for high-performance computing. To advance efforts in multi-scale modeling and encourage its connections with experimental efforts, in FY 2010 CBET will increase funding of projects involving CDI through its disciplinary programs.

CIVIL, MECHANICAL, AND MANUFACTURING INNOVATION $191,660,000 +$16,820,000 / 9.6%

Civil, Mechanical, and Manufacturing Innovation Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, CMMI	**$161.11**	**$174.84**	**$57.76**	**$191.66**	**$16.82**	**9.6%**
Major Components:						
Research and Education Grants	134.28	144.01	56.00	160.65	16.64	11.6%
Centers	5.93	7.11	-	7.11	-	-
Nanoscale Science and Engineering Centers	*5.13*	*6.31*	-	*6.31*	-	-
National Institute for Science Education	*0.55*	*0.55*	-	*0.55*	-	-
National Center for Learning and Teaching	*0.25*	*0.25*	-	*0.25*	-	-
Facilities	20.90	23.72	1.76	23.90	0.18	0.8%
Network for Earthquake Engineering Simulation	*19.20*	*21.82*	-	*22.00*	*0.18*	*0.8%*
National Nanotechnology Infrastructure Network	*1.70*	*1.90*	*1.76*	*1.90*	-	-

The Civil, Mechanical, and Manufacturing Innovation division (CMMI) supports fundamental research leading to advances that promote the global competitiveness of the nation's manufacturing sector; enhance the sustainability and resiliency of the nation's civil infrastructure; help protect the nation from extreme natural events; and economically improve the nation's health care systems. Approximately 69 percent of the funding allocated to the division is available for new research grants, with the remaining 31 percent applied primarily to fund continuing awards made in previous years.

CMMI programs are organized into four clusters: Advanced Manufacturing; Mechanics and Engineering Materials; Resilient and Sustainable Infrastructures; and Systems Engineering and Design. The **Advanced Manufacturing** Cluster is comprised of the Nanomanufacturing, Materials Processing and Manufacturing, Manufacturing and Construction Machines and Equipment, and Manufacturing Enterprise Systems programs. The research and education projects funded by these programs are concerned with every stage of the manufacturing process. The **Mechanics and Engineering Materials** Cluster includes the Materials and Surface Engineering, Structural Materials and Mechanics, Mechanics of Materials, Geomechanics and Geotechnical Systems, and Nano and Biomechanics programs. The **Resilient and Sustainable Infrastructures** Cluster includes the Geotechnical Engineering, Hazard Mitigation and Structural Engineering, Infrastructure Management and Extreme Events, Civil Infrastructure Systems, and the George E. Brown, Jr. Network for Earthquake Engineering Simulation Research (NEESR) programs. The Network for Earthquake Engineering Simulation (NEES) is a system of 15 experimental facilities located at universities across the United States that work together via cyberinfrastructure. This distributed research facility addresses important challenges in earthquake and tsunami engineering research that previously could not be addressed, such as testing structures at near to full scale. The **Systems Engineering and Design** Cluster consists of the Operations Research, Engineering Design and Innovation, Control Systems, Service Enterprise Systems, Sensors and Sensing Systems, and Dynamical Systems programs.

CMMI also promotes the funding of multidisciplinary research and cross-divisional activities through the Interdisciplinary and Cross-divisional Activities program.

FY 2010 Funding

High-emphasis areas for FY 2010 will include civil infrastructure protection, resilience and sustainability; energy manufacturing; megaquakes/megacities; and competitive manufacturing and service enterprises. Funding for research in **civil infrastructure protection, resilience, and sustainability** will enable accelerated progress in understanding the interactions between different elements of civil infrastructure and between people and infrastructure during times of extreme events, leading to knowledge that enables the development of a more resilient and sustainable complex of infrastructure and to more appropriate and effective approaches to recovery from attacks and natural disasters. Funding for research in **energy manufacturing** will enable the manufacturing sector to provide crucial solutions to the Nation's energy problems, enable scale-up of promising energy technologies, and revitalize the manufacturing sector of the U.S. economy. This research focus will include technologies that enhance the availability of energy to the Nation and promote a cleaner, safer environment. Research supported in the area of **megaquakes/megacities** will focus on providing new information to enable better regulation and construction for withstanding extreme events, such as earthquakes and tsunamis, and to mitigate the hazards that these threats impose on people. Funding for **competitive manufacturing and service enterprises** will enable research that provides new technologies for improving the nation's manufacturing and service enterprises. Health care and transportation systems in particular can benefit from the implementation of advanced engineering approaches to manufacturing, including scheduling, resource allocation, and quality control.

Changes by Activity/Cluster

CMMI Research and Education Grants (+$16.64 million, to a total of $160.65 million).

Funds will be allocated to high-quality proposals across CMMI programs to enable the division to raise its success rate in support of the NSF strategic plan. Within this larger investment, funding will also support the following cross-Foundation investments:

- *Science and Engineering Beyond Moore's Law (+$2.0 million, to a total of $2.70 million).* This increase from CMMI reflects the priority this research takes within the division and the engineering community, and the importance of the innovations that will come from these investigations. Efforts in CMMI will concentrate on advanced manufacturing methods for nanoscale circuitry.

- *Cyber-enabled Discovery and Innovation (CDI) (+$900,000, to a total of $4.34 million).* CMMI will increase funding of projects involving CDI through its disciplinary programs. CMMI will support research to model both manufacturing and civil infrastructure systems as interacting networks of communicating system elements, the behaviors of which evolve with time. Such an approach has broad application to intelligent transportation systems, built structures and their attendant utilities and supporting services, and manufacturing supply chains and the accompanying codes and regulations, business relationships, and economic environments in which they all operate.

CMMI Facilities (+$180,000, to a total of $23.90 million).

Additional funding for operations and maintenance costs of George E. Brown, Jr. Network for Earthquake Engineering Simulation provides for inflationary increases within the headquarters function of the 15-site national network.

ELECTRICAL, COMMUNICATIONS, AND CYBER SYSTEMS $95,750,000 +$8,400,000 / 9.6%

Electrical, Communications, and Cyber Systems Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, ECCS	**$83.60**	**$87.35**	**$45.84**	**$95.75**	**$8.40**	**9.6%**
Major Components:						
Research and Education Grants	75.69	79.46	41.00	90.52	11.06	13.9%
Centers	3.36	2.66	-	-	-2.66	-100.0%
STC: The NanoBiotechnology Center	*3.36*	*2.66*	-	-	*-2.66*	*-100.0%*
Nanoscale Science and Engineering Centers	*3.25*	*3.40*	-	*3.40*	-	-
Facilities	4.55	5.23	4.84	5.23	-	-
National Nanotechnology Infrastructure Network	*4.55*	*5.23*	*4.84*	*5.23*	-	-

The Division of Electrical, Communications, and Cyber Systems (ECCS) will address fundamental research issues at the nano, micro, and macro scales underlying device and component technologies, power and energy, controls, networks, communications, computation, and cyber technologies. ECCS will support integration of systems principles in complex engineering systems and networks for a variety of applications areas, including health care, environment, energy, communications, disaster mitigation, homeland security, transportation, and manufacturing. ECCS envisions a research community that will address major technological challenges for the next generation of devices and systems due to convergence of technologies and increased emphasis on interdisciplinary research. ECCS will integrate education into its research programs to ensure preparation of a diverse workforce to meet the technological challenges of a 21st century global economy. In general, 65 percent of ECCS funds are available for new research grants; the remaining 35 percent of funds are in continuing grants made in prior years.

ECCS organizes its research and education activities into three programs: Electronics, Photonics and Device Technologies; Power, Controls and Adaptive Networks; and Integrative, Hybrid and Complex Systems. ECCS supports instrument acquisition through NSF's Major Research Instrumentation program. ECCS has lead oversight and provides funding for a Science and Technology Center in the area of Nano-Biotechnology, which receives its final year of NSF support in FY 2009. The division provides partial funding for several Nanoscale Science and Engineering Centers. ECCS also has lead oversight for the National Nanotechnology Infrastructure Network, an integrated national network of user facilities for research and education in nanoscale science, engineering, and technology, which has been renewed for an additional five-year award period with funding by all NSF research and education directorates and the Office of International Science and Engineering.

FY 2010 Funding

The **Electronics, Photonics and Device Technologies** (EPDT) program will invest in research and education to advance innovation and fundamental understanding of devices and component technologies based on the principles of electronics, photonics, magnetics, organics, electromechanics, and related physical phenomena at the micro- and nanoscale. The program's investments in nanotechnology research are significant and span the areas of nanoelectronics, nanophotonics, and nanomagnetics.

The **Power, Controls and Adaptive Networks** (PCAN) program will invest in research and education in the design and analysis of adaptive and complex engineering systems and networks, including sensing, imaging, controls, and computational technologies for a variety of application domains.

The **Integrative, Hybrid and Complex Systems** (IHCS) program is intended to spur visionary systems-oriented activities in collaborative research and education environments for multidisciplinary integrative activities. The program will focus on innovative research in micro- and nanosystems, communications systems, and cyber systems that integrate physical devices and components with controls, computational intelligence, and networks.

ECCS will support education and workforce development through foundation-wide and Engineering programs, such as CAREER, Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers (ADVANCE), and through Research Experiences for Undergraduates (REU), Research Experiences for Teachers (RET), and Graduate Research Supplements programs.

Changes by Activity/Cluster

Research and Education Grants (+$11.06 million, to a total of $90.52 million).

ECCS will increase funding for highly meritorious research and education activities. Research from investigator-initiated proposals expands the body of knowledge and has the potential for transformative advances in areas of national priority such as energy, infrastructure, health care, security, and economic competitiveness. This increase will enable ECCS to both increase the number and size of its awards. Within this larger investment for research and education grants, funding will also support the following investments.

- *Cyber-Physical Systems (+$4.51 million, to a total of $7.01 million).* Cyber-physical systems deeply integrate computation, communications, and control into physical systems. They can transform how we interact with the physical world and how engineered systems can be realized. ECCS and the Directorate for Computer and Information Science and Engineering (CISE) are collaborating on this important topic and plan to reissue a joint solicitation in FY 2010. ECCS is increasing support for this collaboration, because the engineering community has strongly responded to the opportunity for ground-breaking research supported by this solicitation.

- *Science and Engineering Beyond Moore's Law (+$3.0 million, to a total of $4.60 million).* This NSF-wide investment area is central to ECCS's support of research on nanoelectronics and spin electronics device technologies that focus on concepts beyond the scaling limits of silicon technology. This additional contribution from ECCS reflects the priority this research takes within the division and the engineering community, and the importance of the innovations that will come from these investigations.

- *Cyber-enabled Discovery and Innovation (CDI) (+$1.0 million, to a total of $4.44 million).* Investment in CDI builds capacity for high-performance computing. To advance efforts in multi-scale modeling and encourage its connections with experimental efforts, in FY 2010 ECCS will increase funding of projects involving CDI through its disciplinary programs.

INDUSTRIAL INNOVATION AND PARTNERSHIPS **$156,000,000 +$14,770,000 / 10.5%**

Industrial Innovation and Partnerships Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, IIP	**$130.72**	**$141.23**	**$55.00**	**$156.00**	**$14.77**	**10.5%**
Major Components:						
Small Business Innovation Research (SBIR)	97.51	106.59	44.70	118.49	11.90	11.2%
Small Business Technology Transfer (STTR)	11.56	12.62	5.30	14.03	1.41	11.2%
Grant Opportunities for Academic Liaison w/ Industry (GOALI)	5.79	5.73	2.50	6.44	0.71	12.4%
Industry/University Cooperative Research Centers (I/UCRC)	6.67	7.10	2.50	7.85	0.75	10.6%
Partnerships for Innovation (PFI)[1/]	9.19	9.19	-	9.19	-	-

[1/] Funding for Partnerships for Innovation (PFI) will be transferred in FY 2010 from Integrative Activities (IA) to the Directorate for Engineering, which manages the program. Funding for PFI is shown for all years for comparability.

The Division of Industrial Innovation and Partnerships (IIP) serves the entire foundation by fostering partnerships to transform discoveries into technological innovations with societal benefits. IIP is home to two NSF small business research programs, the Small Business Innovation Research (SBIR) program and the Small Business Technology Transfer (STTR) program. Additionally, IIP leverages industrial support through three research programs, the Industry/University Cooperative Research Centers (I/UCRC) program, the Grant Opportunities for Academic Liaison with Industry (GOALI) program, and the Partnerships for Innovation (PFI) program.

FY 2010 Funding

Each year, the NSF SBIR and STTR programs (mandated by Public Law 106-554 and 107-50, respectively) support ground-breaking research by U.S. small businesses on topics that span the breadth of NSF scientific and engineering research and reflect national and societal priorities. The SBIR and STTR programs target research that is too risky for even early-stage corporate investment, but that, if successful, has the potential for further development and commercialization with investment from capital markets and strategic partners. Although SBIR and STTR are two distinct NSF programs, until recently they both invited proposals from one common solicitation that reflected broad topics. To manage the business community's increasing interest in STTR grants, IIP has begun issuing a separate STTR solicitation. The program's current focus is on multifunctional materials, an area of significant NSF fundamental research with strong innovation potential. This program offers an excellent opportunity to translate academic research into commercial innovations in bio-inspired materials and systems, materials for sustainability, and smart materials and structures by partnering with the small business community.

The SBIR program is aligned into four technology clusters: biotech and chemical technologies; education applications; information and communication technologies; and nanotechnology, advanced materials, and manufacturing. These topics are well positioned to attract research proposals from the small business community; moreover, they are of interest to large corporations that see the potential for strategic partnerships with small businesses, as well as to investors who seek to support and grow new businesses.

The I/UCRCs work closely with industry to develop the enabling technologies needed for national priorities, such as managing the electrical power system, improving manufacturing and biological processes, and improving information and telecommunications technologies. The I/UCRC program provides modest seed funds and management expertise to highly leveraged centers, with states joining in many partnerships to expand the impact of center activities on local economic development. The program also supports a supplemental activity to advance the fundamental science and engineering research underlying the center technologies. The I/UCRC program, in collaboration with the NSF SBIR/STTR programs, recently began supporting academic-small business partnerships as a means to accelerate the innovation process through synergistic opportunities. To further expand the range of businesses involved in the centers, the program is examining additional options for industry participation besides the traditional center memberships and SBIR/STTR partnerships. Due to interest from centers, the I/UCRC program is exploring ways to maintain NSF involvement in graduating centers and to encourage international collaborations.

The GOALI program seeks to increase partnerships between the academic and industrial communities. The program leverages its budget with support from other NSF academic research programs by a factor of four to one. In FY 2010, the GOALI program will continue to seek opportunities to accelerate innovation by strengthening the discovery knowledge base for a quicker translation of discovery to societal benefit.

The PFI program connects knowledge created in the discovery process to learning and innovation. Goals are to: stimulate knowledge transformation created by the national research and education enterprise into innovations that create new wealth, build strong economies, and improve the national well-being; broaden participation to more fully meet the range of workforce needs of the national innovation enterprise; and enhance infrastructure necessary to foster and sustain innovation in the long-term. Partnerships must include a U.S. academic institution as lead and a private sector partner; state/local government partners are also encouraged. In FY 2010, PFI will continue to support partnerships that foster learning and innovation. Funding for Partnerships for Innovation (PFI) will be transferred in FY 2010 from Integrative Activities (IA) to the Directorate for Engineering, which manages the program.

Changes by Activity/Cluster

Small Business Innovation Research (+$11.90 million, to a total of $118.49 million). The increase for the Small Business Innovation Research program (SBIR) will support the anticipated significant increase in Phase I proposals. The interest level for research funding from the small business community has already been very high, which is a reflection of the 2009 economic climate. Further, to help sustain ongoing research by Phase II grantees, some funding will be used for additional supplements.

Small Business Technology Transfer (+$1.41 million, to a total of $14.03 million). NSF received significantly more proposals in response to the FY 2009 STTR solicitation on multifunctional materials. IIP will use the requested FY 2010 increase for the STTR program to raise the funding rate.

Industry/University Cooperative Research Centers (+$750,000, to a total of $7.85 million). The funding increase for the I/UCRC program will be used to support 8 additional centers. The recently expanded partnerships between I/UCRC and SBIR/STTR to graduated awardees will be supported by the increase in funding.

Grant Opportunities for Academic Liaison with Industry (+$710,000 to a total of $6.44 million). The increase for the GOALI program will be used to target growing interest from industry members for supporting post-doctoral fellows in industry. Such an effort will provide future faculty members with experience in an industrial innovation ecosystem and thereby strengthen their ability to educate and train future entrepreneurs and innovators.

ENGINEERING EDUCATION AND CENTERS

$132,000,000
+$14,550,000 / 12.4%

Engineering Education and Centers Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan	
					Amount	Percent
Total, EEC	**$116.02**	**$117.45**	**$32.00**	**$132.00**	**$14.55**	**12.4%**
Major Components:						
Research and Education Grants	52.60	53.90	13.50	60.25	8.55	15.9%
Centers	63.42	63.55	18.50	71.75	8.20	12.9%
Engineering Research Centers	*53.42*	*53.55*	*18.50*	*59.55*	*6.00*	*11.2%*
Nanoscale Science and Engineering	*10.00*	*10.00*	-	*10.00*	-	-
Science of Learning Center [1/]	-	-	-	*2.20*	*2.20*	*N/A*

[1/] Funding for the Science of Learning Center (SLC) is added for all years for comparability. SLC will be cofunded with the Directorate for Social, Behavioral and Economic Sciences (SBE) beginning in FY 2010.

The Engineering Education and Centers (EEC) Division promotes and facilitates university interdisciplinary research and curricula by supporting innovative programs that integrate research and education, improve the quality of the engineering workforce, cut across disciplines, develop partnerships with industry, and enable a breadth of investigation that spans the inception of an idea to proof of concept.

The division's programs are divided into three major categories: (1) Major Centers (Engineering Research Centers and Nanoscale Science and Engineering Centers), for the support of interdisciplinary research that fosters partnerships among academe, government, and industry; (2) Engineering Education Research, for advancing the quality and productivity of both undergraduate and graduate engineering pedagogy; and (3) Human Resources, for the development of a diverse and capable engineering workforce. EEC programs address issues that are critical to all fields of engineering and complement the research and education portfolios of the other divisions of the Directorate for Engineering. In general, 15 percent of the EEC portfolio is available for new grants each year, while 85 percent is used primarily to fund grants made in previous years for centers, graduate fellowships, and undergraduate programs.

FY 2010 Funding

In FY 2010, EEC will continue to support Engineering Research Centers, Nanoscale Science and Engineering Centers, engineering education research, and engineering workforce development.

In FY 2010, 15 ERCs will receive funding to support research that includes: biomaterials for implants, power electronics, detection and warning systems for severe storms, and systems for delivery and management of renewable electric energy. ERCs initiated in FY 2008 or later, known as Generation-3 ERCs, place increased emphasis on innovation and entrepreneurship, partnerships with small research firms, and international collaboration and cultural exchange. These added dimensions speed the translation of fundamental research to innovations in U.S. industry and prepare engineering graduates to succeed in a global economy.

The ongoing NSECs, fully or partially supported by EEC, perform research to advance the development of the ultra-small technology that will transform electronics, materials, medicine, and many other fields.

They involve key partnerships with industry, national laboratories, and other sectors; NSECs also support education programs from the graduate to the pre-college levels designed to develop a highly skilled workforce. Funds are also provided to smaller interdisciplinary teams and to the Network for Computational Nanotechnology (www.nanoHub.org), a web-accessible repository of simulations of nanoscale phenomena for research and education.

Research programs for engineering education are aimed at transforming engineering education to produce an engineering workforce that is diverse and creative, understands the impacts of its solutions on both technical and social systems, and possesses the ability to adapt to the rapidly evolving technical environment in industry, academe, and society.

A second focus for engineering education in FY 2010 will be to encourage engineering schools to recruit and serve veterans, particularly those who receive education benefits under the new GI Bill. Effective August 1, 2009, the Post-9/11 GI bill will provide veterans, service members, and members of the National Guard and Selected Reserve with support in reaching their educational goals.

EEC offers grants to develop the engineering workforce through two human resources programs: the Research Experiences for Undergraduates (REU) program and the Research Experiences for Teachers (RET) program. The REU program supports undergraduate engineering students in summer research internships under the tutelage of a senior engineering professor; in FY 2008, about 1,500 undergraduates participated in the program.

Changes by Activity/Cluster

Centers (+$6.0 million, to a total of $69.55 million).

The FY 2010 increase will enable the addition of three new Generation-3 ERCs as part of the Class of 2010 and will also provide for the planned growth of recently awarded centers in line with the phased funding approach. The increase will enhance the ability of the ERC program to further impact competitiveness and stimulate job creation in two ways: by initiating collaborative research partnerships to translate ERC research advances into innovative new products; and by increasing the involvement of pre-college teachers to bring engineering to pre-college classrooms and stimulate student interest in engineering careers.

Human Resources (+$700,000, to a total of $14.70 million).

Additional FY 2010 funds will be used to expand two successful EEC programs that focus on the engineering workforce. The first program that EEC seeks to expand is the Research Experiences for Undergraduates (REU) program; $500,000 is requested to support two additional REU sites at U.S. universities to diversify the regions and topics involved in the program. The second program that EEC seeks to expand is the Research Experiences for Teachers (RET) program; EEC requests an additional $200,000 to support two additional site awards for this successful program.

Engineering Education (+$700,000, to a total of $12.85 million).

The requested increase will be used to address and bolster the project on personalized learning in engineering education, and the project on encouraging engineering schools to recruit and serve veterans, which EEC will accomplish by providing planning grants and disseminating the plans.

EMERGING FRONTIERS IN RESEARCH AND INNOVATION $29,000,000

+$2,550,000 / 9.6%

Emerging Frontiers in Research and Innovation Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, EFRI	**$25.23**	**$26.45**	**$14.00**	**$29.00**	**$2.55**	**9.6%**
Major Components:						
Research and Education Grants	25.23	26.45	14.00	29.00	2.55	9.6%

The Office of Emerging Frontiers in Research and Innovation (EFRI) resides within the Office of the Assistant Director for Engineering and was established in FY 2007 to fulfill the critical role of helping ENG focus on important emerging areas in a timely manner. Each year EFRI recommends, prioritizes, and funds interdisciplinary topics at the emerging frontiers of engineering research and education. These emerging frontiers are frequently found in transformative interdisciplinary areas. EFRI enables the Directorate for Engineering (ENG) to strategically pursue such research and allows the engineering community to come forward with new and paradigm-shifting proposals at the interface of disciplines and fields.

Technological innovations have given rise to new industries, expanded access to quality healthcare, and fueled national prosperity even as global competition has grown. To help ensure the nation's continued success, EFRI will provide critical, strategic support of fundamental discovery, particularly in areas that may lead to breakthrough technologies and strengthen the economy's technical underpinnings.

EFRI investments represent transformative opportunities, potentially leading to: new research areas for NSF and other agencies; new industries or capabilities that result in a leadership position for the country; and/or significant progress on a recognized national need or grand challenge. These challenges may include areas such as sustainable energy resources; safe, clean water; technologies to overcome physical limitations from disease or injury; and integrated systems designed to thwart attacks on U.S. infrastructures and interests throughout the world. EFRI will have the necessary flexibility to target long-term challenges, while retaining the ability and agility to adapt as new challenges demand.

In general, 95 percent of the EFRI portfolio is available for new research grants while 5 percent is used primarily to fund grants made in previous years.

FY 2010 Funding

The role of EFRI is to invest in research opportunities that would be difficult to fund with other mechanisms, such as Early-concept Grants for Exploratory Research, typical awards, or large research center solicitations. Successful projects usually require small- to medium-sized interdisciplinary teams of researchers and significant funding for several years in order to make substantial progress and to provide evidence for additional follow-on funding through other established mechanisms.

Potential EFRI topics can arise from input from a number of sources: the research community, advisory committees, workshops, professional societies, academies, proposals and awards, and NSF committees of visitors. In addition, EFRI has issued a Dear Colleague Letter and provided the opportunity for direct submission of topic ideas for the FY 2010 competition by the research community through the Web.

Examples of topic areas that EFRI has pursued based on the above sources are Autonomously Reconfigurable Engineered Systems (ARES), Cellular and Biomolecular Engineering (CBE), Cognitive Optimization (COPN), and Resilient and Sustainable Infrastructures (RESIN), Biosensing and Bioactuation: Interface of Engineering and Living Systems (BSBA), and Hydrocarbon from Biomass (HyBi). In ARES, researchers are paving new research frontiers for engineering systems that can modify themselves when subject to *unplanned* events. In CBE, methods and technologies are being developed to regenerate some of the body's most complex tissues. COPN projects are building new dynamic optimization algorithms and robotic systems by studying the way systems of neurons do such complex tasks. RESIN projects are developing the theoretical foundation, methods, and technologies for making interdependent critical infrastructures both resilient and sustainable. BSBA will fund projects that lead to the development of intelligent systems to address a number of national needs including protection of critical and aging infrastructures, early detection and treatment of currently incurable diseases, and mitigation of environmental hazards and pollution. HyBi will fund projects to develop non-ethanol "green gasoline," an area of critical need that will help reduce U.S. dependence on foreign oil while producing fuel through an environmentally-friendly green process.

EFRI research in FY 2010 will better enable ENG to meet its strategic goal of fostering frontier and transformative research. Topics for EFRI support will typically relate to the five ENG research themes as well as consider the grand challenges identified by National Academy of Engineering (www.engineeringchallenges.org). When appropriate, EFRI will partner with other programs within NSF and other agencies.

Changes by Activity/Cluster

Emerging Frontiers in Research and Innovation (+$2.55 million, to a total of $29.0 million).

The additional $2.55 million will allow for the support of 14 awards, rather than 12, to strengthen the impact of this important office.

GEOSCIENCES

$909,000,000
+$101,870,000 / 12.6%

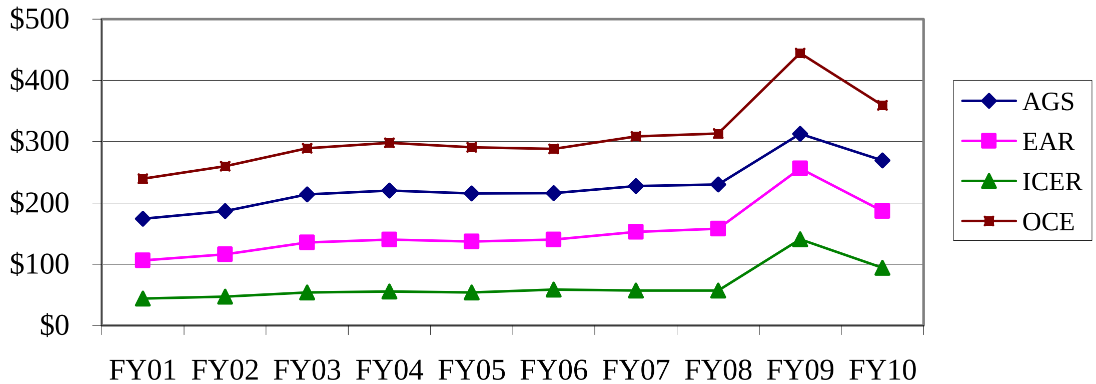
Geosciences Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Atmospheric and Geospace Sciences (AGS)	$230.03	$244.60	$68.20	$269.16	$24.56	10.0%
Earth Sciences (EAR)	157.82	171.00	85.22	186.85	15.85	9.3%
Integrative & Collaborative Education and Research (ICER)	56.96	61.17	79.58	93.92	32.75	53.5%
Ocean Sciences (OCE)	313.06	330.36	114.00	359.07	28.71	8.7%
Total, GEO	**$757.87**	**$807.13**	**$347.00**	**$909.00**	**$101.87**	**12.6%**
Major Components:						
Research and Education Grants	$713.24	$769.77	$274.15	$874.82	$105.05	13.6%
Instrumentation	52.87	67.76	10.32	79.48	11.72	17.3%
Centers Programs	18.56	18.26	-	13.79	-4.47	-24.5%
Facilities O&M	255.05	299.32	62.53	282.30	-17.02	N/A

Totals may not add due to rounding.

As the principal source of federal funding for university-based fundamental research in the geosciences, the Directorate for Geosciences addresses the Nation's need to understand, predict, and respond to environmental events and changes. GEO-supported research also advances our ability to predict natural phenomena of economic and human significance, such as climate changes, hurricanes, and earthquakes.

GEO Subactivity Funding
(Dollars in Millions)



GEO in Context

GEO provides about 63 percent of the total federal funding for university-based, basic research in the geosciences. In addition to playing a critical role in addressing the Nation's need to understand, predict, and respond to environmental events and changes, GEO also helps to determine the best use of Earth's resources. Fundamental research in the geosciences advances scientific knowledge of resources such as fresh water, energy, minerals, and biological diversity, leading to improved future quality of life. GEO investments include many environmental studies coordinated through the U.S. Climate Change Science Program.

GEO supports basic research that advances the frontiers of knowledge and drives technological innovation while improving our understanding of the many processes that affect the global environment. These processes include the role of the atmosphere and oceans in climate, the planetary water cycle, and ocean acidification. Support is provided for interdisciplinary studies that contribute directly to national research priorities: hydrologic systems, biogeochemical dynamics, ecological systems and dynamics, solid earth processes, and solar influences on the Earth system. Lives are saved and property is preserved through better prediction and understanding of natural environmental hazards such as earthquakes, tornados, hurricanes, tsunamis, drought, and solar storms. Basic research supported by GEO enables preparation for and subsequent mitigation of or adaptation to the effects of these and other disruptive natural events.

Key investments in FY 2010 are focused on NSF's Climate Research program and complementary efforts to develop America's workforce by providing graduate research fellowships and promoting education related to climate change.

The FY 2010 Request for GEO includes $8.0 million to leverage activities across the directorate aimed at increasing support for transformative research, including highly innovative research and education projects across the entire range of Geoscience interests. Special attention will be paid to challenges associated with prediction and adaptation to regional climate change and broadening the participation of investigators and institutions in the scientific enterprise. GEO will also utilize NSF's innovative processes for identifying potentially transformative research, such as special competitions and increased use of specialized funding mechanisms, notably NSF's EAGER (EArly-concept Grants for Exploratory Research) grants.

Directorate-wide Changes and Priorities

Climate Research ($46.0 million, new in FY 2010).

In FY 2010, GEO will make a major investment in NSF's new climate change research effort. The major themes under consideration for the program are: forecasting thresholds in environmental changes; balancing the carbon budget; expanding observational and modeling capabilities for water, ice, and ecosystems; understanding the impact of ocean acidification, and developing new energy-efficient computing and networking capabilities and other infrastructure for climate research. The long-term goal of this program is to assert U.S. leadership in understanding the causes and consequences of climate change and develop effective strategies to respond to it.

GEO/EHR Collaboration ($6.0 million, new in FY 2010).

Recognizing the strengths of each organization's programs and communities, in FY 2010 GEO and EHR will initiate a set of collaborative activities intended to broaden participation in the geosciences and to enhance education about and understanding of the geosciences among both students and the broader public.

CAREER (+$1.69 million, to a total of $12.22 million).

The CAREER program supports preeminent young geoscientists, and is a key mechanism for jump-starting junior faculty toward independent careers in research and education. GEO CAREER awardees not only undertake exciting potentially transformative research, but also seek to engage the next generation of citizens and scientists in innovative new ways.

Climate Change Education ($1.50 million, new in FY 2010).

In partnership with EHR, BIO and OPP, GEO will support innovative formal and informal education activities centered on the general theme of climate science.

Graduate Research Fellowships ($1.0 million, new in FY 2010).

To promote the education and participation in the research enterprise of the next generation of geoscientists, GEO is contributing to the NSF-wide Graduate Research Fellowship program. This investment will support fellowships for about 9 high-quality students who would otherwise not receive support.

Program Evaluation and Performance Improvement

The Performance Information chapter describes the Foundation's performance evaluation framework, which is built upon the four strategic outcome goals in NSF's Strategic Plan: *Discovery*, *Learning*, *Research Infrastructure*, and *Stewardship*. Performance evaluation is conducted at all levels within the Foundation, using both qualitative and quantitative measures – including an agency-wide annual review of research and education outcomes by an external expert committee and periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are also factored into the performance assessment process. GEO has a contract for assessment of its cross-directorate education programs.

Number of People Involved in GEO Activities

	FY 2008 Estimate	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate
Senior Researchers	4,618	4,900	2,000	5,500
Other Professionals	2,801	3,000	1,200	3,300
Postdoctorates	562	600	200	700
Graduate Students	2,412	2,600	1,000	2,900
Undergraduate Students	1,658	1,800	700	2,000
Total Number of People	12,051	12,900	5,100	14,400

GEO Funding Profile

	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate
Statistics for Competitive Awards:			
Number of Proposals	4,241	4,700	4,500
Number of New Awards	1,333	1,750	1,500
Regular Appropriation	1,333	1,300	1,500
ARRA	-	450	-
Funding Rate	31%	37%	33%
Statistics for Research Grants:			
Number of Research Grant Proposals	3,696	4,100	4,000
Number of Research Grants	1,059	1,400	1,200
Regular Appropriation	1,059	1,000	1,200
ARRA	-	400	-
Funding Rate	29%	34%	30%
Median Annualized Award Size	$118,339	$125,000	$130,000
Average Annualized Award Size	$149,626	$160,000	$170,000
Average Award Duration, in years	2.8	3.0	3.0

Recent Research Highlights

► **Unmanned Aerial Vehicles Identify Pollution's Role in Asian Warming Trends:** A researcher from the University of California at San Diego has discovered that pollution-filled "brown clouds" over southern Asia are playing a significant role in regional climate change. It was thought the net effect of radiation absorbed and scattered by these pollutant aerosols would be to cool Earth's surface. Instead, instrumented unmanned aerial vehicles sent over the Indian Ocean determined the local effects of the particles released from industrial and vehicle emissions and burning biomass were capable of enhancing solar heating in the lower atmosphere by 50 percent. When the effects of pollution are inserted into a climate model, the results match well with observations, especially from higher elevations such as the rapidly warming Himalayan mountain region. This research shows that on a regional scale in one of the most polluted areas on Earth, the net effect of pollutants is on the same scale as greenhouse gases.

Autonomous Unmanned Aerial Vehicles (UAVs) flown in the field experiment. The image is a montage, as the actual vertical separation of the UAVs was a much larger distance. *Credit: Dr. V. Ramanathan.*

► **First-Ever Global Map of Human Influence on the Marine Ecosystem:** More than 40 percent of the world's oceans are affected heavily by human activities according to the first ever global scale study of anthropogenic impact on marine ecosystems. NSF-funded researchers overlaid maps of 17 different factors of human activity, such as fishing, pollution, and commercial shipping, to produce a composite map of the toll that humans have exacted on the oceans. They also included effects of anthropogenic climate change such as ocean acidification, increased ultraviolet radiation, and ocean temperature in the study. They found that no region is unaffected by human activity but that large regions with relatively little human impact remain, particularly near the poles. They also found that different ecosystems were affected differently. Hard- and soft-bottom continental shelves and rocky reefs have the highest predicted cumulative impact scores while open oceans and deep waters have the lowest.

Coral reef ecosystem. *Credit: Joseph Pawlik (UNCW).*

► **Cultivating the Next Generation of Computer Scientists:** To tackle complex, real-life problems such as climate change we need sophisticated computing and data systems and the people who run them. Currently, the United States faces a shortage of scientists and engineers trained to use and maintain high-performance computer and data systems. The National Center for Atmospheric Research and its Computing and Information Systems Laboratory are striving to make inroads into this issue. In 2007, the lab launched its Summer Internships in Parallel Computational Science, which allows students to gain practical experience with a wide variety of parallel computational science problems. They work with the high-performance computing systems on applications relevant to the center's earth science mission, while being mentored by computational experts. Seven interns from Colorado, North Carolina, and Wyoming universities participated this year.

Students who took part in Summer Internships in Parallel Computational Science. From left to right are Ryan O. Kuinghttons, Colorado School of Mines; Victor Snyder, Colorado School of Mines; Kenny Gruchalla, Univ. of Colorado; Michael Levy, Univ. of Colorado; Arunasalam Rahuynanthan, Univ. of Wyoming; Matthew Norman, North Carolina State Univ.; Robert House, Univ. of Colorado. *Credit: UCAR.*

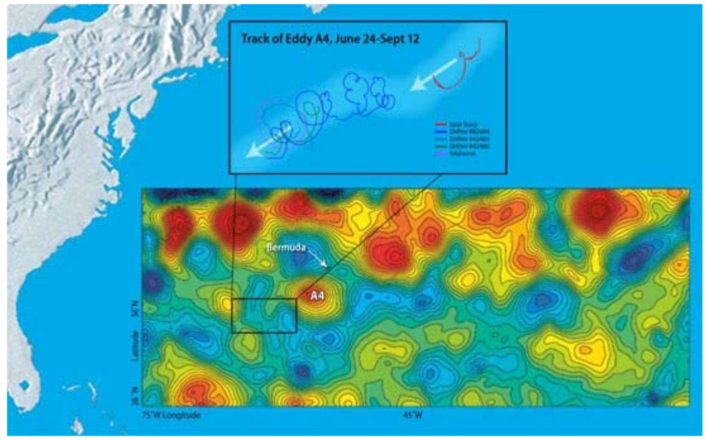
► **Students Explore the Indian Ocean through Virtual Expedition:** In 2007, researchers aboard the R/V *Roger Revelle* explored a unique 2,800-mile-long volcanic ridge in the Indian Ocean called the NinetyEast Ridge. Students from the U.S. and around the world joined the researchers at sea virtually, using Web-based activities and videoconferencing. Students actively tracked the expedition, studied photos of dredged rocks, responded to weekly science assignments from the shipboard scientists, and helped name newly discovered seamounts. Participation grew throughout the expedition and has continued to grow as results from shore-based work became available on the website. The interaction of scientists and students in real time on a research expedition is an example of education outreach that broadens participation from under-represented groups and diverse institutions from a wide array of schools nationally and internationally.

Scientists gather around the rock dredge to look at the rocks brought up from the seafloor on board the R/V *Roger Revelle*. *Credit: William Sager.*

► **Will There Be an Increase in Severe Thunderstorms Due to Climate Change?:** A recent Purdue University study used global and high-resolution regional climate models to examine large-scale meteorological conditions that foster severe weather formation in the United States. The researchers determined that in the late 21st Century, due to climate change, there likely will be an increase in the number of days in which severe thunderstorms occur. Climate models cannot currently simulate phenomena as small as thunderstorms, but they can simulate the larger-scale distributions of temperature, moisture, and winds that influence severe convective storms. In a scenario with increased temperatures from greenhouse emissions, there was growth in convective available potential energy and a decrease in wind shear, both of which are factors for severe storms. The largest future increases are projected to be during the summer, especially in the southern and eastern United States.

A severe thunderstorm that occurred on June 7, 2005, near Murdo, S.D. *Credit: Karen A. Kosiba. Photo courtesy of the Trapp research group.*

► **Wind Influences Biological Productivity of Ocean Eddies:** Researchers repeatedly sampled 10 different ocean eddies in the northern Atlantic Ocean. They found when wind interacted with eddies rotating clockwise, cold, nutrient-rich water swelled up from below the surface and continually moved surface water away from the center of the eddy. The result was sustained biological productivity at the surface and thriving phytoplankton and zooplankton communities below the surface. In contrast, productivity as a result of wind interacting with eddies rotating counterclockwise lasted only a short time due to a reverse effect. These results point to the need to include explicit representations of eddy and wind interactions in ocean and climate models. The Woods Hole Oceanographic Institution, Rutgers University, Bermuda Institute of Ocean Sciences, Virginia Institute for Marine Sciences, National Oceanography Center in the UK, Humboldt State University, the University of California at Santa Barbara and the University of Miami took part in this study.



Data from satellite altimeters (lower inset), which measure sea surface heights, show depressions (blue) and bumps (red) that mark cold- and warm-water eddies in the ocean on June 17, 2005. Researchers tracked the southwestward motion of eddy A4 (light-blue in the upper inset) by ship from June 24 to Sept. 12. They released several drifters and a buoy (colored tracks) to capture the swirling motion of the eddy's currents. *Credit: This figure was drafted by Jim Canavan and provided as a courtesy by Dennis McGillicuddy, WHOI, and the Colorado Center for Astrodynamics Research.*

► **Observations from the Critical Zone:** Scientists refer to the region between the top of the forest canopy and the base of our living environment as the critical zone. To understand the critical zone's response to climatic and land-use forces, NSF initiated observatories in the watersheds of the Sierra Nevada, the Front Range of the Colorado Rockies, and the Appalachian Uplands. The respective site managers are the University of California, the University of Colorado at Boulder, and the Pennsylvania State University. Each observatory will investigate the integration and coupling of Earth surface processes as mediated by the presence and flux of fresh water. The three observatories will work together under the guidance of an independent science steering committee. The observatories will benefit the entire Earth surface science community by spurring more collaboration and linking individual research to big questions.

Schematic vision of a Critical Zone Observatory, showing part of the multiple sensor array that will be used to investigate the hydrological, geochemical, geobiological, and physical evolution of the critical zone. Methods brought to bear by multiple investigators and institutions will range from detailed field surveys to computationally intensive numerical modeling, from geophysical and geochemical investigations to networked cyberinfrastructure that will share and archive an unparalleled data type. *Credit: Roger Bales, UC Merced.*

ATMOSPHERIC AND GEOSPACE SCIENCES **$269,160,000**

+$24,560,000 / 10.0%

Atmospheric and Geospace Sciences Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, AGS	**$230.03**	**$244.60**	**$68.20**	**$269.16**	**$24.56**	**10.0%**
Major Components:						
Research and Education Grants	$220.01	$234.60	$55.00	$259.36	$24.76	10.6%
Instrumentation	29.62	29.62	-	31.00	1.38	4.7%
Centers	8.00	8.00	-	6.80	-1.20	-15.0%
Science and Technology Centers	*8.00*	*8.00*	-	*6.80*	*-1.20*	*-15.0%*
Facilities	91.09	108.92	13.20	103.00	-5.92	-5.4%
National Astronomy and Ionosphere Center	*2.02*	*2.00*	-	*3.00*	*1.00*	*50.0%*
National Center for Atmospheric Research	*89.07*	*106.92*	*13.20*	*100.00*	*-6.92*	*-6.5%*

Summary of FY 2010 Request

Atmospheric and Geospace Science (AGS) (+$24.56 million for a total of $269.16 million in FY 2010). AGS supports activities to further our understanding of the physics, chemistry, and dynamics of the Earth's atmosphere, from the Earth's surface to the sun, on timescales ranging from minutes to millennia. AGS provides support for: 1) basic science projects and 2) the acquisition, maintenance, and operation of observational and cyberinfrastructure facilities and services that enable modern day atmospheric and geospace science research activities. Although the majority of AGS support is through the traditional "individual investigator" merit-reviewed, multi-year grants, the division also supports small scale, limited-duration exploratory research projects; collaborative or multi-investigator group projects focusing on a particular project, subject, or activity; large center or center-like projects; and funding for the research conducted by NSF's National Center for Atmospheric Research (NCAR), which extends and enhances research at universities. The division will increase support in key areas of atmospheric and geospace science such as climate research, space weather, and studies of the genesis and dynamics of storms. Approximately 46 percent of the annual budget of AGS is used to support individuals and small groups of researchers, with approximately 16 percent of the total division budget being available to support new research grants.

Key investments in FY 2010 include:

- $12.0 million to support NSF's new Climate Research activity, with emphasis on advanced computation and modeling of the dynamic climate system.
- $100.0 million to support activities at the National Center for Atmospheric Research, including operation of an advanced supercomputer center and of research aircraft.
- A general emphasis on increasing award size and duration across the research portfolio.

EARTH SCIENCES $186,850,000

+$15,850,000 / 9.3%

Earth Sciences Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, EAR	**$157.82**	**$171.00**	**$85.22**	**$186.85**	**$15.85**	**9.3%**
Major Components:						
Research and Education Grants	$151.26	$164.74	$68.57	$183.86	$19.12	11.6%
Instrumentation	23.25	23.60	10.32	25.84	2.24	9.5%
Centers	6.56	6.26	-	2.99	-3.27	-52.2%
Science and Technology Centers	*6.56*	*6.26*	-	*2.99*	*-3.27*	*-52.2%*
Facilities	30.96	36.31	6.33	37.41	1.10	3.0%
IRIS	*11.75*	*12.00*	*2.33*	*12.36*	*0.36*	3.0%
EarthScope	*19.21*	*24.31*	*4.00*	*25.05*	*0.74*	*3.0%*

Summary of FY 2010 Request

Earth Sciences (EAR) (+$15.85 million for a total of $186.85 million in FY 2010). The Division of Earth Sciences supports activities to discover how the Earth functions as a complex system. Studies span topics including earthquakes and related tsunamis, volcanoes, the processes leading to formation of fossil fuels, and the hydrologic cycle which provides the clean water we require to sustain life. In FY 2010, EAR will focus on climate research, including past episodes of climate change, supporting operation and maintenance of the recently-completed EarthScope facility, and enhancing programs looking at dynamic Earth process. Approximately 65 percent of the annual budget of EAR is used to support individuals and small groups of researchers, with approximately 29 percent of the total division budget available to support new research grants.

Key investments in FY 2010 include:

- Funding for research and education grants in EAR will increase by $11.57 million (10.7 percent) over FY 2009.
- EAR will contribute $7.0 million to NSF's new Climate Research activity.
- $35,000 will be added to CAREER awards bringing the total to $4.30 million in FY 2010.
- Funding for the Sustainability of Semi-Arid Hydrology and Riparian Areas (SAHRA) Science and Technology Center (STC) will end following 10 successful years of operation. EAR continues to support the National Center for Earth-surface Dynamics (NCED).
- EarthScope operations and maintenance costs will increase by 3 percent over the FY 2009 budget to $25.05 million, providing for full operation of the EarthScope facility.

INTEGRATIVE AND COLLABORATIVE EDUCATION AND RESEARCH — $93,920,000 +$32,750,000 / 53.5%

Integrative & Collaborative Education and Research Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, ICER	**$56.96**	**$61.17**	**$79.58**	**$93.92**	**$32.75**	**53.5%**
Major Components:						
Research and Education Grants	$55.86	$59.71	$79.58	$91.92	$32.21	53.9%
Facilities	1.10	2.00	-	2.00	-	-
Ship Operations	*1.10*	*2.00*	-	*2.00*	-	-

Summary of FY 2010 Request

Integrative and Collaborative Education and Research (ICER) (+32.75 million for a total of $93.92 million in FY 2010). ICER supports novel, complex, or partnership projects in both research and education. These investments cut across traditional boundaries within the geosciences, encouraging interdisciplinary activities and responding directly to critical needs of the entire geoscience community. ICER's principal goals are to develop innovative means to initiate and support geoscience education, attract underrepresented groups to careers in the geosciences, foster the interchange of scientific information nationally and internationally, and to join with other parts of NSF in major integrative research and education efforts. In FY 2010, the division will make strategic investments in climate research, high-risk/high-reward science, and education, diversity and human resource development. Over 90 percent of the annual budget of ICER is used to support individuals and small groups of researchers, with approximately 49 percent of the total division budget being available to support new research grants.

Key investments in FY 2010 include:

- $15.0 million to launch a new program on climate research, which will target interdisciplinary areas of climate science, and advance our ability to predict and mitigate against future climate change.
- $1.50 million to partner with EHR, BIO and OPP on a cross-Foundation climate science education activity. This program will support innovative education and public outreach activities to broaden understanding of climate change among students and the general public.
- $1.0 million to support Graduate Research Fellowships. Initiated in FY 2009 with ARRA funds, this will enable additional fellowships to be granted to geoscience students.
- $6.0 million to support a number of activities in partnership with the Education and Human Resources Directorate, in recognition of the strong potential to enhance diversity and education across the geosciences. Specific program plans are currently under development.
- $8.0 million to leverage investments in highly innovative research and education projects across the entire range of Geoscience interests. Special attention will be paid to challenges associated with prediction and adaptation to regional climate change and broadening the participation of investigators and institutions in the scientific enterprise. Also of interest are projects that explore the interactions between society and the environment and understanding the processes associated with environmental hazards.

OCEAN SCIENCES

$359,070,000
+$28,710,000 / 8.7%

Ocean Sciences Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, OCE	**$313.06**	**$330.36**	**$114.00**	**$359.07**	**$28.71**	**8.7%**
Major Components:						
Research and Education Grants	$286.11	$310.72	$71.00	$339.68	$28.96	9.3%
Instrumentation	-	14.54	-	22.64	8.10	55.7%
Long-term Ecological Research Centers	3.74	3.64	-	4.49		
Centers	4.00	4.00	-	4.00	-	-
Science and Technology Centers	*4.00*	*4.00*		*4.00*	-	-
Facilities	131.90	154.09	43.00	141.89	-12.20	-7.9%
Academic Research Fleet	*75.28*	*98.68*	*18.00*	*87.58*	*-11.10*	-11.2%
Integrated Ocean Drilling Program	*37.41*	*43.41*	*25.00*	*43.41*		
Ocean Observatories Initiative	*19.21*	*12.00*	-	*10.90*	*-1.10*	*-9.2%*

Summary of FY 2010 Request

Ocean Sciences (OCE) (+28.71 million for a total of $359.07 million in FY 2010). Research, education, and infrastructure funded by OCE address the central role of the oceans in a changing Earth and as a national strategic resource. OCE supports interdisciplinary research of the water column to better understand controls on natural processes such as CO_2 exchange between the oceans and atmosphere and implications for ocean acidification. OCE also supports research on the geology of the ocean margins and sub-seafloor to investigate past ocean and climate conditions, natural hazards associated with earthquakes and volcanic eruptions, and biological strategies used in the deep biosphere. Ocean education, formal and informal, draws on the interdisciplinary nature of ocean sciences, sophisticated visualization capabilities and the impact of the oceans on environmental change. Because ocean science requires access to the sea, OCE supports research vessels, deep submergence capability including submersibles and autonomous vehicles, and technologically advanced sensors and instrumentation. In FY 2010, OCE will emphasize research on climate change, including the impact of increased atmospheric CO_2 on ocean acidification, and operation and maintenance of infrastructure such as the academic research fleet and infrastructure associated with the Ocean Observatories Initiative. Approximately 34 percent of the OCE budget is available to support new research activities annually.

Key investments in FY 2010 include:

- OCE will contribute $12.0 million to NSF’s new Climate Research activity.
- $10.90 million will support initial operation of the Ocean Observatories Initiative project, which is being constructed through the MREFC Account.
- $87.58 million will support operation and upgrade of the Academic Research Fleet. Within this total, $5.0 million will support the continuing construction of a new human occupied deep submergence vehicle, and $2.0 million will support design work to enable possible future construction of new research vessels.

MATHEMATICAL AND PHYSICAL SCIENCES $1,380,000,000

+$124,040,000 / 9.9%

Mathematical and Physical Sciences Funding

(Dollars in Millions)

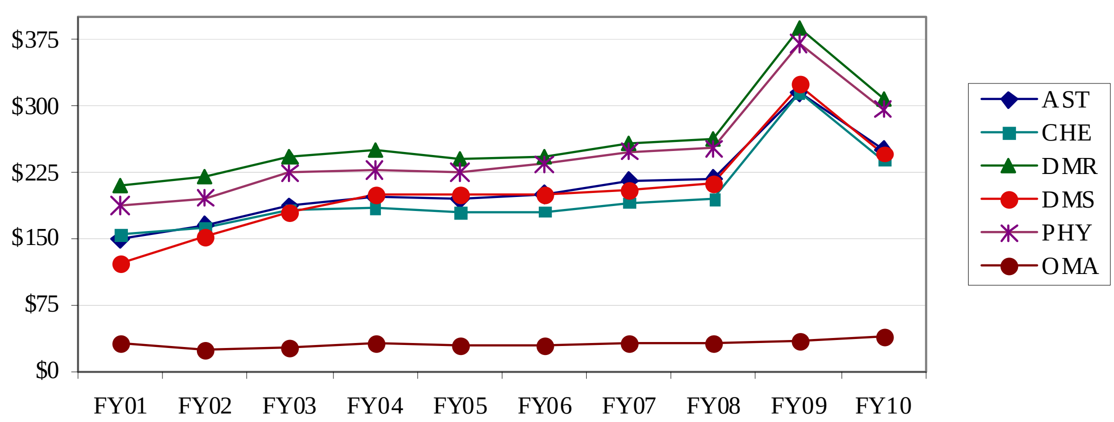
	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Astronomical Sciences	$217.90	$228.62	$85.80	$250.81	$22.19	9.7%
Chemistry	194.62	211.35	103.00	238.60	27.25	12.9%
Materials Research	262.55	282.13	106.90	308.97	26.84	9.5%
Mathematical Sciences	211.75	226.18	98.00	246.41	20.23	8.9%
Physics	251.64	274.47	96.30	296.08	21.61	7.9%
Office of Multidisciplinary Activities	32.67	33.21	-	39.13	5.92	17.8%
Total, MPS	**$1,171.13**	**$1,255.96**	**$490.00**	**$1,380.00**	**$124.04**	**9.9%**
Major Components:						
Research and Education Grants	773.16	845.24	403.45	934.55	89.31	10.6%
Instrumentation	52.25	47.71	25.95	69.68	21.97	46.0%
Centers Programs	97.37	114.95	-	114.27	-0.68	-0.6%
Facilities Operation & Maintenance	248.35	248.24	60.60	261.50	13.26	5.3%

Totals may not add due to rounding.

The Directorate for Mathematical and Physical Sciences (MPS) supports a broad portfolio of investments in fundamental research, facilities, and instruments that enable discovery and development as well as in integrated education and research activities that contribute to the development of the science and engineering workforce. The portfolio includes MPS participation in NSF-wide and interagency research and education, and emphasizes discovery, innovation, and learning aligned with the overall goals of the Administration and NSF's mission and vision.

MPS Subactivity Funding

(Dollars in Millions)



MPS in Context

MPS provides about 46 percent of federal funding for basic research at academic institutions in the mathematical and physical sciences, ranging from about 35 percent in physics to over 60 percent in the mathematical sciences.

MPS funding enables research that ranges from basic, fundamental, curiosity-driven research to technologies that have immediate societal and economic impact. Basic research plants the seed-corn of creative and innovative ideas, some of which has been proven to lead to technologies that transform society and enhance our Nation's global economic competitiveness. MPS-funded research underpins biomedical advances and national security technologies. Support for this broad range of research has been documented in numerous studies conducted by the National Academies (e.g., *Rising Above the Gathering Storm*, 2006) and professional societies (e.g., *Measure for Measure: Chemical R&D Powers the U.S. Innovation Engine*, 2005).

MPS is the steward of numerous major research facilities (astronomical observatories, gravitational-wave and neutrino observatories, light sources, high magnetic field laboratories, nuclear physics laboratories), which together form an important component of the Nation's scientific research infrastructure. MPS strategically invests in the development of the next generation of facilities and is increasing its Centers programs while protecting individual investigators and small group investigators. MPS emphasizes the entire pipeline of the science and technology workforce, supporting undergraduate and graduate students as well as postdoctoral fellows.

MPS also invests in sustainable energy, climate research, education, nano-science, cyber-enabled discovery and innovation and convergence of the physical sciences with the life sciences.

The FY 2010 Request for the MPS includes $10.0 million *to leverage* activities across MPS aimed at increasing support for transformative research. Examples of mechanisms to be used for identifying potentially transformative research include special solicitations and competitions, and increased use of specialized funding mechanisms, notably NSF’s EAGER (EArly-concept Grants for Exploratory Research).

Directorate-wide Changes and Priorities

Research and Education Grants (+$88.63 million, to a total of $933.87 million).

MPS assigns high priority to providing strong support of individual investigators and small groups pursuing fundamental research across all MPS disciplines. This is paramount to meeting science opportunities in MPS disciplines, to maintaining a competitive workforce in these areas, and to enabling a vital interdisciplinary effort. Extraordinary research opportunities exist in all of the MPS sciences, as well as opportunities to connect with National priorities. Within the context of disciplinary and interdisciplinary research, MPS emphasis areas interact with each other, with National priorities, and with the overall portfolio in a synergistic fashion, reflecting commonalities in the underlying complex physical systems. In FY 2010, MPS will continue its research in areas such as Physics of the Universe, Mathematical Sciences, Complex Biological Systems, MPS-Life Science interface, Quantum Information Sciences, and Sustainability.

Major emphases in Research and Education in FY 2010 include:

- *Science and Engineering Beyond Moore’s Law (+$10.0 million, to a total of $18.68 million).* MPS leads NSF's effort in Science and Engineering Beyond Moore's Law (SEBML)[1], a multidisciplinary research investment with strong ties to economic competitiveness and potential for transformation. Related to both nanotechnology and cyberinfrastructure, it builds on past NSF investments in these areas and energizes them with new directions and challenges. SEBML activities include research into new materials, devices, and processes that exploit the capability to create and manipulate specific quantum states and new algorithms that take advantage of hardware and architecture characteristics to deliver maximal total computing power, including those that utilize quantum interactions. MPS works with the other directorates in areas such as developing new connection architectures with new control principles, massive parallelism, and designed asynchronicity and indeterminacy and creating new software that allows the effective use of new devices. MPS's SEBML investment crosses the Chemistry, Materials Research, Mathematical Sciences, and Physics Divisions.

- *Climate Research (+$7.0 million, to a total of $7.0 million).* In FY 2010, MPS will invest in NSF's Climate Change effort. Two major themes under consideration are understanding molecular interactions at atmospheric interfaces and development of mathematical methods and effective computational techniques needed for simulation and analysis of climate models. The long-term goal of this program is to assert U.S. leadership in understanding causes and consequences of climate change and to develop effective strategies in response.

- *Cyber-enabled Discovery and Innovation (CDI) (+$6.75 million, to a total of $18.56 million).* MPS will continue its collaborations with other directorates in NSF's high priority CDI activities, creating synergy with related work in Cyberinfrastructure and enhancing the government-wide Networking and Information Technology Research and Development (NITRD) effort. MPS supports CDI out of the research of all its divisions, with the Division of Mathematical Sciences investing most heavily. Modeling, algorithms, software, and simulation are essential research components in all MPS disciplines, as are virtual computing networks accessing common databases and analytic tools. Examples include the synthesis and characterization of new molecular systems; the prediction and discovery of new materials and new states of matter; the creation, manipulation, and control of quantum mechanical states in solid and condensed states of matter; the development of mathematical structures to describe complex, multi-scale networks as typified by electrical power grids and the internet; and the creation of visualization and "mining" techniques for both sparse and dense data.

- *CAREER (+$5.46 million, to a total of $49.50 million).* The CAREER program remains the primary mechanism for jump-starting junior faculty toward independent careers in research and education, a key Administration priority. All MPS divisions invest in CAREER.

- *Graduate Research Fellowship (+$4.11 million, to a total of $4.11 million).* To promote the education and participation in the research enterprise of the next generation of mathematical and physical scientists, MPS is contributing to the NSF-wide Graduate Research Fellowship program. This is part of a Presidential Initiative to triple the number of new fellowships by FY 2013.

Instrumentation *(+21.97 million, to a total of $69.68 million).*

In FY 2010 MPS will make a focused investment across the directorate in Research Resources, particularly mid-scale instrumentation. For example, in the Division of Astronomical Sciences, an additional $9.65 million will support instrumentation activities such as the Advanced Technologies and Instrumentation (ATI) grants program, technology development for future large facilities, such as the Giant Segmented Mirror Telescope (GSMT) and the Large Synoptic Survey Telescope (LSST), and

[1] Moore's Law: In 1965 the co-founder of Intel, Gordon E. Moore, predicted that computing power based on semiconductor integrated circuits would double every 18 to 24 months, a predication that has staying power for over 40 years.

large projects and experiments beyond the scale of single investigators. In the Division of Materials Research, an additional $5.14 million will support the design and construction of a variety of mid-scale instruments, including synchrotron and neutron beamlines, high-field magnets, detectors, and preparation environments at major U.S. facilities. The funding increase also includes support for research and development on X-ray coherent light sources. The Divisions of Physics and Chemistry will increase their research resources support by $1.80 million and $1.50 million respectively.

MPS Centers *(-$680,000, to a total of $114.27 million).*

MPS manages or co-funds over forty different individual centers in five centers program areas. For more information, see the Centers section in the NSF-Wide Investments chapter. Major funding changes in FY 2010 include:

- *Centers for Chemical Innovation (CCIs) (+$8.50 million, to a total of $24.0 million).* CCIs promote the integration of research and education through the extensive involvement of students and postdoctoral fellows in all phases of work, as well as partnerships with industry and National Laboratories. CCIs are expected to be agile, responding to opportunities as they arise, and to creatively engage the public. The FY 2010 request reflects the establishment of two new Phase II Centers (for a total of five) and four new Phase I Centers (for a total of eleven).

Facilities Operations and Maintenance *(+13.26 million, to a total of $261.50 million).*

MPS manages over ten multi-user research facilities. Detailed information on each can be found in the Facilities chapter. Major funding changes in FY 2010 include:

- *Atacama Large Millimeter Array (ALMA) (+*$6.*57 million, to a total of $17.57 million).* ALMA operations continue to ramp up in preparation for early science expected to start in mid-2011, with a first call for proposals from the science community in late 2010. FY 2010 funding will provide for growth in staff for Chile operations; user support, development, and implementation of the North American ALMA data archive and software systems; and education, training, and engagement of the North American scientific user community.

- *National High Magnetic Field Laboratory (NHMFL) (+$5.45 million, to a total of $31.95 million).* The FY 2010 increase for NHMFL will allow the facility to strengthen user support programs and in-house research, education, and training at all levels as well as meet increased operation costs. FY 2010 funding will cover increased electricity and cryogenics costs, purchase of critical parts for replacement of aging equipment, completion of the planned split-magnet development, and support for technical staff, education, and training.

Program Evaluation and Performance Improvement

The Performance Information chapter describes the Foundation's performance evaluation framework, which is built upon the four strategic outcome goals in NSF's Strategic Plan: *Discovery*, *Learning*, *Research Infrastructure*, and *Stewardship*. Performance evaluation is conducted at all levels within the Foundation, using both qualitative and quantitative measures – including an agency-wide annual review of research and education outcomes by an external expert committee and periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are also factored into the performance assessment process.

In FY 2009, a MPS Committee of Visitors (COV) review took place for the Division of Physics. All MPS Divisions are responding to and implementing recommendations from recent COVs. COVs for the Divisions of Chemistry and Mathematical Sciences are scheduled for 2010.

In addition, the National Research Council of the National Academy of Sciences is currently preparing the Astronomy and Astrophysics Decadal Survey. Funded by NSF, NASA, and Department of Energy, the Committee on Astro2010 is surveying the fields of space- and ground-based astronomy and astrophysics, recommending priorities for the most important scientific and technical activities of 2010-2020. The Committee hopes to release an unedited, pre-publication report to the public in mid-2010.

Number of People Involved in MPS Activities

	FY 2008 Estimate	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate
Senior Researchers	7,316	7,724	1,134	8,191
Other Professionals	1,901	1,997	209	2,113
Postdoctorates	2,160	2,348	645	2,486
Graduate Students	7,606	8,021	2,224	8,474
Undergraduate Students	6,163	6,244	920	6,535
K-12 Teachers	347	306	68	319
K-12 Students	280	304	91	313
Total Number of People	25,773	26,944	5,291	28,431

MPS Funding Profile

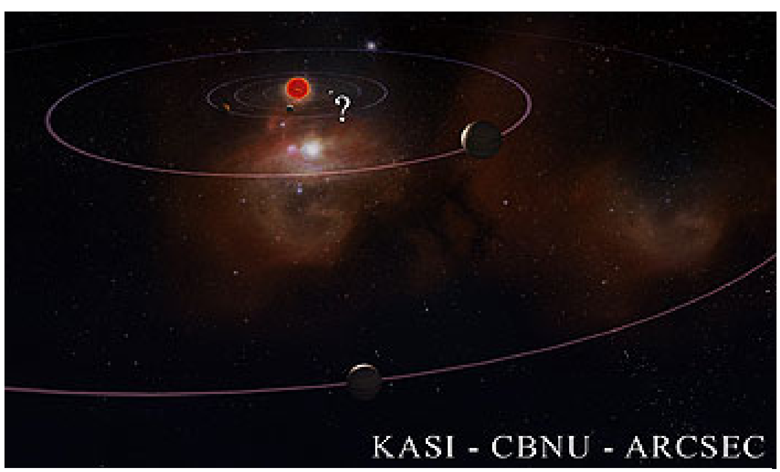
	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate
Statistics for Competitive Awards:			
Number of Proposals	7,839	8,400	9,300
Number of New Awards	2,271	3,400	2,750
Regular Appropriation	2,271	2,400	2,750
ARRA	-	1,000	-
Funding Rate	29%	40%	30%
Statistics for Research Grants:			
Number of Research Grant Proposals	6,470	6,600	7,000
Number of Research Grants	1,720	2,600	1,950
Regular Appropriation	1,720	1,850	1,950
ARRA	-	750	-
Funding Rate	27%	39%	28%
Median Annualized Award Size	$104,999	$107,000	$107,000
Average Annualized Award Size	$132,748	$145,000	$145,000
Average Award Duration, in years	3.1	3.1	3.1

Recent Research Highlights

► **A Stellar Discovery:** The biggest black hole ever discovered is 15.7 times the mass of our Sun and about 3 million light years from Earth in a neighboring galaxy named M33. Contrary to popular myth, black holes are not empty space but the dark, dense remnants of giant stars that have burned themselves out. An international team of scientists detected the massive black hole and the exceptionally large companion star that it orbits – 70 times the size of our Sun – with a combination of X-ray data from NSF's Gemini Observatory and ground-based optical images and spectroscopy data from NASA. The discovery is not only exceptional, it is puzzling. The star that created the black hole was even heavier than its behemoth companion. At that size, the star would have been large enough to share its atmosphere with its companion, yet apparently it did not. This observation challenges current theories of how binary pairs exchange mass.

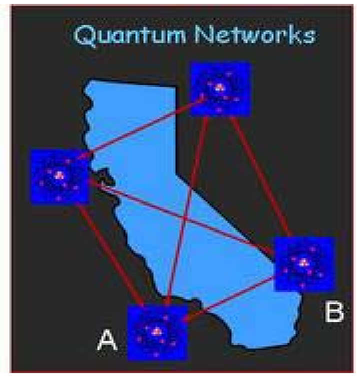
An artist's conception of the largest black hole discovered and its companion star. This unusual pair of stellar objects resides in nearby galaxy M33 and challenges current theories of how binary pairs exchange mass. *Credit: Illustration: NASA/CXC/M.Weiss.*

► **Star Systems Like Our Own May Be Common:** The discovery of a solar system nearly 5,000 light years away with scaled-down versions of Jupiter and Saturn suggests our galaxy could contain many star systems similar to our own. Although the star is much dimmer than our Sun, temperatures at both planets are likely to be similar to that of Jupiter and Saturn because they are closer to their star. One of the planets has 70 percent of Jupiter's mass, and another has 90 percent of Saturn's mass. The two planets were revealed when the star they orbit crossed in front of a more distant star being observed from Earth. The nearer star magnified the light shining from the farther star in a process known as "gravitational microlensing." The data analyzed for this discovery was collected on 11 different ground-based telescopes in countries around the world, including New Zealand, Tasmania, Israel, Chile, the Canary Islands, and the United States.



Astronomers have discovered a solar system analogous to ours, containing scaled-down versions of Saturn and Jupiter. Their finding suggests that our galaxy hosts many star systems like our own. *Credit: KASI - CBNU - ARCSEC (KASI is the Korea Astronomy and Space Science Institute, CBNU is the Chungbuk National University, and ARCSEC is Astrophysical Research Center for the Structure and Evolution of the Cosmos.)*

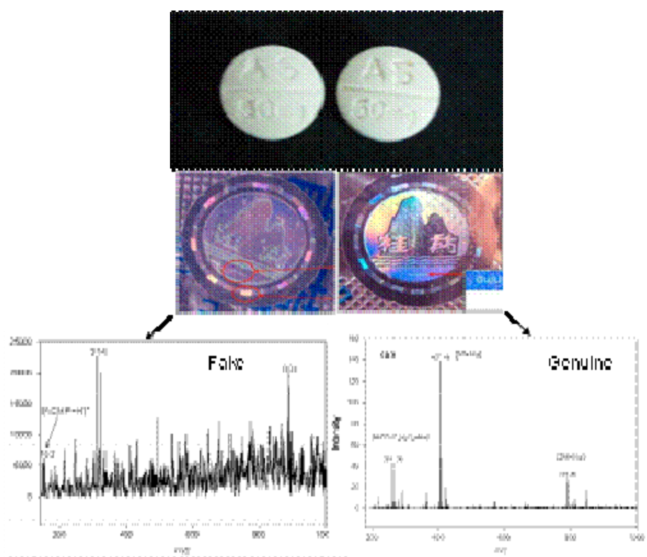
► **A Quantum Leap:** If technology continues to follow "Moore's Law," the continually shrinking size of circuitry packed onto silicon chips will eventually reach a point where individual elements are no larger than a few atoms. At this scale, the laws switch from classical physics to quantum physics. The concept of quantum technology, which would be exponentially more powerful than today's computer technology, addresses this concern. Researchers at Caltech have succeeded in showing the operation of "quantum repeaters," a crucial component of quantum information technology. The device distributes "entanglement" into segments in a way that could lead to commercially viable quantum technology. Entanglement occurs when the behavior of two particles or components are correlated in spite of the physical distance separating them. Einstein once referred to the phenomenon as "spooky action at a distance." The significant achievement of the Caltech group is that they demonstrated an initial version of one segment.



Quantum networks based on entanglement distribution could be used for secure communication, with its security guaranteed by the laws of physics. *Credit: H. Jeff Kimble, Caltech.*

► **Malaria Drug Counterfeiters Caught:** Researchers at the Georgia Institute of Technology developed a rapid chemical assay based on mass spectrometry to screen the quality of malaria drugs in Asia and four African countries. Motivation for this research came from a recent onslaught of counterfeit malaria tablets in those countries. The bogus tablets contained little or no therapeutic levels of an active ingredient known as artesunate. Malaria remains a public health problem in the countries subjected to the fake tablets, with estimates in excess of 2 million cases per year and more than 10,000 deaths per year. The research team used their method to test the quality of hundreds of tablets in a short period of time. The work allowed evidence-based suggestions as to where some of the fake artesunate was manufactured. Armed with this information, authorities in China were able to arrest some of the suspects.

Genuine (Right) and Counterfeit (Left) Arsumax (Artesunate) from Cameroon. *Credit: Manuela Sunjio.*



Contrasting mass spectra compare chemical signatures for counterfeit and genuine artesunate tablets. *Credit: Facundo Fernández.*

► **New Mathematical Models Lead to Improved Stent Design:** Coronary artery disease is the major cause of heart attack in the United States. Clinical treatments for the disease can only be studied in detail with a reliable model that describes the response of arterial walls to pulsating blood flow. A research group at the University of Houston has developed mathematical tools to study the interaction of arterial walls and pulsating blood flow. The group also has made considerable progress designing improved stents for propping open narrowed arteries and better stent-grafts that are more compatible with the human body. Nine months after publishing their results in Endovascular Today, Endologix, Inc., launched a new stent-graft on the market with the exact geometry suggested in the publication.

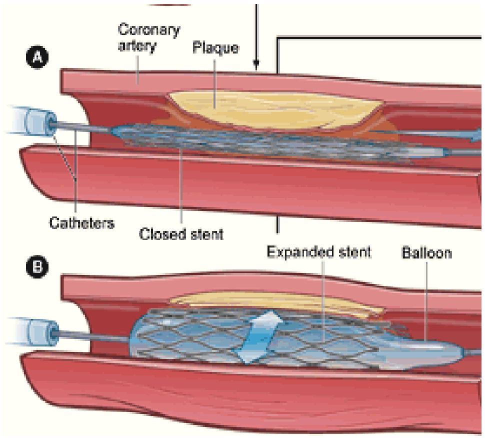
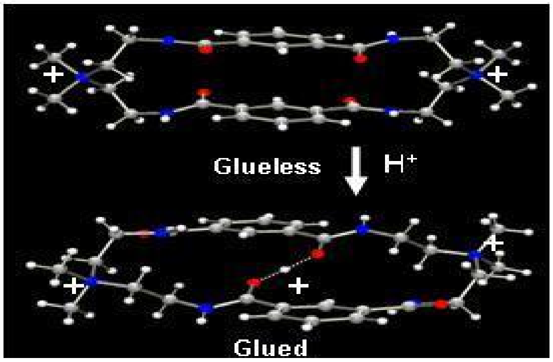
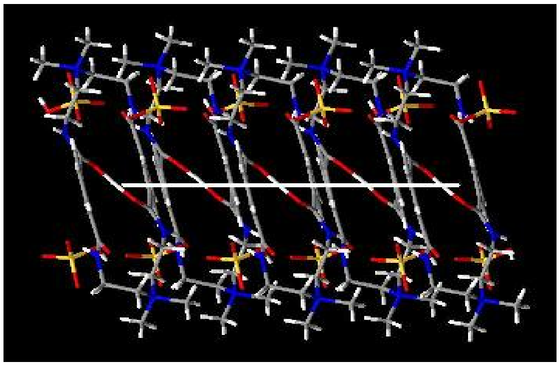


Diagram of coronary angioplasty and stent placement. Image of an artery prior to and immediately following stent expansion. Mathematical modeling is used to optimize the stent design in order to minimize limb thrombosis rates. *Credit: http://en.wikipedia.org/wiki/National_Institutes_of_Health.*

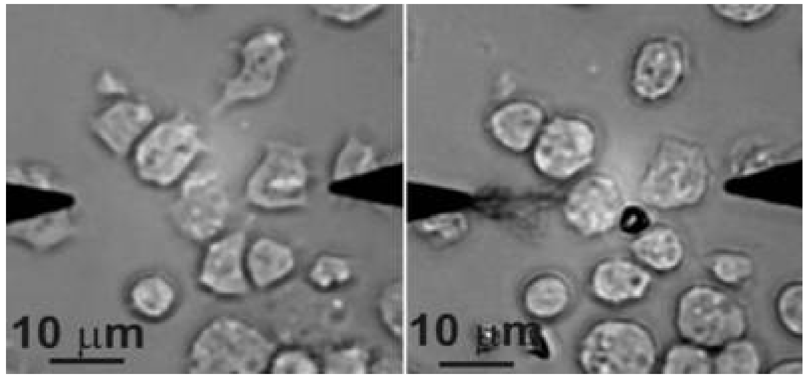
► **A Special Bond:** Using a technique known as X-ray crystallography, scientists at the University of Kansas discovered an especially strong form of hydrogen bond known as a Low Barrier Hydrogen Bond that links two atoms at very short distances. The simple finding of a Low Barrier Hydrogen Bond changing the shape of a cyclic molecule may influence concepts about chemical bonding in biological systems. Low Barrier Hydrogen Bonds are much stronger than ordinary hydrogen bonds and were believed to be less common; however, if they are more prevalent than anticipated, as suggested by this finding, they could play a major role in protein folding, enzymatic activity, and the flow of ions across cell membranes. Unraveling the chemistry at the atomic level of this simple system may help explain more complex biological processes. Ultimately this knowledge may lead to more effective ways of addressing enzymatic "problems" such as diseases that affect living species.



Without any hydrogen bonds, the top cyclic molecule is symmetrical. With a Low Barrier Hydrogen Bond, the bottom cyclic molecule is skewed. This type of bond is unique in that it induces a positively charged molecule to be attracted to the positively charged hydrogen atom. Under normal circumstances, a positive charge is attracted to a negative charge and repels another positive. (Colors: red, oxygen; blue, nitrogen; gray, carbon; white hydrogen.) *Credit: Image provided by Kristin Bowman-James, Department of Chemistry, University of Kansas.*



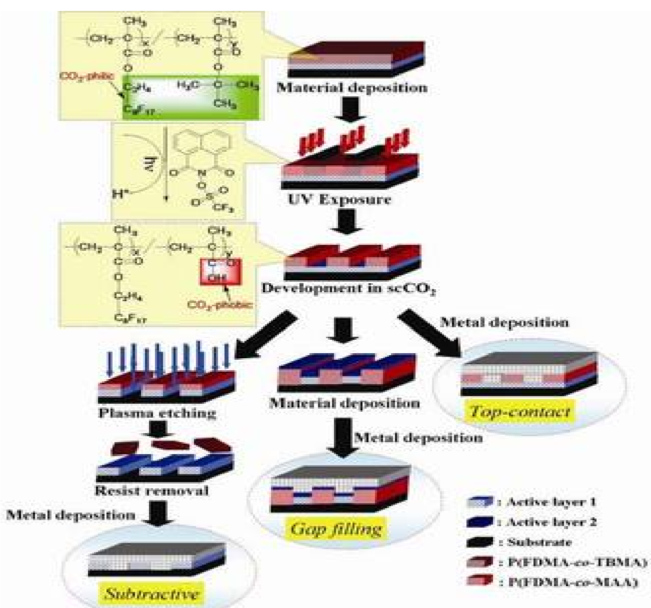
The solid white line in the image shows the direction of the hydrogen (H+) channel or the "proton channel" in the stacked cyclic molecules of a crystal. The yellow and red species are bisulfate ions in the crystal. *Credit: Image provided by Kristin Bowman-James, Department of Chemistry, University of Kansas.*



Oklahoma State researchers produce a cell-wire interface by applying 100 milli-electronvolts to the wire. *Credit: Sent by Bret Flanders.*

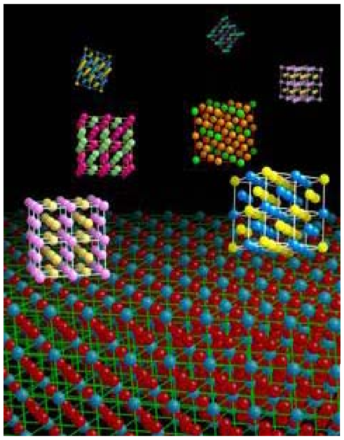
► **A Nanowire's Tiny Touch Offers Huge Potential for Neuroscience:** Tiny electric wires, one one-thousandth of the size of a human hair, called nanowires, will allow scientists to electrically stimulate a single cell and study the cell's response. A new process developed at Oklahoma State University allows precise control of the wire's diameter, along with growing the wire and attaching it to the cell in a single step. The process consists of passing an alternating voltage across two electrodes immersed in a salt solution. The process produces a perfectly formed nanowire between the two electrical contacts. The researchers control the diameter of the nanowire by varying the frequency of the alternating voltage – the higher the frequency, the smaller the diameter. Using nickel electrodes, the researchers successfully grew a nanowire next to a live cell. This research offers a radically new technology for studying and controlling cells at the nanoscale. Its impact on neuroscience can already be seen.

► **Organic Semiconductors Make Serious Progress:** Researchers at Cornell University and the University of Melbourne, Australia, report their organic semiconducting device is a major step forward in creating a low-cost alternative to traditional electronic devices made of silicon and other inorganic materials. Ordinary solvents used to fabricate semiconducting devices are very damaging to organic materials. To get around this problem, the researchers developed a novel photolithographic patterning process that employs supercritical carbon dioxide as a solvent. Supercritical carbon dioxide has properties midway between a liquid and a gas. It's becoming a more common solvent in processes that range from dry cleaning clothes to decaffeinating coffee. The researchers' organic light emitting device means that rolled-up computer screens, light emitting clothes, and more efficient solar energy harvesting are one step closer to reality.



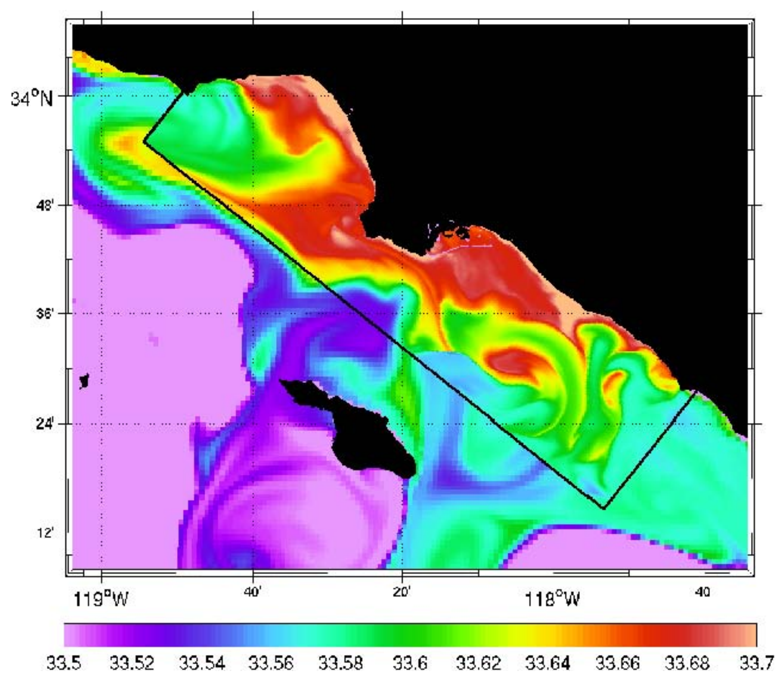
Schematic diagram of photolithographic patterning process in supercritical carbon dioxide. *Credit: Christopher Ober, Cornell University.*

► **Absence Makes a Researcher Grow Curious:** A researcher at Brigham Young University wondered why nature favored some arrangements of the atoms that make up materials over others. He enumerated all the possible regular and periodic arrangements of atoms allowed by geometry and found that some patterns on his list were never seen by scientists. By measuring the effect of chemical bonding, he discovered a trend in nature toward arrangements that are most ordered. Still, some very "ordered" structures were absent. The researcher's own computer calculations predicted some of these absentee structures. This research led to some likely candidates for new arrangements of atoms in crystals that have never been seen, including some compounds of silver, platinum, palladium. and cadmium. Experimentalists are working to see if these new structures can be observed. These results demonstrate progress towards using computers to design new materials with desired properties.



The figure shows possible arrangements of atoms in crystalline materials. This work opens a new avenue in the quest to discover new materials and to predict how atoms are arranged in materials when only the identity of their constituent atoms is known. *Credit: Gus Hart.*

► **Math Model Gives Insight to How Natural Forces Change Shorelines:** A team of investigators from the University of Arizona has developed mathematical tools to model the natural forces that reshape shorelines. Their work offers a powerful new technique to predict the effects of storms and also the effectiveness of remediation efforts. Their tools are ideally suited to model sand bars created by storms – a process previously inaccessible to models of shore processes. A comparison of the team's modeling results with field experiments carried out by the U.S. Army Corps of Engineers is in agreement. Future development of these mathematical modeling tools will allow engineers to deal more effectively with the enormous challenges posed by the action of water on shore topography.



Instantaneous surface salinity distribution on the 65th Julian day in 2002, when an extensive upwelling event was observed in Southern California Bight. The high-resolution nested simulation is capable of reproducing intense upwelling of subsurface water with higher salinity. *Credit: UCLA oceanic modeling group.*

ASTRONOMICAL SCIENCES

$250,810,000
+$22,190,000 / 9.7%

Astronomical Sciences Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, AST	**$217.90**	**$228.62**	**$85.80**	**$250.81**	**$22.19**	**9.7%**
Major Components:						
Research and Education Grants	68.39	74.00	61.20	83.09	9.09	12.3%
Instrumentation	25.50	23.28	6.00	31.53	8.25	35.4%
Centers	3.32	2.66	-	-	-2.66	-100.0%
Science & Technology Center	*3.32*	*2.66*	-	-	*-2.66*	*-100.0%*
Facilities	120.69	128.68	18.60	136.19	7.51	5.8%
Gemini Observatory	*18.69*	*18.71*	-	*19.10*	*0.39*	*2.1%*
Nat'l Astronomy & Ionosphere Ctr.	*10.72*	*9.60*	*3.10*	*8.40*	*-1.20*	*-12.5%*
Nat'l Optical Astronomy Observ. [1]	*38.55*	*39.58*	*10.10*	*41.60*	*2.02*	*5.1%*
Nat'l Radio Astronomy Observ.	*45.09*	*49.79*	*5.40*	*49.52*	*-0.27*	*-0.5%*
Atacama Large Millimeter Array	*7.64*	*11.00*	-	*17.57*	*6.57*	*59.7%*

[1] NOAO includes the National Solar Observatory and the Telescope System Instrumentation Program.

The Division of Astronomical Sciences (AST) is the federal steward for ground-based astronomy in the U.S., working in partnership with private institutions to enhance overall observing capacity and capability. Research support covers an array of observational, theoretical, and laboratory research aimed at understanding the origins and characteristics of planets, the Sun, other stars, our galaxy, extragalactic objects, and the structure and origin of the Universe through awards to individual investigators, small groups, and national facilities. AST supports the development of advanced technologies and instrumentation, planning and design for future observational facilities and collaborative projects in astronomy, and management of the electromagnetic spectrum for scientific use. About 14 percent of the AST portfolio is available for new research grants. The remaining 86 percent is used primarily to fund continuing grants made in previous years including approximately 54 percent to support facilities.

AST provides the U.S. share of funding for the operation of the international Gemini Observatory and supports the operation of the National Astronomy facilities: the National Astronomy and Ionosphere Center (NAIC); the National Optical Astronomy Observatory (NOAO), including the National Solar Observatory (NSO); and the National Radio Astronomy Observatory (NRAO), including the U.S. share of the international Atacama Large Millimeter Array (ALMA) project. These major world-class facilities provide access to a wide range of observational resources on a competitive basis and serve over 3000 users annually.

Changes by Activity

Individual investigator program (+7.50 million, to a total of $57.0 million).

This is primarily for activities in the Astronomy and Astrophysics Research Grants and the Education and Special Programs, to address priorities expressed in the Interagency plan for the Physics of the Universe program.

CAREER program (+$1.0 million, to a total of $4.10 million).
This is to increase the division's support for beginning faculty.

Instrumentation Activities (+$8.25 million, to a total of $31.53 million).
This funds increased activity in partnership with the academic community, taking advantage of opportunities for scientific discovery that requires instrumentation and experimentation at the mid-scale range of $5.0 million to $20 million.

Science and Technology Center for Adaptive Optics
Funding ends in FY 2010 as ten year support for this center sunsets as planned.

Astronomy Facilities (+$7.51 million, to a total of $136.19 million). Changes are:

- *Gemini Observatory (+$390,000, to a total of $19.10 million).* This will enable continued operating and visitor support per the international partnership agreement.

- *NAIC (-$1.20 million, to a total of $8.40 million).* AST support is reduced following the recommendation of the AST Senior Review. This will result in reduced levels of programming, user support, and observing time.

- *Combined NOAO/NSO (+$2.02 million, to a total of $41.60 million).* Within this total, funding for NOAO primary operations and maintenance funding increases by $1.92 million to $27.50 million and the Telescope System Instrumentation Program (TSIP), administered through NOAO, increases by $1.0 million to $5.0 million in FY 2010. NSO funding decreases by $900,000 to $9.10 million, with the Advanced Technology Solar Telescope (ATST) being funded from the Major Research Equipment and Facilities Construction (MREFC) account. For more information on ATST, see the MREFC chapter.

- *NRAO (-$270.000, to a total of $49.52 million)* and *ALMA operations ($+$6.57 million, to a total of $17.57 million).*

Detailed narratives on each facility can be found in the Facilities chapter.

CHEMISTRY

$238,600,000
+27,250,000 / 12.9%

Chemistry Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, CHE	**$194.62**	**$211.35**	**$103.00**	**$238.60**	**$27.25**	**12.9%**
Major Components:	194.62					
Research and Education Grants	165.89	180.47	73.25	195.10	14.63	8.1%
Instrumentation	13.44	7.97	14.75	14.75	6.78	85.1%
Centers	13.79	21.01	-	26.85	5.84	27.8%
Centers for Chemical Innovation	*7.87*	*15.50*	-	*24.00*	*8.50*	*54.8%*
Science & Technology Centers	*3.32*	*2.66*	-	-	*-2.66*	*-100.0%*
Nanoscale Science & Engr. Centers	*2.60*	*2.85*	-	*2.85*	-	-
Facilities	1.50	1.90	15.00	1.90	-	-
Nat'l High Magnetic Field Lab.	*1.50*	*1.50*	-	*1.50*	-	-
Nat'l Nanofabrication Infra. Network	-	*0.40*	-	*0.40*	-	-

Chemistry is a bold and creative science that finds efficient ways to prepare nature's compounds and to make ones that have never existed. Investment in basic molecular sciences is a major contributor to the $637.0 billion U.S. chemical industry. Approximately one third of the industrial output of the U.S. derives from the chemical industry, which in turn requires more than 2,000 PhD graduates per year to operate efficiently. The NSF Division of Chemistry (CHE) plays a crucial role in the vitality of the basic research enterprise, especially in academic laboratories, and needs increased resources to sustain, expand, and improve the community's ability to perform transformative and translational research. In general, about 37 percent of CHE's portfolio is available for new research grants. The remaining 63 percent funds continuing grants made in previous years.

Changes by Activity

Research and Education Grants (+$14.63 million, to a total of $195.10 million).

This will fund the expected increase in the number of unsolicited proposals in basic research and education in chemistry due to a realignment of the Division's disciplinary programs, expected to take place starting in FY 2010. Advances in fundamental science and education that will impact national priorities in areas such as the environmental health and safety of nanomaterials, basic research that underpins improvement in climate models, catalysis enabling sustainability and energy research, the link between chemistry and the life sciences, and cyberinfrastructure. FY 2010 support includes:

- *Molecular electronics and Science and Engineering Beyond Moore's Law (+$3.0 million, to a total of $6.08 million).*

- *Cyber-enabled Discovery and Innovation (+$1.25 million, to a total of $2.45 million).*

- *Climate Research program (total of +$5.0 million).*

- *CAREER program (+$300,000, to a total of $20.80 million).*

- *American Competitiveness in Chemistry Fellowship Program (total of $2.0 million).* This program provides consistent bridges to the top ranked young talent in chemistry as they progress to the professoriate.

- *Discovery Corps Fellowship Program (total of $1.50 million).* This program will be adapted in FY 2010 to address public education about global chemistry issues.

- *Graduate Research Fellowship Program (total of $1.59 million).*

- *NSTC Priorities* – the National Nanotechnology Initiative, Networking and Information Technology Research and Development, and Climate Change Technology Program – will see increased support from CHE.

- The *Environmental Molecular Science Institutes* will be completely phased out in FY 2010. A new program, Environmental Chemical Sciences, will be initiated to provide continuity in this important area.

Instrumentation and Instrument Development (+$6.78 million, to a total of $14.75 million). In FY 2010, facility funding will be maintained but no increases are requested.

Centers (+$5.84 million, to a total of $26.85 million. This includes:

- *Centers for Chemical Innovation (+$8.50 million, to a total of $24.0 million*). This program is designed to inspire research on strategic, transformative "big questions" in basic chemical research. This funding reflects the establishment of two additional Phase II Centers (for a total of five) and four new Phase I Centers (for a total of eleven).

- *Center for Environmentally Responsible Solvents and Processes*. Funding for this Science and Technology Center ends as ten-year support sunsets as planned in FY 2010.

MATERIALS RESEARCH

$308,970,000
+$26,840,000 / 9.5%

Materials Research Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, DMR	**$262.55**	**$282.13**	**$106.90**	**$308.97**	**$26.84**	**9.5%**
Major Components:						
Research and Education Grants	136.29	149.94	78.00	159.27	9.33	6.2%
Instrumentation	9.98	10.00	5.20	15.14	5.14	51.4%
Centers	73.13	84.72	-	81.54	-3.18	-3.8%
Materials Research Sci. & Engr. Centers	*57.15*	*68.51*	-	*66.01*	*-2.50*	*-3.6%*
Nanoscale Science & Engr. Centers	*7.98*	*8.21*	-	*8.21*	-	-
Science & Technology Centers	*8.00*	*8.00*	-	*7.32*	*-0.68*	*-8.5%*
Facilities	43.15	37.47	23.70	53.02	15.55	41.5%
Nat'l High Magnetic Field Lab.	*26.25*	*25.00*	*5.00*	*30.45*	*5.45*	*21.8%*
Cornell Electron Storage Ring	-	*1.00*	*6.50*	*6.60*	*5.60*	*560.0%*
Cornell High Energy Synchrotron Source	*5.60*	*2.51*	*7.20*	*6.67*	*4.16*	*165.7%*
Nat'l Nanofabrication Infra. Network	*2.85*	*2.65*	-	*2.65*	-	-
Other MPS Facilities [1]	*8.45*	*6.31*	*5.00*	*6.65*	*0.34*	*5.4%*

[1] Other MPS Facilities = SRC, CHRNS, CheMatCARS

The Division of Materials Research (DMR) advances the intellectual frontiers of materials research and is a critical component of U.S. competitiveness. DMR awards enable the science and engineering community to make new discoveries about the fundamental behavior of matter and materials; to create new materials and new knowledge about materials phenomena; to address questions about materials that often transcend traditional scientific and engineering disciplines and lead to new technologies; to prepare the next generation of materials researchers; to develop and support instruments and facilities that are crucial to advance the field; and to share the excitement and significance of materials and condensed-matter science with the public at large.

DMR supports a balanced portfolio of research topics through individual investigator grants, small groups, centers, and awards for instrumentation and user facilities, with considerable emphasis on interagency and international partnerships to advance materials research and education. DMR Centers address major interdisciplinary research challenges in materials and condensed-matter sciences. The division also supports world-class facilities for high magnetic fields, synchrotron radiation, and neutron scattering, and provides partial support for the National Nanofabrication Infrastructure Network (NNIN). In general, 17 percent of the DMR portfolio is available for new research grants. The remaining 83 percent is used primarily to fund continuing awards made in previous years, including about 45 percent to fund cooperative agreements in support of centers and facilities.

In FY 2010, approximately 17 percent of the funds requested for DMR will be available for new competitive research grants; about four percent will be available for new instrumentation awards. Almost five percent will support increased funding for DMR facilities. About 3 percent of funds will support new mid-size group/small center research awards that complement current DMR individual investigator, small group, and center awards. Remaining funds will support continuing research and education grants from previous years, as well as cooperative agreements for centers and facilities. In FY 2008, DMR had a funding rate of just over 20 percent.

Changes by Activity

Research and Education Grants (+$9.33 million, to a total of $159.27 million).
Emphasis will be placed on research relevant to NSF-wide activities, including Science and Engineering Beyond Moore's Law (SEBML) and Cyber-Enabled Discovery and Innovation (CDI); support for SOLAR, a cross-divisional MPS activity in solar energy research; funding for young investigators through CAREER and other awards, and for undergraduate research through Research Experiences for Undergraduates (REU) Site awards.

Instrumentation (+$5.14 million, to a total of $15.14 million).
This includes support for the design and construction of mid-scale instruments relevant to materials research that are too costly to be funded through other NSF instrumentation programs. Funding will allow for two to four additional awards in FY 2010, including research and development on X-ray coherent light sources.

Centers (-$3.18 million, to a total of $81.54 million).
In FY 2010 DMR plans to initiate support for medium-size groups/small materials research centers that effectively bridge the gap between individual investigator/small group research and large center research. Changes include:

- *Materials and Devices for Information Technology Research (-$680,000, to a total of $3.32 million).* Support for this Science and Technology Center is phased out in anticipation of a planned sunset in FY 2011.

- *Materials Research Science and Engineering Centers (-$2.50 million, to a total of $66.01 million).* Funding is decrease as selected centers complete their planned phase outs in 2010.

Facilities (+$15.55 million, to a total of $53.02 million). This includes:

- *NHMFL (+$5.45 million, to a total of $30.45 million).* This will strengthen user support programs by paying for increased electricity and cryogenics costs, purchase of critical parts for aging equipment, and completion of the planned split-magnet development.

- *CESR/CHESS combined (+$9.76 million, to a total of 413.27 million).* CESR as a facility for elementary particle physics concluded in FY 2009; as of FY 2010 CESR is primarily dedicated to providing electrons for the operation of CHESS, a synchrotron radiation facility for X-ray light research. This combined increase will allow continued operation of CESR/CHESS as a synchrotron user facility as well as support of research and development necessary for coherent X-ray sources.

Detailed narratives on each facility can be found in the Facilities chapter.

MATHEMATICAL SCIENCES $246,410,000

+$20,230,000 / 8.9%

Mathematical Sciences Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, DMS	**$211.75**	**$226.18**	**$98.00**	**$246.41**	**$20.23**	**8.9%**
Major Components:						
Research and Education Grants	211.37	226.08	98.00	246.21	20.13	8.9%
Centers	0.38	0.10	-	0.20	0.10	1.0%
Ctrs. for Analysis & Synthesis	-	*0.10*	-	*0.10*	-	-
Nanoscale Science & Engr. Centers	*0.38*	-	-	*0.10*	-	*N/A*

The Division of Mathematical Sciences (DMS) supports research at the frontiers of fundamental, applied, and computational mathematics and statistics and enables discovery in other fields of science and engineering. In turn, advances in science and engineering that are driven by powerful computing environments and that routinely generate large datasets require development of ever more sophisticated mathematical tools. DMS plays a key role in training the Nation’s scientific and engineering workforce. In general, 53 percent of the DMS portfolio is available for new research grants. The remaining 47 percent is used primarily to fund continuing grants made in previous years.

DMS supports research programs in algebra, number theory and combinatorics; analysis; applied mathematics; computational mathematics; foundations; geometry and topology; mathematical biology; probability and statistics. In addition, DMS supports national mathematical sciences research institutes; postdoctoral, graduate and undergraduate training opportunities; and infrastructure, such as workshops, conferences, and equipment.

NSF plays a critical role in the mathematical sciences, as it provides more than 60 percent of all federal support for basic research in the Nation’s colleges and universities. In certain areas of the mathematical sciences this percentage is even higher, since NSF supports a broader range of fundamental and multidisciplinary research topics than other federal agencies.

In FY 2008, DMS received 2,181 research proposals and made 678 awards for a funding rate of 31 percent.

Changes by Activity

Mathematical Sciences Research Institutes (+$6.0 million, to a total of $26.0 million).

These institutes are supported in 10-year cycles. The current funding cycle for four of the Institutes ends in FY 2009. They are eligible to re-compete in a FY 2010 Institutes solicitation with other projects. The FY 2010 budget can accommodate an increase in the number and size of Institute awards. Four to six awards are expected.

Cyber-enabled Discovery and Innovation (CDI) (+$5.20 million, to a total of $10.40 million).

CDI uses the mathematical sciences to provide new ways of obtaining insight into the nature of complex phenomena in science and engineering.

Science and Engineering Beyond Moore’s Law (SEBML) (+$2.0 million, to a total of $2.75 million).

In parallel with Moore's Law for hardware, SEBML continues the algorithmic "Moore's Law", i.e., the exponential increase in speed of basic computations due to innovative new algorithms, and develops new mathematical frameworks for computation.

Solar Energy Research (SOLAR) (+$1.70 million, to a total of $2.40 million).
SOLAR will support multi-disciplinary teams engaged in potentially transformative research on the efficient harvesting, conversion, and storage of solar energy.

Climate Research (CR) will start in FY 2010 at $1.85 million.
CR will support development of mathematical methods and effective computational techniques needed for simulation and analysis of climate models.

PHYSICS

$296,080,000
+$21,610,000 / 7.9%

Physics Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, PHY	**$251.64**	**$274.47**	**$96.30**	**$296.08**	**$21.61**	**7.9%**
Major Components:						
Research and Education Grants	158.93	181.46	93.00	211.75	30.29	16.7%
Instrumentation	4.00	7.20	-	9.00	1.80	25.0%
Centers	6.35	6.36	-	5.68	-0.68	-10.7%
Science & Technology Centers	*3.95*	*3.96*	-	*3.28*	*-0.68*	*-17.2%*
Nanoscale Science & Engr. Centers	*2.40*	*2.40*	-	*2.40*	-	-
Facilities	82.36	79.45	3.30	69.65	-9.80	-12.3%
Laser Interferometer Grav. Wave Observ.	*29.50*	*30.30*	-	*28.50*	*-1.80*	*-5.9%*
Large Hadron Collider	*18.00*	*18.00*	-	*18.00*	-	-
IceCube	*1.50*	*2.15*	-	*2.15*	-	-
Nat'l Superconducting Cyclotron Lab.	*19.25*	*20.50*	*2.00*	*21.00*	*0.50*	*2.4%*
Cornell Electron Storage Ring	*14.11*	*8.50*	*1.30*	-	*-8.50*	*-100.0%*

The Division of Physics (PHY) supports fundamental research that leads to the understanding of the make-up of the Universe, from the formation of stars and galaxies to the principles of life processes on earth. This research is spread across a range of physics subfields: atomic, molecular, optical and plasma physics, elementary particle physics, gravitational physics, nuclear physics, particle and nuclear astrophysics, biological physics, physics at the information frontier, and theoretical physics. PHY is the primary supporter of all U.S. research in gravitational physics and the leading supporter of fundamental research in atomic, molecular, and optical physics in the U.S. PHY is a major partner with the Department of Energy (DOE) in support of elementary particle physics, nuclear physics, and plasma physics. PHY also has the only U.S. program designed for the support of physics research in living systems. The development of the most advanced cutting-edge computational resources, innovative technology, and new instrumentation is a key part of physics research, and tools developed by the physics community continuously have major impact in other scientific and engineering fields.

Based on FY 2008 actuals, 19 percent of the PHY portfolio is available for new research grants. 41 percent supports continuing awards made in prior years; eight percent supports cooperative agreements for large-scale centers and institutes; 32 per cent is dedicated for the support of maintenance and operations for three facilities that are a key part of the division portfolio: the Laser Interferometer Gravitational Wave Observatory (LIGO), the Large Hadron Collider (LHC), and the National Superconducting Cyclotron Laboratory (NSCL).

Changes by Activity

Deep Underground Science and Engineering Laboratory (+$4.0 million, to a total of $36.0 million).
This will support design and research and development as part of a coordinated NSF/Department of Energy plan. This is projected to lead to a baseline funding profile for potential construction of the laboratory as well as provide a basis for estimates of future operations and maintenance expenses and research support.

Physics of Living Systems program (+$2.0 million, to a total of $7.80 million).
This will enable the support of an additional twelve investigators and continue the planned growth in this divisional priority area to a target level of $20.0 million.

Research Resources (+1.80 million, to a total of $9.0 million).
This increase will continue the planned growth of funding to fulfill needs for mid-scale instrumentation for all programs within the division.

Disciplinary programs supporting Science and Engineering Beyond Moore's Law and Cyber-Enabled Discovery and Innovation (+$4.25 million, to a total of $6.95 million).
This will increase the number of investigators supported in these areas by a factor of two.

Facilities (+$9.80 million, to a total of $69.65 million). This includes:

- *Cornell Electron Storage Ring (CESR) (-$8.50 million).* This will complete the close-out of PHY funding for operations and maintenance of the facility as a research tool for elementary particle physics. Operations and maintenance funding for CESR will be assumed by the Division of Materials Research as part of the operations of the Cornell High Energy Synchrotron Source (CHESS).

- *Laser Interferometer Gravitational Wave Observatory facility (-$1.80 million, to a total of $28.50 million).* This reflects a change in the operations and maintenance profile to coordinate with the construction profile for the Advanced LIGO project. Funding for LIGO is expected to return to a higher level in FY 2011. (See the MREFC chapter for more details on Advanced LIGO).

- *National Superconducting Cyclotron Laboratory (+$500,000, to a total of $21.0 million).* This brings the funding level back to the originally planned funding profile.

Detailed narratives on each facility can be found in the Facilities chapter.

MULTIDISCIPLINARY ACTIVITIES

$39,130,000
+$5,920,000 / 17.8%

Multidisciplinary Activities Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, OMA	**$32.67**	**$33.21**	**-**	**$39.13**	**$5.92**	**17.8%**
Major Components:						
Research and Education Grants	32.02	32.11	-	39.03	6.92	21.6%
Instrumentation	-	1.00	-	-	-1.00	-100.0%
Centers	0.65	0.10	-	0.10	-	-

The Office of Multidisciplinary Activities (OMA) enables and facilitates MPS support of particularly novel, challenging, or complex projects of varying scale, in both research and education, which are not readily accommodated by traditional organizational structures and procedures. This is done primarily in partnership with the five MPS disciplinary divisions to encourage proposals from all segments of the MPS community and especially activities by multi-investigator, multidisciplinary teams pursuing problems on a scale that exceeds the capacity of individual investigators. Most often, these cooperative undertakings involve two or more partners – within MPS or beyond – that join with OMA to foster new directions of scientific understanding and that broaden and enrich education and research training activities in the MPS disciplines.

Because OMA plays a catalytic role in seed-funding new multidisciplinary activities and enabling broadening participation, the portfolio includes relatively few commitments, in terms of continuing grant increments, from prior years. In FY 2010, the majority of OMA funds will be available for new research grants. Additional funds will be available for grants and supplements supporting innovative educational and/or broadening participation projects, sometimes affiliated with large centers and facilities or with professional organizations. Nearly all awards made with OMA funding are managed within the MPS disciplinary divisions.

Changes by Activity

To enable the long-term impact of the MPS community and to extend the intellectual frontiers of the MPS disciplines, OMA will focus on multidisciplinary research addressing fundamental science critical to advancing computing and communications technologies beyond Moore's Law; cyber-enabled discovery and innovation; mathematical and physical scientific foundations of energy sustainability and the environment; the behavior of quantum matter and the limitations of quantum information processing; the interface between MPS and the life sciences to provide insight into the molecular basis of life processes, as well as the synthesis of bio-inspired and biomimetic materials; and team efforts by scientists, mathematicians, and engineers aiming to develop next-generation instrumentation.

To catalyze the development of a diverse, well-prepared science, technology, education, and mathematics (STEM) workforce, OMA will facilitate MPS participation in NSF-wide programs and in other activities that leverage MPS's research investment. These activities enrich education and training at all levels and facilitate the formation of research-based partnerships that not only increase diversity and broaden participation, but also build physical and intellectual capacity of educational institutions, particularly minority serving institutions, to produce larger, more diverse cohorts of graduates.

Total OMA funding (+$5.92 million, to a total of $39.13 million).
This will support activities that take place primarily in disciplinary and interdisciplinary research.

This includes:

- *Solar Energy Research (SOLAR)* solicitation in conjunction with DMS, DMR, and CHE at the level of $3.0 million and *Pro-active Recruitment in Introductory Science and Mathematics* at the level of $1.0 million.

- A total of $4.0 million will support *broadening participation* in the MPS disciplines, including: diversity-targeted partnerships involving minority-serving institutions and MPS-supported groups, centers and facilities; diversity-building partnerships with MPS professional organizations; and graduate student, postdoctoral, and mid-career fellowship opportunities.

- A total of $1.0 million is provided for *collaborative public education and outreach activities* at MPS-supported research centers and facilities. This supports activities that enable effective leveraging of the MPS research investment for public science education, and clear public articulation of cross-cutting science themes with significant MPS involvement, such as cyber-enabled discovery and innovation as well as science and engineering beyond Moore's Law.

- About $1.0 million for investment in *cooperative international research and training* is meant to enhance the global competitiveness of U.S. scientists, engineers, and students.

- Support for *cooperative activities between academic research groups and industry* will increase. OMA will increase co-funding from $300,000 to $500,000 for awards made within the MPS divisions through the Grant Opportunities for Academic Liaison with Industry (GOALI) program, which promotes university-industry partnerships by making project funds or fellowships/traineeships available to support a mix of industry-university links.

- About $3.0 million is provided for conceptual design, research, and development related to candidate MPS *large facilities*, which serve researchers from many disciplines. These funds will be provided for the S4 solicitation for the Deep Underground Science and Engineering Laboratory (DUSEL).

- Funding for the *National Institute for Mathematical and Biological Synthesis* (NIMBioS, formerly CIMBS) a Center for Analysis & Synthesis, remains level at $100,000.

SOCIAL, BEHAVIORAL, AND ECONOMIC SCIENCES $257,000,000
+$16,700,000 / 6.9%

Social, Behavioral, and Economic Sciences Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Behavioral and Cognitive Sciences (BCS) [2]	$87.30	$88.70	$43.00	$96.90	$8.20	9.2%
Social and Economic Sciences (SES) [2]	93.40	95.14	42.00	101.14	6.00	6.3%
Science Resources Statistics (SRS)	28.66	38.80	-	34.62	-4.18	-10.8%
Office of Multidisciplinary Activities (OMA) [1,2]	18.51	17.66	-	24.34	6.68	37.8%
Total, SBE	**$227.87**	**$240.30**	**$85.00**	**$257.00**	**$16.70**	**6.9%**
Major Components:						
Research and Education Grants	174.51	176.03	85.00	188.07	12.04	6.8%
Research Resources	36.21	47.09	-	43.16	-3.93	-8.3%
Centers Programs	14.10	11.30	-	19.90	8.60	76.1%
Facilities O&M	0.30	0.40	-	0.40	-	N/A

Totals may not add due to rounding.

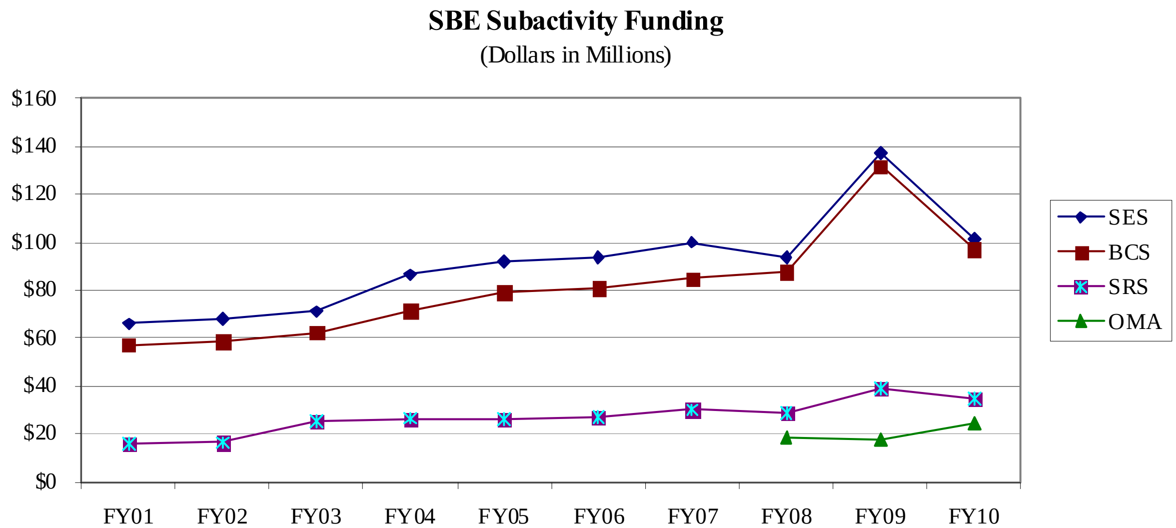
[1] In FY 2010, Science of Learning Centers (SLC) funding is transferred from the Office of Integrative Activities to SBE and split between BCS and OMA. Funding for SLCs is shown in SBE for all years for comparability.

[2] In FY 2010, GK-12, SBE Minority Postdoctoral Fellowships, Research Experience for Undergraduates (REU) Sites, and Science of Science Policy (SciSIP) program funding responsibilities are transferred from SES and BCS to OMA. Funding for these programs are shown for all years for comparability.

The Directorate for Social, Behavioral, and Economic Sciences (SBE) supports fundamental research and related activities that yield new knowledge of human cognition, social organization, and patterns of development and change. In recent decades, SBE research has resulted in new understandings of human development and social dynamics; of perception, memory, linguistic, and reasoning processes; of how people behave as individuals and as members of groups and organizations; and of key social institutions and indicators.

The core of SBE activity addresses the dynamics of cognition, behavior, and social interactions that are important to developing such understanding. Major surveys such as the *Panel Study of Income Dynamics*, the *American National Elections Studies*, and the *General Social Survey* provide broad-based infrastructure for the research community. The Science of Science and Innovation Policy (SciSIP) program aims to understand the contexts, structures and processes of science and engineering (S&E) research, to evaluate tangible and intangible returns from investments in research and development (R&D), and to predict the likely returns from future R&D investments. The data collections and analyses of the Division of Science Resources Statistics (SRS), the designated federal statistical entity with responsibility for the S&E enterprise writ large, are important for evaluating progress toward the goals of the American Competitiveness Act.

SBE participates in inter-directorate, interagency, and international research and education activities and encourages and supports many forms of transformative research. The portfolio includes novel connections among disciplines, research that challenges scientific orthodoxy, development or use of technologies such as functional magnetic resonance imaging (fMRI) and geographical information systems (GIS), experiments with infrastructure for transformative research in the social sciences, rapid-response research on disruptive events, and engagement with urgent, real-world problems.



SBE in Context

SBE provides about 56 percent of federal funding for basic research at academic institutions in the SBE sciences. In some fields, including archaeology, political science, linguistics, and non-medical anthropology and sociology, SBE is the predominant or exclusive source of federal basic research support. SBE also provides predominant federal support for the social aspects of psychology.

Over the past decade, three key elements have caused research in the SBE sciences to undergo dramatic changes. First, new technologies, analytical techniques, and cyber capabilities have been critical. For example, fMRI techniques have enabled behavioral scientists to link behavior to brain activity, opening new channels for investigation. Likewise, the integration of GIS into existing and novel analyses has provided spatial data leading to new insights, since why something happens is often a function of where it happens. New genomic analysis has transformed work on human origins and new cyberinfrastructure has had pervasive, transformative effects on the human sciences.

Second, these new analytical techniques and enhanced cyber capabilities have combined with more traditional technological change to create new approaches to shared infrastructure, making survey information and databases more broadly accessible and enabling links across datasets collected for different purposes. This new infrastructure yields finer resolution of phenomena and enhanced ability to explore complexity in human systems across a broad spectrum of research areas.

Simultaneously, NSF's strong emphasis on partnerships for exploring human and social dynamics has provided the third key element for progress in the SBE sciences. SBE researchers are exploring the processes and implications of constantly changing systems, along with partners across NSF who share an interest in the way human and social behavior interacts with natural and built systems, influences learning, and mediates the interaction between basic research results and marketable technologies. This has led to collaborative enterprises with other directorates focusing on the human dimensions to many aspects of science and engineering as well as STEM learning and education.

This confluence of drivers positions SBE well to contribute toward meeting major national challenges, including addressing human and social aspects of new technologies. SBE will continue to support government-wide activities such as the National Nanotechnology Initiative (NNI), Climate Change Science Program (CCSP), and the Networking and Information Technology Research and Development (NITRD) program. In addition, SBE will continue to support the administration's programmatic priorities relating to homeland security.

SBE will further support NSF's Cyber-enabled Discovery and Innovation (CDI) investment, focusing on the tipping points and emergent phenomena that permeate the human sciences. Multi-directorate activities that investigate the human dimensions of environmental phenomena, such as climate change, water supply and quality, and sustainable energy, now account for almost 20 percent of the SBE portfolio. This includes participation in the cross-directorate (SBE, BIO, and GEO) standing program — the Dynamics of Coupled Natural and Human Systems (CNH) — which brings together multi-disciplinary teams of scientists and engineers to explore the complex interactions between human and natural systems.

SBE's Science Resources Statistics (SRS) Division conducts, analyzes, and disseminates survey results relating to science and engineering (S&E). SRS activities, products, and services provide critical benchmarking information on research and development (R&D), the S&E workforce, the international S&E enterprise, the role of U.S. S&E in a globalized economy, and the outputs of the S&E enterprise such as patents and scientific publications. In addition to the biennial publications *Science and Engineering Indicators* and *Women, Minorities and Persons with Disabilities in Science and Engineering*, SRS provides access to a variety of data on S&E through its website (www.nsf.gov/statistics) and online databases.

The FY 2010 Request for SBE includes $5.0 million to leverage activities across the directorate aimed at increasing support for transformative research. Examples of potential foci for these investments include funding to support research on complex systems, development of new, enabling infrastructure, and large-scale interdisciplinary work. These themes reflect successful elements of the recently concluded Human and Social Dynamics priority area that SBE has recognized for their ability to transform the way research is done in the SBE sciences.

FY 2010 Directorate-wide Changes and Priorities

Science of Learning Centers (SLC) (+$8.6 million, to a total of $19.1 million).

In FY 2010, SBE assumes primary responsibility for funding and management of the SLC program through the new Office of Multidisciplinary Activities (OMA) and responsibility for co-funding three SLCs with close disciplinary alignment in the Division of Behavioral and Cognitive Sciences (BCS). FY 2008 and FY 2009 funding consistent with SBE's FY 2010 responsibilities for the SLC program is included within the SBE totals for comparability purposes. SLC increases by $6.40 million in OMA (to a total of $12.90 million) and by $2.20 million in BCS (to a total of $6.20 million). Funding of the six active SLCs in FY 2010, including co-funding from BIO, CISE, and ENG, totals $25.80 million (an increase of $13.30 million over the FY 2009 total of $12.5 million). The large increment results from the renewal of the initial cohort of SLCs, which did not require funding in FY 2009.

Climate Research (+$4.0 million, to a total of $4.0 million).

SBE invests $4.0 million in Climate Research in FY 2010, and focuses on strategies for mitigation, adaptation, and dealing with impacts as part of a broader portfolio of activities related to human dimensions of climate change. Human actions influence climate change at the same time as changes in climate affect the environment in which humans live. This duality creates a critical role for SBE researchers in addressing an important national challenge.

Cyber-enabled Discovery and Innovation (CDI) (+$3.02 million, to a total of $5.60 million).

CDI includes three themes for FY 2010, all of which are central to SBE goals: 1) From Data to Knowledge, 2) Understanding Complexity in Natural, Built, and Social Systems, and 3) Virtual Organizations. Funding for CDI will increase work on complexity and systems models of human thought and behavior as well as social organizations, institutions, and processes. Such approaches promise to transform analysis and understanding by reconceptualizing fundamental behaviors and processes and revealing the emergent properties of dynamic systems.

Disciplinary and Interdisciplinary Research and Education (+$4.32 million, to a total of $170.84 million).

SBE investments in fundamental research in the social, behavioral, and economic sciences stretches across traditional boundaries, encouraging interdisciplinary and international research at the frontiers of discovery across all its fields.

Faculty Early Career Development (CAREER) (+$700,000, to a total of $5.40 million).

CAREER remains the primary mechanism for jump-starting junior faculty toward independent careers in research and education, a priority for FY 2010.

Science Resources Statistics (SRS) (-$4.18 million, to a total of $34.62 million).

A reduction of $6.0 million for the National Survey of College Graduates (from $12.0 million to $6.0 million) reflects the major work done on sample redesign in FY 2009. This amount includes the administration of the NSCG to a larger than normal sample as testing and refinement of the sample frame continues. An increase of $1.82 million continues development in other high priority areas within the SRS portfolio.

Program Evaluation and Performance Improvement

The Performance Information chapter describes the Foundation's performance evaluation framework, which is built upon the four strategic outcome goals in NSF's Strategic Plan: *Discovery, Learning, Research Infrastructure*, and *Stewardship*. Performance evaluation is conducted at all levels within the Foundation, using both qualitative and quantitative measures – including an agency-wide annual review of research and education outcomes by an external expert committee and periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are also factored into the performance assessment process.

In FY 2010, SBE is scheduled to hold two Advisory Committee (AC) meetings. In addition, a committee of Visitors (COV) is scheduled for the SES division.

Number of People Involved in SBE Activities

	FY 2008 Estimate	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate
Senior Researchers	2,983	3,230	1,050	3,478
Other Professionals	407	430	147	441
Postdoctorates	138	200	49	259
Graduate Students	1,952	2,200	683	2,462
Undergraduate Students	1,141	1,240	403	1,330
Total Number of People	6,621	7,300	2,332	7,970

SBE Funding Profile

	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate
Statistics for Competitive Awards:			
Number of Proposals	4,364	4,368	4,600
Number of New Awards	1,126	1,410	1,187
Regular Appropriation	1,126	1,130	1,187
ARRA	-	280	-
Funding Rate	26%	32%	26%
Statistics for Research Grants:			
Number of Research Grant Proposals	3,237	3,243	3,500
Number of Research Grants	684	938	720
Regular Appropriation	684	690	720
ARRA	-	248	-
Funding Rate	21%	29%	21%
Median Annualized Award Size	99,121	99,130	104,086
Average Annualized Award Size	116,070	119,552	121,873
Average Award Duration, in years	2.5	3.0	3.0

Recent Research Highlights

► **Sacred Values in Decision Making and Cultural Conflict:** A team of researchers at the University of Michigan Ann Arbor is investigating the role of ethical and religious beliefs, or "sacred values," in motivating human behavior. Sacred values often concern issues of justice, honor, and religion, and are dissociated from prospects of success. The team is looking at the relationship between sacred values and decision making, the role of sacred values in intergroup conflict, and possibilities for reducing intergroup conflict through a better understanding of sacred values. Researchers found that material incentives often backfire in conflict resolution while symbolic concessions may be a key to resolving conflicts. The research included interviews with both students and leaders involved in the Israeli-Palestinian conflict. Most of the participants responded negatively if the proposed solution was an economic trade-off, responded extremely negatively if offered a trade-off along with some substantial material incentive, and responded more positively to a trade-off also involving a symbolic concession.

Israeli soldiers join Jewish settlers at withdrawal from Gaza Strip on Monday, Aug. 15, 2005. *Credit: US Dept of State public image database.*

► **Research Breakthrough on First Modern Humans:** Arizona State University researchers have made striking new discoveries about the earliest modern humans, including their ecology, social structures and evolutionary history. *Homo sapiens* arose between 200,000 and 100,000 years ago. During this period, coastal South Africa offered one of the most hospitable environments for human habitation. The area offers rich shellfish beds and a vegetation regime - abundant food for hunter-gatherers. The team found that people on this coast began to eat shellfish about 164,000 years ago. Hunter-gatherers who ate this diet could reduce their mobility and increase their group size. The team also discovered the earliest evidence for the use of pigment as well as stone tools made with very small blades that probably were hafted. Altogether, the findings show people were behaving in ways that resemble complex modern humans at an earlier time in our evolution than previously thought.

A view of the Indian Ocean from the coast of South Africa at Pinnacle Point where the archaeological discoveries were made. *Credit: Marean.*

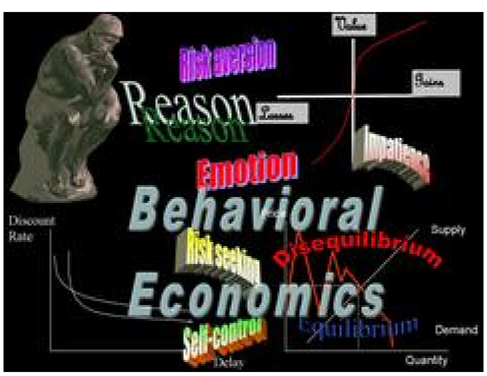
Researchers excavating shell fish. The high quantity of this stable food source was likely a significant factor in the evolution of modern humans, who were able to survive as hunter-gatherers at this site between 100,000 and 200,000 years ago. *Credit: Marean.*

► **High School Exit Exams and Labor Market Outcomes Among Young Adults:** In a study of high school exit examinations requirements, researchers at the University Minnesota-Twin Cities and the University of California-Davis studied whether certifying that students possess basic skills necessary for success in the modern labor market enhances students' post-high school economic prospects and labor market outcomes. Using data from the Department of Labor Current Population Surveys and the Population Censuses, the researchers found no evidence that passing state exit exams positively affects labor force status or translates into higher earnings. Further, they find no evidence that employment and earning outcomes vary by students' race and ethnicity or the level of difficulty of state exit exams. These findings make clear that having a policy that makes passing exit exams a requirement for earning a high school diploma does not improve (or worsen) wages earned by graduates. The meaning and value that employers attach to the high school diploma appear unaffected by states' exit exam polices. This empirical evidence calls into question the basic assumption that standardizing high school graduation requirements improves employability and earnings. Employers do not assign additional value to passing the exit exams. To them high school diplomas are the same--with or without passing the exit exams.

► **Influences on Language Development:** Researchers at Rutgers University studied more than 1,250 children, including 450 pairs of twins, to learn how genetic factors and prenatal and neonatal environments affect children's language, cognitive, motor, and social development. They found that genetic factors play a greater role in the development of pronunciation and grammar than they do in the development of vocabulary. The same genetic factors also affect fine motor development but not gross motor development. The researchers showed very early environmental factors, such as premature birth, low birth weight, and some medical treatments, affect spoken language, gross motor, fine motor and social development more than later postnatal environment factors, such as family income and parent education. In contrast with their findings for spoken language and motor development, Stromswold and her students have found that written language is affected more by the postnatal environment than the early environment. This study may help identify children who are at risk for particular types of disorders and eventually aid in the prevention and treatment of these disorders.

Even though identical twins are genetically identical, sometimes they have different experiences in the womb and are quite different at birth. *Credit: Karin Stromswold.*

► **The Rise of Behavioral Economics:** Traditionally, economics has been a study of the role of incentives in influencing behavior. Increase the price of a commodity and you will eventually decrease the rate at which people consume it. Researchers at the University of Pennsylvania, Yale University, and Cornell University in the new subfield of *behavioral economics* are examining a broader set of influences on behavior and expanding the economists' policy toolkit in the process. One fundamental assumption behavioral economists have employed with great success is that the carriers of value - those things that sway our decisions one way or another -- are gains and losses rather than final amounts of wealth. A second particularly powerful assumption concerns what is referred to as "loss aversion," -- the observation that the pain people experience



Behavioral Economics. *Credit: Jonathan Leland.*

from a loss of a given magnitude is far more intense than the pleasure associated with experiencing a gain of equivalent magnitude. These assumptions imply that the way options are framed may influence peoples' choices - outcomes of decisions may appear to be losses or may appear to be gains depending on what people perceive as the status quo. A remarkable implication of this sensitivity to framing is that effective policies to alter behaviors, from willingness to save to the propensity to spend economic stimulus money, may be achieved by simply re-describing the alternative courses of action - and economists used to say "there's no such thing as a free lunch!"

BEHAVIORAL AND COGNITIVE SCIENCES

$96,900,000
+$8,200,000 / 9.2%

Behavioral and Cognitive Sciences Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over* FY 2009 Plan Amount	Percent
Total, BCS[1]	**$87.30**	**$88.70**	**$43.00**	**$96.90**	**$8.20**	**9.2%**
Major Components:						
Research and Education Grants	81.08	81.97	43.00	87.74	5.77	7.0%
Centers	4.40	4.38	-	6.58	2.20	50.2%
Science of Learning Centers (SLC) [2]	*4.00*	*4.00*	-	*6.20*		
Long Term Ecological Res. (LTER)	*0.22*	*0.20*		*0.20*		
Nano S&E Centers	*0.18*	*0.18*	-	*0.18*	-	-

Totals may not add due to rounding.

[1] In FY 2010, GK-12, SBE Minority Postdoctoral Fellowships, Research Experiences for Undergraduates (REU) Sites, and Science of Science Policy (SciSIP) program funding responsibilities are transferred from BCS and SES to OMA. Funding for these programs is shown as if it were in OMA for all years for comparability.

[2] In FY 2010, there is a transfer of program funding responsibilities for co-funding of 3 Science of Learning Centers from Integrative Activities to BCS. Funding is shown as if it were in BCS for all years for comparability.

Behavioral and Cognitive Sciences Division (BCS) (+$8.20 million, to a total of $96.90 million). BCS supports research and related activities that advance fundamental understanding in the behavioral, cognitive, anthropological, and geographic sciences. The division seeks to advance scientific knowledge and methods focusing on human cognition and behavior including perception, thought processes, language, learning, and social behavior across neural, individual, family, and group levels. The division also supports activities focusing on human variation at the scales of society, culture, and biology, and how these variations and related patterns develop. BCS research is helping us prepare for and mitigate the effects of natural and human-initiated disasters, predict and address how people respond to stressors, improve methods for effective learning, enhance the quality of social interaction, and respond to issues such as globalization, terrorism, and climate change. The division aims to increase basic understanding of and capabilities to explore geographic distributions and relationships, with an emphasis on interactions of human and natural systems on the Earth's surface. Strong core programs are complemented by active involvement in competitions that support collaborative and cross-disciplinary projects.

In general, 60 percent of the BCS portfolio is available for new research grants. The remaining 40 percent is used primarily to fund continuing grants made in previous years. The BCS portfolio mainly supports research and education grants ranging in scope from dissertation and individual-investigator awards to larger group projects that span multiple disciplines and institutions.

Major activities include:

- Understanding fundamental human processes including language, cognition, perception, reasoning, and action planning in relation to adult and childhood developmental and learning processes;
- Providing fundamental understanding of human social behavior including attitude formation and change, social cognition, affective and motivational influences, and personality processes;
- Integrating qualitative and quantitative analyses to better understand cultures;

- Understanding human biological variation, adaptation, and ontology;
- Using a geographic framework for understanding social, political, and economic change;
- Facilitating research to address the complexity in human-environmental interactions;
- Using non-linear models to understand dynamics of human behavior;
- Documenting the world's endangered languages in order to preserve retrievable information about linguistic structures; and
- Creating platforms for annotating and archiving textual, audio, and video language samples, as well as accessing the material for analyses.

Research and Education Grants (+$5.77 million for a total of $96.90 million in FY 2010).

BCS aims to strengthen the basic research enterprise and encourage transformative research in the behavioral, cognitive, anthropological, linguistic, and geographic sciences through increased support to programs that serve these critical research communities. Emphasize additional funding to expand in new directions, increase cross-disciplinary interactions, and support the work of early career scientists. Funding Changes for FY 2010:

- $2.49 million will strengthen disciplinary research to enhance the number of transformative projects that expand in new directions, increase cross-disciplinary interactions, and support early career scientists.

- $1.51 million will fund BCS-related investments in the CDI activity with emphasis on complexity and interacting systems in the behavioral, cognitive, anthropological, and geographic sciences.

- $2.0 million will support an expansion of environmental research for work on human causes and consequences of environmental change and sustainable energy related to the NSF-wide investment in climate research.

Centers (+2.20 million for a total of $6.58 million in FY 2010).

BCS co-funds (with SBE's OMA) three Science of Learning Centers (SLC) and also supports Long Term Ecological Research centers and Nanotechnology Science and Engineering centers. Funding Changes for FY 2010:

- $2.20 million for increased funding requirements for the BCS-related SLCs.

SOCIAL AND ECONOMIC SCIENCES

$101,140,000
+$6,000,000 / 6.3%

Social and Economic Sciences Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, SES[1]	**$93.40**	**$95.14**	**$42.00**	**$101.14**	**6.00**	**6.3%**
Major Components:						
Research and Education Grants	82.38	83.34	42.00	89.08	5.74	6.9%
Research Resources	7.91	8.94	-	8.94	-	-
Centers	1.01	0.42	-	0.42	-	-
Nano S&E Centers	*1.01*	*0.42*	-	*0.42*	-	-
Facilities	0.30	0.40	-	0.40	-	-
NNIN	*0.30*	*0.40*	-	*0.40*	-	-

Totals may not add due to rounding.

[1] In FY 2010, GK-12, SBE Minority Postdoctoral Fellowships, Research Experience for Undergraduates (REU) Sites, and Science of Science Policy (SciSIP) program funding responsibilities are transferred from BCS and SES to OMA. Funding for these programs is shown as if it were in OMA for all years for comparability.

Social and Economic Sciences Division (SES) (+6.0 million, to a total of $101.14 million). SES supports research and related activities, conducted within the U.S. and globally, that improve systematic understanding of political, economic, and social institutions and how individuals and organizations behave within them. It also supports research and activities related to risk assessment and decision making by individuals and groups; the nature and development of the various sciences and technologies and their implications for society; methods and statistics applicable across the social, economic, and behavioral sciences; scholarly career development; and broadening participation in the social, behavioral, and economic sciences. Its programs include economics, political science, and sociology, and interdisciplinary fields such as decision making and risk, law and social science, and science and technology studies. In many of its programs, SES is the major (sometimes only) source of federal funding for fundamental research, making crucial investments in the data resources and methodological advances that produce transformative research.

SES supports research and education through grants that range in size from small supplements for undergraduates to collaborate with faculty on research projects to multi-million-dollar survey awards such as the *Panel Study of Income Dynamics* (PSID), the *American National Elections Studies* (ANES), and the *General Social Survey* (GSS). These surveys are national resources for research, teaching, and decision-making that have become models for similar efforts in other societies.

SES also coordinates the Ethics Education in S&E Program, supporting (with other NSF directorates) the Online Ethics Center for Engineering and Science, and manages the Centers for Nanotechnology in Society. SES is also a participant in a number of Nanoscale Science and Engineering Centers and the National Nanoscale Infrastructure Network

In general, 60 percent of the total SES portfolio is available for new research grants. The remaining 40 percent is used primarily to fund continuing grants made in previous years.

Funding Changes for FY 2010:

- $2.49 million will strengthen fundamental research in programs that has transformative potential for the social and economic sciences and will support new investigators. SES will give particular emphasis to the development and application of advanced qualitative and quantitative methods and to research that addresses the origin, shaping, and uses of science, knowledge, and technology.

- $1.51 million will increase support for SBE-related investments in CDI through programmatic funding for applications of computational and complexity thinking to the most challenging scientific problems in the human sciences. Social and economic phenomena are inherently complex, because they include patterns and structures that only emerge through the accumulation of individual decisions and actions that occur over space, time and populations. Complexity and interacting systems have transformative potential across the spectrum of social and economic sciences. Virtual organizations are both objects of study for SES researchers and vehicles that extend the transformative capacity of SES research.

- $2.0 million will expand support for research on the fundamental problems in economics, decision making, and methodology that underlie the human causes and consequences of disruptive weather events, long-term climate change, and the consumption of scarce natural resources in conjunction with the NSF investment in Climate Research. Decision making under uncertainty is a major factor in risk mitigation strategies.

SCIENCE RESOURCES STATISTICS

$34,620,000
-$4,180,000 / -10.8%

Science Resources Statistics Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, SRS	**$29.96**	**$38.80**	-	**$34.62**	**-4.18**	**-10.8%**
Major Components:						
Research and Education Grants	1.43	0.10	-	0.10	-	-
Research Resources	28.30	38.15	-	34.22	-3.93	-10.3%

Totals may not add due to rounding.

Science Resources Statistics Division (SRS) (-$4.18 million, to a total of $34.62 million). The legislative mandate for SRS as stated in the National Science Foundation Act of 1950, as amended, is "…to provide a central clearinghouse for the collection, interpretation, and analysis of data on scientific and engineering resources and to provide a source of information for policy formulation by other agencies of the Federal Government…." To meet this mandate, SRS, in its role as the federal statistical agency with responsibility to cover the S&E enterprise, provides policymakers, researchers, and other decision makers with high quality data and analysis on R&D and the S&E workforce for making informed decisions. The work of SRS involves survey development, methodological and quality improvement efforts, data collection, analysis, information compilation, dissemination, web access and customer service to meet the statistical and analytical needs of a diverse user community, as well as preparation of the congressionally mandated biennial reports — *Science and Engineering Indicators (SEI)* and *Women, Minorities and Persons with Disabilities in Science and Engineering (WMPD)*. The data collected by SRS serve as an important tool for researchers in SBE's Science of Science and Innovation Policy (SciSIP) program and as the major component of the content of *SEI*.

The funding portfolio for SRS includes ongoing, cyclical surveys; reports and other products; and projects accomplished primarily through contracts and also a few standard grants. In FY 2010 SRS will:

- Continue to conduct surveys and engage in analytical activities that produce information for carrying out NSF's statutory mandate, for meeting NSF strategic goals, and for developing *SEI* and *WMPD*. SRS will also aim to continually improve the relevance and quality of the data it collects and the information it disseminates. Such activities will lead to additions to current activities in subsequent years.
- Implement the results of prior methodological, analytical, and planning activities directed toward improving the quality, relevance, timeliness, and accessibility of all SRS products.
- Continue to hold workshops with industry, R&D, and S&E workforce experts; data users, and innovation experts on enhancing the Science of Science and Innovation Policy (SciSIP). These workshops inform and enhance the redesigns underway for the SRS surveys, analytical reports and *SEI*.
- Continue ongoing activities to improve information on the globalization of the S&E enterprise, through continued interaction with OECD, EUROSTAT, UNESCO Institute for Statistics, and other international and national statistical agencies.
- Work with the National Science Board on potential improvements and enhancements for *SEI 2012*.

Funding Changes for FY 2010:

- The FY 2009 Current Plan includes a significant increase in order to redesign the sample design for the National Survey of College Graduates (NSCG) to replace the decennial census long-form, which was used in previous decades. The new frame will be the American Community Survey (ACS), which includes a question on field of degree that will provide the basis for NSCG sampling in the future. In FY 2010, a reduction of $6.0 million for the NSCG (from $12.0 million to $6.0 million) reflects the major work done on sample redesign in FY 2009. Plans for FY 2010 include refining the sample design, launching the first administration of the NSCG using the new ACS-based frame, and conducting analyses to guide activities in the future.

- Increase of $1.30 million for continuing development of a Microbusiness R&D and Innovation module, work on exploring how best to collect data on innovation in the academic sector as part of the redesigned Higher Education Research and Development Survey (HERD); redesign activities related to the Survey of Earned Doctorates and continuing work on harmonization and modernization of SRS taxonomies. Work will also begin to explore implementing recommendations from the Committee on National Statistics report on updating the federal R&D surveys.

- Increase of $700,000 to develop a pilot data collection on postdocs based on feasibility activities undertaken in FY 2006 through FY 2009. The pilot will study how best to develop a sample frame for postdocs that includes those who do not have a research doctorate from a U.S. institution and those who work in non-academic institutions. Implementation of the pilot is planned in FY 2010.

- Evaluate the redesign of the survey of R&D in the industrial and services sectors (conducted in FY09 as a full-scale pilot) and implement the survey for 2010 with appropriate changes. The newly re-named Business Research and Development and Innovation Survey (BRDIS) collects data for the manufacturing and services sectors on: the role of R&D in both the U.S. and internationally, R&D infrastructure, the way R&D is currently conducted, and limited innovation and technology transfer data, all critical components for understanding economic competitiveness. Survey data will be in the 2012 *SEI*.

- Invest in a number of activities to determine how best to link important SRS statistical data sets with supplemental data on publications, patents, and innovation-related activities. In addition, SRS will work on harmonizing taxonomies of fields of science to more fully integrate its data sets both internally and with other national and international data; this includes support for international activities to encourage data comparability and usefulness in data collected and used by international organizations such as OECD, Eurostat and the UNESCO Institute of Statistics. All these activities will be in support of both *SEI* and SciSIP.

OFFICE OF MULTIDISCIPLINARY ACTIVITIES **$24,340,000**
+$6,680,000 / 37.8%

Office of Multidisciplinary Activities Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
OMA Total [1,3]	**$18.51**	**$17.66**	**-**	**$24.34**	**$6.68**	**37.8%**
Major Components:						
Research and Education Grants	9.62	10.62	-	11.15	0.53	5.0%
Instrumentation	-	-	-	-	-	N/A
Centers	8.69	6.50	-	12.90	6.40	98.5%
Science of Learning Centers [2]	*8.69*	*6.50*	-	*12.90*	*6.40*	*98.5%*

Totals may not add due to rounding.

[1] OMA was created in FY 2010 by shifting funding from Integrative Activities (Science of Learning Centers) and SBE/BCS and SBE/SES (all other activities).

[2] In FY 2010, there is a transfer of program funding for Science of Learning Centers from Integrative Activities to OMA. Funding is shown as if it were in OMA for all years for comparability.

[3] In FY 2010, GK-12, SBE Minority Postdoctoral Fellowships, Research Experience for Undergraduates (REU) Sites, and Science of Science Policy (SciSIP) program funding and responsibilities are transferred from BCS and SES to OMA. Funding for these programs is shown as if it were in OMA for all years for comparability.

Office of Multidisciplinary Activities (OMA) (+$6.68 million, to a total of $24.34 million). OMA provides a focal point for programmatic activities that cut across SBE disciplinary boundaries, including agency-wide Science of Learning Centers (SLCs), Science of Science and Innovation Policy (SciSIP) which engages in much interagency work, Research Experiences for Undergraduates (REU) sites, and Minority Postdoctoral Research Fellowships (MPRF). Co-funding with other divisions in SBE and with divisions in other directorates is typical for OMA. While all SBE divisions are expected to pursue an appropriate range of interdisciplinary work, OMA assists with seeding multidisciplinary activities for the future. All areas of SBE sciences are represented in the OMA portfolio.

In general, 38 percent of the OMA portfolio is available for new research grants. The remaining 62 percent funds continuing grants made in previous years. In particular, funding for SLCs is entirely committed to continuing awards.

OMA is a new office in FY 2010. The majority of its budget is devoted to the SLC program, which moves from Integrative Activities to SBE in FY 2010. OMA houses management of the six current SLCs, with matching co-funding from disciplinary partners in BIO, CISE, ENG, and SBE/BCS. SBE has transferred programmatic responsibility for SciSIP, REU sites, and MPRF, previously shared by BCS and SES, to OMA, as well as providing additional funds for seeding transformative multidisciplinary research.

OMA Priorities for FY 2010

- The SLC program as a whole (including co-funding outside OMA) increases from $12.50 million in FY 2009 to $25.80 million in FY 2010. This allows for renewal of the first cohort of SLCs, which did not require funding in FY 2009. Within OMA, the SLC program increases by $6.40 million to a total of $12.90 million.

- Provide multidisciplinary oversight for the SLC program, ensuring all Centers are managed appropriately toward their goals and objectives.
- Approximately $1.50 million will enable OMA to stimulate transformative multidisciplinary research through co-funding with other organizations, including at least $1.0 million for the SBE-wide pool.

OFFICE OF CYBERINFRASTRUCTURE $219,000,000
+$19,720,000 / 9.9%

Office of Cyberinfrastructure Funding

(Dollars in Millions)

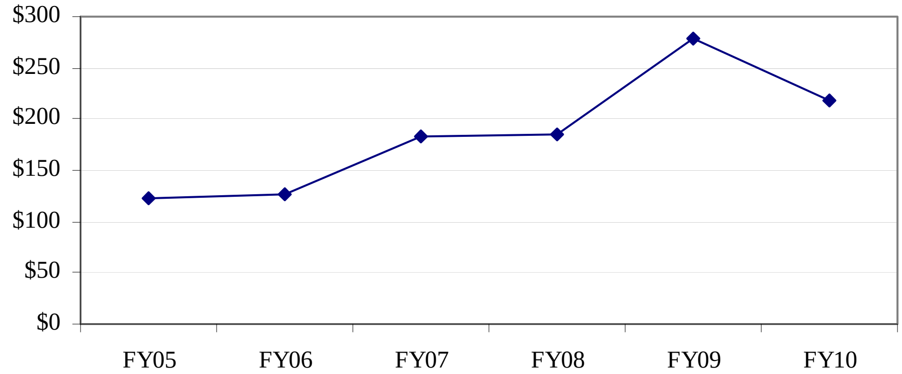
	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Percent
Total, OCI	**$185.15**	**$199.28**	**$80.00**	**$219.00**	**$19.72**	**9.9%**
Major Components:						
Research and Education Grants	31.48	38.63	63.00	58.03	19.40	50.2%
Track-1 (Blue Waters)	13.65	45.23	-	97.00	51.77	114.4%
Track-2	14.19	68.73	-	26.95	-41.78	-60.8%

The Track-1 activity is designed to provide researchers with a sequence of leadership-class systems at intervals of four to five years. The Track-2 activity is designed to maintain a diverse portfolio of national-scale supercomputing and storage infrastructure for the research and education community.

The Office of Cyberinfrastructure (OCI) supports research, development, acquisition, and operation of advanced shared and connecting cyberinfrastructure (CI) that enables otherwise unrealizable advances in 21st century science and engineering research and education. It increasingly supports the use of advanced CI to attack frontier science problems through the growing discipline of computational science and engineering, as well as the computational scientists who develop and use it. OCI capitalizes on a broad range of fundamental scientific and engineering research as well as education and research in other directorates to create and expand the next generation of CI. This CI is critical to converting data to knowledge, understanding complexity through simulation and prediction, and creating more systematic knowledge about the social and technical issues of large-scale, multidisciplinary collaborative communities, known as virtual organizations, needed to address complex problems and grand challenges facing science and society.

OCI-supported CI includes the comprehensive set of deployable hardware, software, and algorithmic tools that support research, education, and increasingly collaboration across and among all research disciplines, whether they are experimental, theoretical, and/or computational. CI consists of computing systems, data storage systems, data repositories and advanced instruments, visualization environments, people, and the necessary intellectual capital, all linked together by software and advanced networks to sustain and improve scholarly productivity and enable breakthroughs in complex problem solving. OCI supports socio-technical research on the use of CI and on ways of improving its effectiveness. It supports training in the development and use of advanced CI as well as research on its use to enhance learning. OCI also supports the scientific and engineering professionals who create and maintain these leading-edge resources and systems, and who provide the Nation's researchers and educators with essential CI services. OCI makes investments that improve CI for science and engineering research, funding the deployment of current CI and innovative developments in future CI. In doing so, it both leverages and complements investments made by other federal agencies. For example, some of NSF's high-end computing investments take advantage of expertise at laboratories funded by the Department of Energy (DOE) and hardware and software developments funded by the Department of Defense's Defense Advanced Research Projects Agency (DARPA). In addition, OCI investments in petascale applications and tools complement those of DOE's Scientific Discovery through Advanced Computing (SciDAC) program, and OCI's TeraGrid infrastructure is used by researchers funded by the National Institutes of Health (NIH), DOE, and other agencies.

OCI Funding
(Dollars in Millions)



OCI in Context

OCI supports the development and deployment of cyberinfrastructure (CI) that is shared by all scientific and engineering disciplines, making possible potentially transformative basic research in areas such as nanotechnology, physics, chemistry, materials science, sustainable energy, climate/weather, and engineering. It also promotes interoperability between components of CI both here in the U.S. and abroad. About two-thirds of NSF's investments in CI are made by the directorates and offices responsible for fundamental domain specific research and education in science and engineering, with the remaining one-third provided by OCI. Through coordinated planning and investments facilitated by NSF's Cyberinfrastructure Council, OCI works to support integrated applications and teams that use advanced CI to solve complex multidisciplinary science and engineering problems, providing economies of scale and scope to ensure that NSF's CI portfolio delivers the highest returns on the Nation's investment.

OCI's investments are guided by NSF's *Cyberinfrastructure Vision for 21st Century Discovery* (www.nsf.gov/dir/index.jsp?org=OCI), a comprehensive CI strategic plan for the Foundation; by many blue-ribbon panel and advisory reports, such as the 2005 Presidential Information Technology Advisory Committee (PITAC) (www.nitrd.gov/Pitac/reports/20050609_computational/computational.pdf) report; by the America COMPETES Act; and by the opportunities identified by the academic and industrial research community through workshops and white-papers. The America COMPETES Act calls for the Foundation to conduct long-term basic and applied research on high-performance computing and networking, and OCI's investments are central to advancing that goal.

OCI activities are key components in the federal government's Networking and Information Technology Research and Development (NITRD) program. The technologies developed and the systems deployed by OCI facilitate discovery and innovation and bolster national competitiveness. PITAC specifically recommended in 2005 that federal agencies reorganize to support more effectively multidisciplinary computational science, which it called the "third pillar" of science and engineering of the 21st century. OCI was created in 2005, and is now specifically taking on a role as steward of computational science activities in coordination with directorates and offices across the Foundation.

The FY 2010 Request for OCI includes $2.0 million to leverage activities aimed at increasing support for transformative research. Examples of potential foci for these investments include the Strategic

Technologies for Cyberinfrastructure (STCI) Program and the EArly-concept Grants for Exploratory Research (EAGER). The primary purpose of the STCI Program is to support work leading to the development and/or demonstration of innovative cyberinfrastructure services for science and engineering research and education that fill gaps left by more targeted funding opportunities. In addition, STCI considers highly innovative cyberinfrastructure education, outreach and training proposals that lie outside the scope of targeted solicitations. The EAGER mechanism supports high-risk, exploratory and potentially transformative research.

Office-wide Changes and Priorities

Learning (+$8.45 million to a total of $13.10 million).

Consistent with NSF's Cyberinfrastructure Vision for 21st Century Discovery, the President's Council of Advisors on Science and Technology (PCAST) 2007 report and in response to OCI's 2008 Committee of Visitors (COV) recommendation, OCI will significantly expand its participation in the area of learning and workforce development. This will be accomplished by co-funding OCI mission consistent Graduate Research Fellowships (GRF), and expanding participation in the REU program by initiating support for REU sites in addition to providing ongoing support for REU supplements. These are all new areas for OCI investments. In addition, the OCI 2008 COV identified the lack of an "extensive workforce initiative" in the context of Learning activities. During FY 2010, OCI shall introduce an education and training program exploiting the dual nature of CI, i.e. both as a resource for teaching and as a resource for learning. Such an activity is important to development of a 21st century workforce.

OCI Disciplinary & Interdisciplinary Research (+$7.04 million to a total of $40.70 million).

The 2008 OCI COV report states "... in order for [OCI] to create cutting-edge research infrastructure, OCI must actively and deeply engage in the research itself." Addressing that recommendation, OCI will augment its Cyber-enabled Discovery and Innovation (CDI) funding and complement it with investments in several research areas within OCI, in partnership with directorates across the Foundation. Of particular interest will be programs in software, large data, and scientific applications that require advanced CI. In conjunction with NSF's other research directorates, OCI will participate in Science and Engineering Beyond Moore's Law (SEBML), and in Climate Research. In addition, OCI will increase its investments in supporting grand challenge communities and virtual organizations as well as in programs seeking innovative technologies in CI. As OCI begins to play a stronger role in computational science, it will actively increase its participation in NSF's research programs in partnerships with other units across the Foundation, and expects to catalyze new multidisciplinary programs in computational sciences in the future.

CAREER (+$3.88 million to a total of $3.88 million).

The CAREER program remains the primary mechanism for jump-starting junior faculty toward independent careers in research and education. The program has been very successful in supporting traditional areas of science, but less so in computational science, an area so important to the future of science and engineering that it has been called the "third pillar" of scientific inquiry. In order to address this, OCI will support CAREER awards in computational science, across all disciplines for outstanding young faculty who prototype and develop the next generation cyberinfrastructure, and/or apply it to advance their basic science disciplines.

Stewardship (+$67,000 to a total of $4.32 million).

A number of activities are funded directly from NSF's programs to advance NSF's Stewardship goal. These include Intergovernmental Personnel Act appointments, NSF-wide studies and evaluations, and mission-related information technology investments.

Networking and Computational Resources Infrastructure and Services (-$353,000 to a total of $156.65 million)

OCI FY 2010 infrastructure activities are highly dynamic, principally as a direct result of the NSF Track-2 awards acquisition phase winding down, the transition to operations and maintenance in these awards, and the beginning of significant milestone payments to the petascale Track-1 award coming due. As OCI expands activities in computational science research, OCI expects to increase investments in software both at the infrastructure level and to support complex application development in and among the various science domains. OCI will strengthen its broadband investments that cover research and development in high-performance network deployment, tools, and scientific applications. The goal is to "raise the bar" in national and international end-to-end network connectivity and availability in support of scientific research and education. Activities funded in this program are expected to result in an array of new integrated CI capabilities ranging from major advances in network performance, domestic connectivity for institutions in need, new global partnerships in international networking, and leadership class operational awareness in network enabled scientific applications and collaboration. FY 2010 represents a transition year between current TeraGrid award activities and the new eXtreme Digital (XD), also known as TeraGrid III. There are TeraGrid resources that will transition off while new, less costly, resources will be made available through the most recent Track-2 acquisition. In addition support for some programs that were initiated prior to the creation of OCI (by the division of Shared Cyberinfrastructure in the Directorate for Computer and Information Science and Engineering) ends in FY 2009.

- *Track-1 and Track-2 HPC Activities (+$9.98 million to a total of $123.95 million).* Driven by the needs of the science and engineering communities, two complementary "tracks" for provisioning high-performance computing, storage and personnel resources are currently in progress. The Track-1 activity is designed to provide researchers with a sequence of leadership-class systems at intervals of four to five years. The first Track-1 award will support the deployment of a system capable of sustaining performance exceeding a petaflop per second on very difficult problems in a range of research areas, permitting ground-breaking research in areas as diverse as astrophysics, climate, engineering and life sciences. This award, of approximately $208 million, was made in 2007 to the University of Illinois at Urbana-Champaign (UIUC) in a partnership with IBM to develop a system to be named Blue Waters. The first set of deliverables from IBM, relating mostly to software, were received by UIUC in Fall 2008 and were subsequently reviewed by the project team, an external review panel, and NSF. The IBM deliverables were accepted by UIUC in April 2009. The schedule for the commencement of full operations remains mid-2011. UIUC is constructing a specially designed facility to house Blue Waters and its support staff. Begun in October 2008, it is on schedule, due to be completed in 2010.

  The Track-2 activity is designed to maintain a diverse portfolio of national-scale supercomputing and storage infrastructure for the research and education community. The first phase of this activity included four annual solicitations beginning in FY 2005 and ending in FY 2009. No solicitation is planned for FY 2010 and the next phase of high-end computing competitions will begin in FY 2011. The first Track-2 award was made in FY 2006 to the Texas Advanced Computing Center for a total of approximately $59 million for acquisition and operation of a system, named Ranger, built by Sun Microsystems Inc. This entered full service in February 2008. The second award, of $64.4 million for the acquisition and operation of a sequence of systems built by Cray Inc., was made in FY 2007 to the University of Tennessee at Knoxville. The first full production phase, a Cray XT4, entered service in August 2008. The next phase, a Cray XT5, entered production use in February 2009. A final upgrade is scheduled for the second half of 2009. The third Track-2 award is currently being negotiated with the Pittsburgh Supercomputing Center (PSC) and is expected to enter production service in 2010. The final round of the first phase of Track-2 competitions anticipated making several awards intended to provide the research community with access to innovative and experimental production computing architectures. Two awards resulting from this round are currently being negotiated with the potential awardees. One is for a data-intensive computing system, scheduled to enter full production in 2011. The other is for an experimental high-performance computing system with a parallel architecture that includes many-core accelerators. At least one more award from the fourth Track-2 competition is anticipated.

The Office of Cyberinfrastructure is working with NSF's Advisory Committee for Cyberinfrastructure (ACCI) to gather input from the researchers and educators who use computing and the technologists who develop high-performance computing on future requirements and opportunities for the national CI.

Program Evaluation and Performance Improvement

The Performance Information chapter describes the Foundation's performance evaluation framework, which is built upon the four strategic outcome goals in NSF's Strategic Plan: *Discovery*, *Learning*, *Research Infrastructure*, and *Stewardship*. Performance evaluation is conducted at all levels within the Foundation, using both qualitative and quantitative measures – including an agency-wide annual review of research and education outcomes by an external expert committee and periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are also factored into the performance assessment process.

To ensure the highest quality in processing and recommending proposals for awards, OCI convenes a Committee of Visitors (COV), composed of qualified external evaluators, to review each program every three years. These experts assess the integrity and efficiency of the processes for proposal review and provide a retrospective assessment of the quality of results of NSF's investments. The most recent OCI Committee of Visitors met in FY 2008. The COV focused on two specific areas, in the context of OCI's four focus areas of High Performance Computing, Data, Virtual Organizations, and Learning and Workforce Development: (1) assessments of the quality and integrity of program operations and program-level technical and managerial matters pertaining to proposal decisions; and (2) comments on how the outputs and outcomes generated by awardees have contributed to the attainment of NSF's mission and strategic outcome goals. The COV made a number of recommendations that OCI is currently working to address.

Number of People Involved in OCI Activities

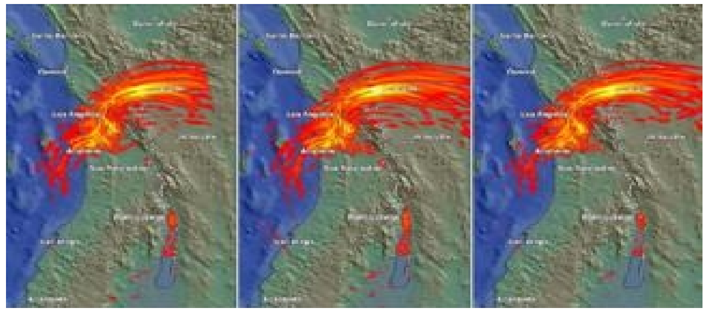
	FY 2008 Estimate	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate
Senior Researchers	535	395	158	448
Other Professionals	596	628	251	712
Postdoctorates	51	71	29	80
Graduate Students	252	196	78	222
Undergraduate Students	67	60	24	68
Total Number of People	1,501	1,350	540	1,530

OCI Funding Profile

	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate
Statistics for Competitive Awards:			
Number of Proposals	501	555	580
Number of New Awards	98	147	119
Regular Appropriation	98	105	119
ARRA	-	42	-
Funding Rate	20%	26%	21%
Statistics for Research Grants:			
Number of Research Grant Proposals	482	518	558
Number of Research Grants	80	124	98
Regular Appropriation	80	86	98
ARRA	-	38	-
Funding Rate	17%	24%	18%
Median Annualized Award Size	179,398	192,797	212,188
Average Annualized Award Size	221,237	237,761	261,674
Average Award Duration, in years	2.3	2.7	2.5

Recent Research Highlights

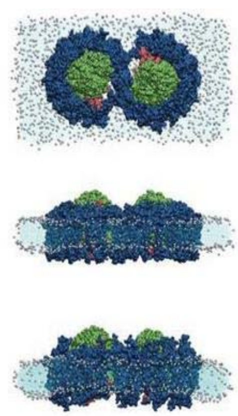
► **ShakeOut Exercise Prepares Californians for Earthquakes:** The Great Southern California ShakeOut, held in November 2008, was the largest earthquake drill in U.S. history. The exercise was designed to inspire Southern Californians to get ready for major earthquakes and, through public preparedness, to prevent disasters from becoming catastrophes.



Comparison of ShakeOut Simulations performed at different sites using different codes. The good agreement between the results helped to build confidence in the ground motions projected by the simulations for the ShakeOut scenario event. TeraGrid resources at TACC and PSC were used to run these 1Hz simulations. *Credit: SCEC.*

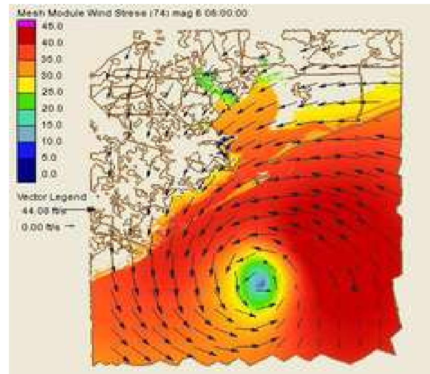
The ShakeOut Scenario defines a plausible Mw7.8 earthquake on the southern San Andreas Fault. Scientists and computer scientists from the Southern California Earthquake Center have performed several large-scale simulations using TeraGrid computer resources at the Texas Advanced Computer Center, San Diego Supercomputer Center, and Pittsburgh Supercomputer Center to ensure that the scenario was as realistic as possible. Simulations performed in support of the scenario extend from basic research to earthquake rupture processes, to collaborative simulations to verify results, and to innovative visualizations that help the general public understand the exercise and its implications. This exercise involved several million people in California.

► **The Computational Microscope:** Simulating cellular molecules from the atomic level up is essential to comprehending the human body and to designing effective medicines and treatments. The functions of biomolecules like proteins and DNA are well known but certain aspects of these molecules still elude researchers even with the aid of powerful microscopes. A researcher at the University of Texas at Austin collects and analyzes information from electron microscopy, X-ray crystallography, quantum chemistry, and multi-scale molecular dynamics, and uses TeraGrid's Ranger supercomputer as a "computational microscope" to integrate the data on thousands of parallel processors. The researcher is using Ranger to model the largest and most complex biomolecular machinery to date: the 100 million atom chromatophores of purple bacteria. His experience using his highly scalable code on Ranger is pointing the way to future algorithms and codes capable of modeling larger biomolecular systems on next-generation high-performance computing systems.



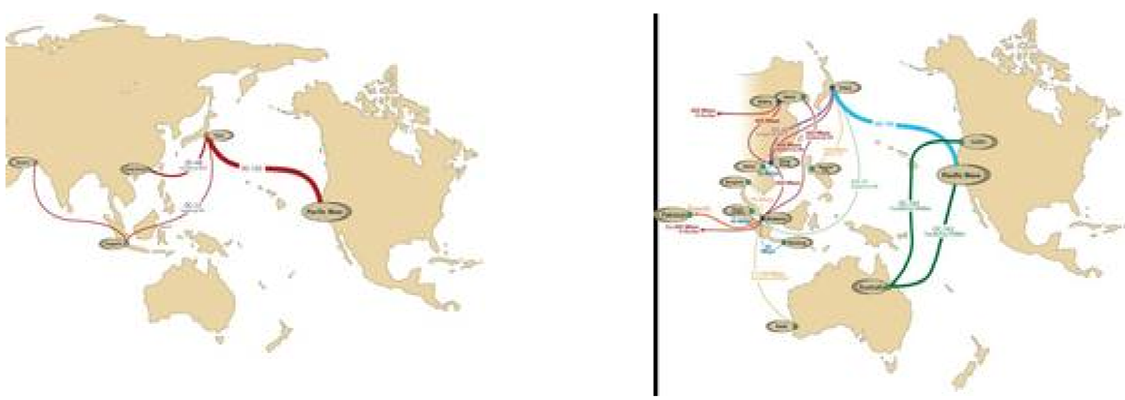
Simulation of the LH1-RC-PufX dimer. LH1 is colored in blue, the RCs in green, and PufX in red. a) Snapshots at the beginning of the simulation, viewed from the cytoplasm (top), and in the plane of the membrane (bottom). b) Snapshot of the simulated system at the end of the 20 ns equilibration. The LH1 protein exhibits a slight bending towards the periplasmic side. The membrane adapts to the LH1's change in shape. *Credit: Theoretical and Computational Biophysics Group, University of Illinois at Urbana-*

► **New Computer Model Helps Coastlines Prepare for Storm Surges:** Recent events in the Gulf of Mexico and around the world have demonstrated the vulnerability of coastal populations and infrastructure to storm surges. In response, researchers from the University of Texas at Austin, using the TeraGrid Ranger computing system, are developing the Advanced Circulation Storm Surge Model. The model has been used in design and planning mode prior to the hurricane season, in forecasting mode as storms approach land, and in hindcasting mode after the event. The researchers are developing a new model which includes highly refined details of the Texas coast, and which will be much more computationally intensive. This model will be used to perform hundreds of hurricane scenarios for the state of Texas, develop flood risk maps, and study potential inundation in high risk areas, such as the Houston-Galveston corridor and the Brownsville region.



The eye of the hurricane with wind vectors and wind speed just before landfall. *Credit: University of Texas at Austin.*

► **Extending Research and Education Connectivity to Pakistan:** Indiana University is leading an NSF-funded effort to upgrade Pakistan’s internet service to gigabit level and extend its connectivity to public institutions, including libraries, health centers, and schools. The new Pakistan and Education Research Network also will provide researchers in Pakistan with connectivity to their international colleagues and to the global internet. The goal of this project is to increase cooperation between American and Pakistani scientists; the establishment of high-performance network connectivity is only a first step. Three to six months after the network connection is active, the project will host a science collaboration seminar in the United States, which will bring together researchers from different scientific disciplines from the United States and Pakistan to discuss how the network connection can enhance their research.

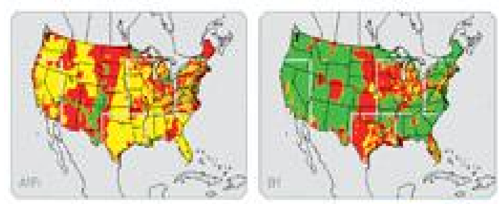


Map of the Pakistan and Education Research Network (PERN). *Credit: Indiana University.*

► **Remote Sensing of Ice Sheets Provides Ideal Training Opportunity:** The vision for the NSF project "Cyberinfrastructure for Remote Sensing of Ice Sheets" is to equip the current and next generation of traditionally, under-represented minority scientists, engineers, and educators with the knowledge and skills necessary to conduct interdisciplinary research in areas, including cyberinfrastructure, remote sensing, engineering, and modeling related to glaciers and ice sheets. The project is a significant step forward in providing the necessary virtual training environment and grid computing power that the students and scientists associated with the NSF Science and Technology Center for Remote Sensing of Ice Sheets require. To date, the project has deployed students to Antarctica, sponsored virtual field work at Elizabeth City State University in North Carolina, and funded travel for 16 students to attend a 2008 symposium in Virginia Beach on computing issues relevant to minority students, education, and institutions.

ECSU graduate student Je'aime Powell is shown in Ilulissat, Greenland where he provides technical support for the Cyberinfrastructure project which provides a field and base camp server for storage and visualization of CReSIS Polar Science SAR data sets. *Credit: ESCU.*

► **Development of a Regional Climate Model for U.S. Midwest Applications:** A team of scientists at the Illinois State Water Survey and the University of Illinois at Urbana-Champaign used high-performance computers to examine ways in which global climate change and human-driven emissions will affect future air quality. The team applied a new modeling system that integrates a regional climate model, an emissions model, and an air quality model nested within global climate and chemistry models. Among the issues the team examined was the impact of "transboundary emissions" from Mexico and Canada on ground-level ozone concentrations. They found that these emissions had a major impact on U.S. air quality, indicating that efforts to reduce emissions must be transnational. The TeraGrid Resources provided the critical computation and human support needed to evaluate the simulations.



Relative contributions percent) of the projected emissions (EMS) and climate (MET) changes to total surface ozone concentration trends between 2050 and 1998: A1Fi scenario and B1 scenario. Green denotes the dominance of the EMS effect (contribution greater than 70 percent), yellow denotes the MET effect (contribution greater than 70 percent), and red denotes where both effects are deemed to be important. *Credit: Xin-Zhong Liang, University of Illinois at Urbana-Champaign.*

OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING — $49,000,000 +$4,970,000 / 11.3%

Office of International Science and Engineering Funding

(Dollars in Millions)

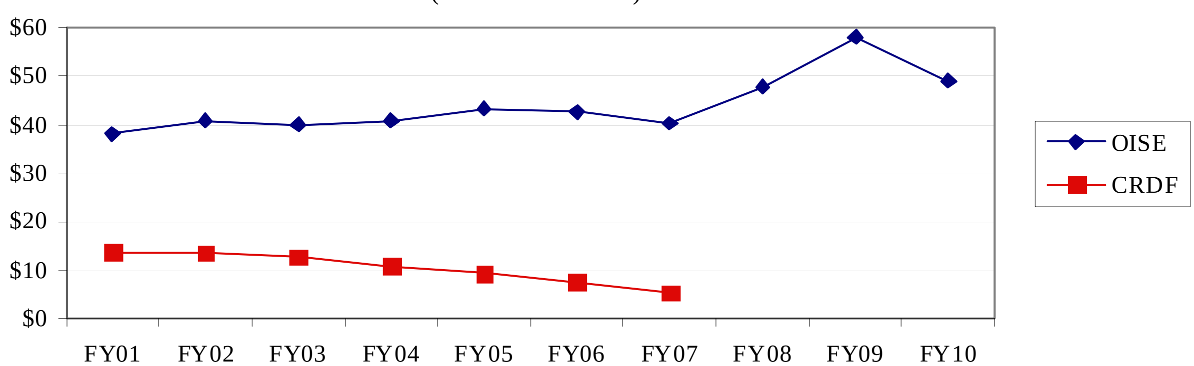
	FY 2008 Actual[1]	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, OISE	**$47.77**	**$44.03**	**$14.00**	**$49.00**	**$4.97**	**11.3%**
Major Components:						
Research and Education Grants	47.29	42.13	14.00	47.04	4.91	11.7%

[1] FY 2008 Actual includes $5.46 million in funds provided by the U.S. Department of State for an award to the US Civilian Research and Development Foundation that was a carryover from FY 2007 and obligated in FY 2008.

The Office of International Science and Engineering (OISE) serves as the focal point, both inside and outside of NSF, for international science and engineering activities. OISE promotes the development of an integrated, Foundation-wide international strategy and manages international programs that are innovative, catalytic, and responsive to a broad range of NSF and national interests. Recognizing that scientific discovery is a global enterprise, OISE supports U.S. scientists and engineers engaged in international research and education activities in all NSF supported disciplines involving any region of the world.

OISE Funding

(Dollars in Millions)



The bottom line shows additional funds provided by the U.S. Department of State for an award to the U.S. Civilian Research and Development Foundation (CRDF) in FY 2001 ($13.75 million), FY 2002 ($13.66 million), FY 2003 ($12.83 million), FY 2004 ($10.99 million), FY 2005 ($9.42 million), FY 2006 ($7.73 million), and FY 2007 ($5.46 million), The FY 2007 transfer from the Department of State was carried forward to and obligated in FY 2008. Beginning in FY 2009, NSF no longer receives a funding transfer from the U.S Department of State for a CRDF award.

OISE in Context

Science and engineering are international enterprises critical to addressing societal challenges, competitiveness, and security. Bold exploration at the frontiers of science and engineering increasingly requires international partnerships. NSF — as the Nation's principal source of support to U.S.

universities for fundamental science and engineering research and education — plays a unique role in leading the worldwide efforts of the U.S. science, engineering, and education communities.

OISE programs and activities are designed to complement and enhance the Foundation's broad research and education portfolio and to overcome barriers involved in international collaboration. America's next generation of scientists and engineers must be able to work effectively in the global arena and marketplace. OISE supports programs that enable students and researchers to experience and engage in international research and educational activities across such areas as cyberinfrastructure, complex biological systems, natural hazards prediction and mitigation, nanotechnology, water resources, climate change, and energy sustainability. The Office carries out its functions by working closely with the other NSF directorates and offices as well as through its own programs. In addition, OISE manages NSF's offices in Beijing, Paris, and Tokyo that report on and analyze in-country and regional science and technology developments and policies, promote greater collaboration between U.S. and foreign researchers, liaise with foreign counterpart agencies and research institutes, and facilitate coordination and implementation of NSF research and education programs.

The future of international science and engineering research and education clearly includes the ability to communicate, interact, and share facilities across great distances without physically traveling to the remote site. To promote new directions in international scientific engagement, OISE is raising its support of Cyber-enabled Discovery and Innovation (CDI) by ten percent to $550,000.

OISE will increase the size and duration of its awards in order ensure that OISE programs provide sufficient support for catalytic, innovative, and transformative research collaborations that will prove meritorious enough to be mainstreamed into NSF's disciplinary programs. The purpose is to increase the level of international activity in NSF as a whole.

OISE will continue to expand networks between U.S. researchers and those in developing countries. Under a Memorandum of Understanding between NSF and the U.S. Agency for International Development (USAID), OISE will use up to $5.0 million of its $14.0 million FY 2010 investment in new Partnerships for International Research and Education (PIRE) projects in a coordinated effort to support collaborative research activities. The PIRE program seeks to catalyze a higher level of international engagement in the U.S. science and engineering community by supporting innovative, international research and education collaborations. Under this arrangement, a comparable contribution by USAID will support research and infrastructure costs in developing countries where the research being funded can have a positive effect on development. Similar arrangements will be pursued with other U.S. government agencies and non-profit organizations that have interests that could be furthered by cooperative research activities.

OISE will continue to provide approximately $8.50 million per year in support of U.S. participation in international organizations such as the Civilian Research and Development Foundation, the Global Science Forum, the Human Frontier Science Program, the International Institute of Applied Systems Analysis, and the International Council of Science.

Office-wide Changes and Priorities

Partnerships for International Research and Education (+$4.0 million, to a total of $24.0 million).
Partnerships for International Research and Education (PIRE) has become an NSF flagship program for enabling U.S. scientists and engineers to establish collaborative relationships with international colleagues in order to advance new knowledge and discoveries at the frontiers of science and to

promote the development of a diverse, globally engaged U.S. STEM workforce. Competitions are currently held every other year and proposals submitted in FY 2009 will receive their initial funding in FY 2010. OISE plans to contribute $46.0 million over five years to fund five to 20 new PIRE awards. Of the $24.0 million in FY 2010 funding, $14.0 million will go to new PIRE awards. In addition to OISE funds, co-funding will be sought from other NSF offices and directorates. Outyear commitments for PIRE awards made in FY 2007 will amount to approximately $10.0 million in FY 2010.

Cyber-enabled Discovery and Innovation (+$50,000, to a total of $550,000).
The international dimensions of Cyber-Enabled Discovery and Innovation (CDI) include connecting U.S. CDI scientists and their students with international researchers, expanding research cooperation internationally, and linking the resources of international institutes to U.S. research groups in pursuit of the three CDI themes ("From Data to Knowledge," "Understanding Complexity in Systems," and "Building Virtual Organizations"). OISE's objectives are to promote international CDI research and education collaboration and to encourage intellectual partnerships involving investigators from academia, industry, and research organizations around the globe. As a result, OISE is raising its support of CDI by ten percent to $550,000 in FY 2010.

Program Evaluation and Performance Improvement

The Performance Information chapter describes the Foundation's performance evaluation framework, which is built upon the four strategic outcome goals in NSF's Strategic Plan: *Discovery, Learning, Research Infrastructure*, and *Stewardship*. Performance evaluation is conducted at all levels within the Foundation, using both qualitative and quantitative measures – including an agency-wide annual review of research and education outcomes by an external expert committee and periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are also factored into the performance assessment process.

OISE is working with the Division of Acquisition and Cooperative Support to contract with a firm that will evaluate the International Research Fellowship Program (IRFP) and the East Asia Pacific Summer Institutes (EAPSI) Program. These evaluations will focus on four tasks: 1) a study of the IRFP and EAPSI fellows' experiences in applying for and participating in the programs; 2) a comparative data analysis of professional outcomes (educational and occupational) for EAPSI and IRFP awardees and other applicants; 3) an analysis of the impact IRFP and EASPI have on U.S. academic institutions and on the foreign institutions that host IRFP and EAPSI fellows; and 4) the bringing together of an advisory group to ensure the quality of the evaluation process.

Number of People Involved in OISE Activities

	FY 2008 Estimate	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate
Senior Researchers	1,152	1,224	252	1,404
Other Professionals	29	31	6	35
Postdoctorates	559	594	172	681
Graduate Students	1,920	2,040	420	2,340
Undergraduate Students	1,302	1,383	285	1,587
Total Number of People	4,962	5,272	1,135	6,047

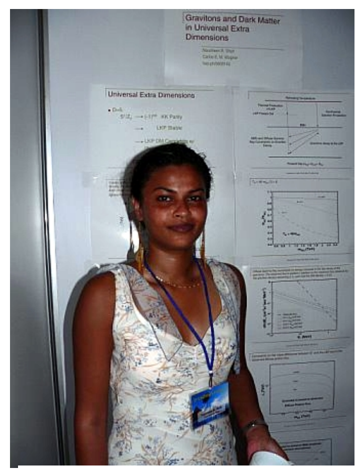
OISE Funding Profile

	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate
Statistics for Competitive Awards:			
Number of Proposals	911	843	936
Number of New Awards	358	349	247
Regular Appropriation	358	264	247
ARRA	-	85	-
Funding Rate	39%	41%	26%
Statistics for Research Grants:			
Number of Research Grant Proposals	475	500	457
Number of Research Grants	54	50	73
Regular Appropriation	54	40	73
ARRA	-	10	-
Funding Rate	11%	10%	16%
Median Annualized Award Size	29,664	40,000	50,000
Average Annualized Award Size	28,576	40,139	145,802
Average Award Duration, in years	2.0	2.0	2.2

Recent Research Highlights

► **Looking beyond the Standard Model:** In the fall of 2006, 40 young physicists, half from the U.S. and half from Latin America, attended a series of lecture courses and seminars in the fields of cosmology, astroparticles and particle physics in Puerta Vallarta, Mexico, through a program supported by NSF and the Department of Energy. The topic selected was particularly timely in light of strong evidence gathered over the last decade which clearly shows that the standard model of particle physics is not complete despite its great success in explaining the results of experiments to date. This is an exciting time in particle physics, since many of these theoretical ideas make predictions that can be tested in experiments soon to come online at the Large Hadron Collider, the world's largest particle accelerator complex under the Franco-Swiss border near Geneva, Switzerland. The program's multidisciplinary approach was taken to make the students aware of the close connections between these three fields and to broaden their scientific perspective beyond the narrowly focused experience that is typical for physicists in these early stages of their careers.

Postdoctoral researcher Emerson Luna from the Institute of Physics, State University of Sao Paulo, Brazil, describing his poster "Large Rapidity Gaps in pp and ppbar collisions at the Large Hadron Collider" to Tatiana Rodriguez, a graduate student in experimental high energy physics at the University of Pennsylvania working on the CDF experiment at Fermilab. *Credit: Photo provided by Dr. Marleigh Sheaff.*



Graduate student Nausheen Shaw in front of poster entitled "Gravitons and Dark Matter in Universal Extra Dimensions," presented at poster session. *Credit: Permission granted by Dr. Marleigh Sheaff.*

► **In Search of the North American Monsoon:** A group of undergraduate and graduate students in the Department of Earth and Environmental Science of New Mexico State University spent nearly three weeks in Sonora, Mexico, as part of a large international field campaign to study the North American Monsoon. The monsoon is a regional atmospheric phenomenon that controls hydrological and ecological conditions during the summer season in the southwestern U.S. and northwestern Mexico. Given its regional extent, ecohydrological studies of the North American Monsoon require coordinated research efforts between U.S. and Mexican scientists. All together, 21 students and researchers from the U.S. and Mexico participated this year in the Sonora Field Campaign, engaging in scientific and cultural exchanges. The students helped plan, organize, and carry out a series of ecohydrological experiments in a remote, mountainous region in northern Sonora. Predicting the North American Monsoon should prove very useful to communities affected by its weather patterns.

U.S. and Mexican students at a high-accuracy precipitation gauge site within a high elevation oak savanna ecosystem in northern Sonora, Mexico. The three students (Luis Méndez-Barroso, Tonantzin Tarín, and Lorena Liuzzo) were dynamically calibrating the siphoning, tipping bucket rain gauge (while overlooking the mountainous landscape). *Credit: Photo provided by Dr. Enrique Vivoni.*

► **Graduate Student Tracks Avian Flu:** A graduate student from the University of Maryland organized a research team to outfit 30 bar-headed geese with GPS satellite transmitters in partnership with scientists at the newly opened Chinese Academy of Sciences' Qinghai Lake Reserve Joint Research Center. The research uses satellite telemetry to determine the timing, pathways, stopover locations and habitat use of bar-headed geese originating from the Qinghai Lake breeding grounds. Qinghai Lake was the site of a large outbreak of H5N1 avian influenza in 2005, where more than 6,000 birds died. The data expected from this study will be essential in tracking wild birds' interaction with domesticated poultry populations and thereby predicting the potential spread of avian influenza transmission in Asia. The research will provide important information with which to address the ecology and evolution of the H5N1 virus in relation to wild birds and domestic poultry in China, a global health concern.

► **Visualizing the African Superplume:** Through the Partnership for International Research and Education program, a partnership between Pennsylvania State University, several other U.S. universities, and collaborators in universities and geological surveys in southern and eastern Africa are studying the African Superplume, a structure under Africa where a huge mass of the hot and chemically distinct rock extends from the edge of the core farther up into the Earth's mantle than in any other place on Earth. AfricaArray has worked with dozens of countries across southern and eastern Africa to establish a network of seismic recording stations. These stations have generated a very rich new dataset that has allowed the U.S. and African geologists to detect an anomalous rock layer in the midmantle (650-680 kilometers deep) across eastern Africa. This indicates that the African Superplume extends from the lower mantle into the upper mantle and that it extends through the Earth's mantle, but not vertically. The structure initiates below southern Africa and then migrates to the northeast as it rises through the mantle, coming to the surface beneath eastern Africa.

Candra Gross, an undergraduate student from Fort Valley State University, helps to install a seismic station in Mpiji, Uganda, June 2007. *Credit: Andrew Nyblade.*

► **First U.S.-India Advanced Studies Institute in Nanoscale Science and Engineering:** The first U.S.-India Advanced Studies Institute in Nanoscale Science and Engineering in Chennai, India, enabled advanced graduate students and world-class researchers from both countries to meet about fundamental topics and cutting-edge developments in nanoscale science and engineering disciplines. The panel discussions ranged across physics, chemistry, materials engineering, chemical engineering, and economics. They included policy perspectives from academia, government and industry representatives.

Inauguration Ceremony for Nanoscale Advanced Studies Institute. *Credit: Photos provided by G. Ramanath, RPI.*

Participants at the First U.S.-India Nanoscale Advanced Studies Institute. *Credit: Photos provided by G. Ramanath, RPI.*

Senior researchers delivered state-of-the-art lectures covering scientific, technological, educational and societal aspects of nanoscience and engineering. According to first reports, the institute stimulated student interest in nanoscale science and engineering and strengthened connections between U.S. and Indian scientific communities. The 27 U.S. participants included advanced graduate students, postdoctoral researchers, early-CAREER faculty and industry researchers. Holding this Advanced Studies Institute in Chennai was a first for India. It was co-funded by NSF and India's Department of Science and Technology.

Office of Polar Programs

$516,000,000
+$45,330,000 / 9.6%

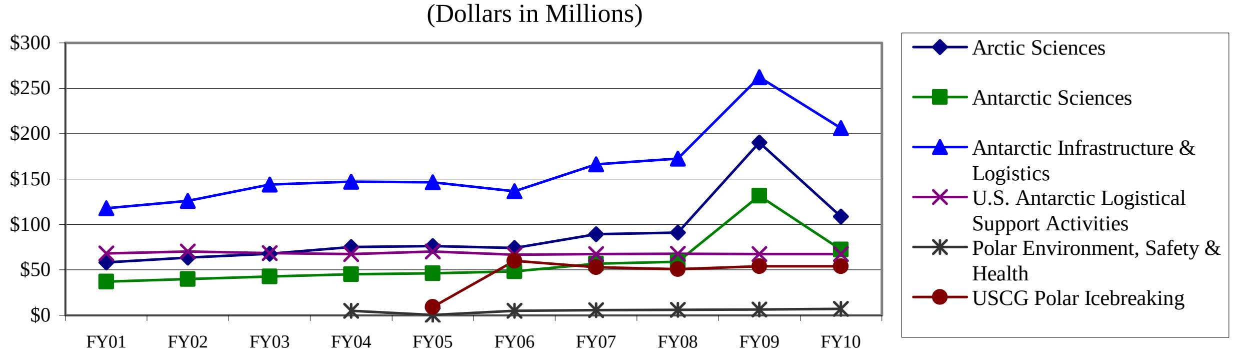
Office of Polar Programs Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Arctic Sciences	$91.19	$98.26	$92.00	$108.70	$10.44	10.6%
Antarctic Sciences	59.06	65.25	66.50	72.50	7.25	11.1%
Antarctic Infrastructure & Logistics	240.08	246.87	15.50	273.60	26.73	10.8%
U.S. Antarctic Logistical Support	*67.63*	*67.52*	-	*67.52*	-	-
Polar Environment, Health & Safety	5.91	6.29	-	7.20	0.91	14.5%
U.S. Coast Guard Polar Icebreaking	50.89	54.00	-	54.00	-	-
Total, OPP	**$447.13**	**$470.67**	**$174.00**	**$516.00**	**$45.33**	**9.6%**
Major Components:						
Research and Education Grants	100.71	116.05	151.50	128.30	12.25	10.6%
Centers Programs	4.45	4.00	-	4.00	-	-
Non-Facility Research Infrastructure	5.91	6.29	-	7.20	0.91	14.5%
Facilities O&M	336.06	344.33	22.50	376.50	32.17	9.3%

Totals may not add due to rounding.

Polar research provides insights into earth systems – the atmosphere, oceans and solid earth – that cannot be gained elsewhere. For example, the study of polar ice sheets reveals how the Earth's climate has changed in the past and provides information essential to predicting future global sea level change. Polar regions also offer important opportunities for environmental research. The extreme sensitivity of polar ecosystems to changes in climate enables study of the linkages between the physical and living components of the coupled earth systems. A key goal of these studies is to predict climate change and its impacts on a regional scale. In addition, the Arctic and Antarctic are premier natural laboratories whose extreme environments and geographically unique settings enable research on phenomena and processes not feasible elsewhere. For example, the cold, dry environment and high altitude at the South Pole make it the world's best location for key astrophysics measurements, and forefront polar research probes how organisms have adapted to the extreme polar environment.

OPP Subactivity Funding
(Dollars in Millions)



NOTE: U.S. Antarctic Logistical Support Activities are shown separately from the Antarctic Infrastructure & Logistics Division, where it is administered.

Office of Polar Programs in Context

OPP is the primary U.S. supporter of fundamental research in polar regions. In addition, NSF provides interagency leadership for U.S. activities in polar regions. In the Arctic, NSF leads research planning as directed by the Arctic Research Policy Act of 1984. The NSF Director chairs the Interagency Arctic Research Policy Committee created for this purpose. In the Antarctic, per Presidential Decision Directive, NSF manages all U.S. activities as a single, integrated program, making research possible in Antarctica by scientists supported by NSF and by U.S. mission agencies. The latter include the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, the Smithsonian Institution, and the Department of Energy. The U.S. Antarctic Program supports the U.S. governance role through the Antarctic Treaty.

Research in polar regions addresses critical aspects of the global earth system – glacial and sea ice, permafrost, terrestrial and marine ecosystems, the ocean, and the atmosphere – that help shape the global environment and climate. This work addresses the Administration's focus on making the U.S. a leader on climate change and builds on a foundation established during the International Polar Year (IPY) 2007-2009. The vision for IPY established by the National Academy of Sciences/Polar Research Board included an "… intense, coordinated campaign of polar observations, research, and analysis … that will benefit society by exploring new frontiers and increase understanding of the key roles of the polar regions in globally linked systems." Although IPY has officially concluded, synthesis of the research results will provide much needed information about the state of the climate and will improve the reliability of the prediction of future climate change. OPP continues to make these investments in climate change research and the necessary observing systems, as well as in climate change education, a high priority. Research in polar regions also offers opportunities for fundamental advances in each of the disciplinary sciences, ranging from the behavior of the Earth's inner core, the formation of galaxies, the biology of life in the cold and dark, and how Arctic residents and institutions are affected by environmental change.

The Administration is assessing the overarching issues facing the Arctic, including those associated with impacts of climate change, increased human activity, new or additional information needs, and conservation of Arctic resources. This approach will necessarily include identifying any implementation issues associated with the Arctic policy signed by the previous Administration.

Since 1958, the Nation has reviewed its Antarctic programs roughly once a decade to determine whether they are effectively structured, appropriately balanced, and in line with national goals. The landmark Antarctic Treaty will mark its 50th Anniversary on December 1, 2009, and the time is particularly ripe for a high-level strategic review of the U.S. program for several reasons: the new South Pole Station is nearing completion, the official International Polar Year activities have just concluded and they point to new research directions and modalities, and the last such strategic review was completed in 1996/1997. In FY 2009, NSF—which administers the Antarctic program on behalf of the U.S. Government—will work with the White House and other federal agencies to plan a new assessment. The results of the review will inform the FY 2013 budget request for NSF and other affected agencies.

OPP's priorities support national energy security goals. The seasonal and permanent research facilities supported by OPP in the Arctic and the Antarctic are served by sea and air links and have been powered mostly via conventional fuels. Reducing our usage of fossil fuels will reduce our impact on polar and global environments while also improving the quality of measurements in these pristine environments. Our planned increased reliance on renewable energy sources will also reduce our costs over the longer term.

The FY 2010 Request for OPP includes $4.0 million to leverage activities across the office aimed at increasing support for transformative research. Examples of potential foci for these investments include innovative processes for identifying potentially transformative research, special solicitations and competitions, and increased use of specialized funding mechanisms, notably NSF's EAGER (EArly-concept Grants for Exploratory Research). The challenges facing polar research and research support are well understood. Among the important challenges is the need to identify, predict and mitigate the effects of global and regional climate change on the environment and people. There is also the challenge to create additional flexibility in research support systems at both poles so that new and emerging research frontiers can be supported without undue delay.

Office-wide Changes and Priorities

Climate Research (+$65.26 million, to a total of $65.26 million).

OPP will participate in the broad NSF program that emphasizes a systems approach to climate research, expanding on approximately $57.0 million already supporting programs in this area In part, this activity builds on IPY synthesis activities to transform Arctic System Science by shifting greater attention to feedbacks among the different components of the earth system and including them in models that enable more reliable simulations and predictions. The work will include continued focus on measurements to identify the feedback mechanism and increasing emphasis on modeling climate change on more fine-grained regional and temporal bases. An important aspect of this activity includes further study of ecosystem response to changes in the physical environment, including ocean acidification.

Climate Change Education (+$1.50 million, to a total of $1.50 million).

OPP will participate in the NSF-wide program to engage the full spectrum of its awardee community in a new, multidisciplinary, multi-faceted climate change education program, expanding on approximately $1.30 million already supporting programs in this area. It will enable a variety of partnerships, including those among K-12 education, higher education, the private sector, and related non-profit organizations, in formal and informal settings, as well as relevant education and/or climate-related policymakers. The program will support individual investigators and multidisciplinary teams of STEM researchers and educators in a range of activities, including those local, regional, and/or global in scope. Among a variety of other activities, these partnerships will establish model professional development opportunities for climate policy decision makers.

Energy Security ($22.0 million).

The sustained operation of U.S. research facilities in Antarctica hinges on reducing the amount of fossil fuel that must be imported to the stations with the aid of icebreakers. OPP will intensify its efforts during FY 2010 and beyond to improve the energy and operational efficiency of its remote polar research stations and camps in both polar regions through conservation and increased deployment of renewable energy sources. The efforts will range from installing more energy efficient windows and siding to buildings to installing new solar and wind power energy sources and buildings in Greenland and at the South Pole and McMurdo stations. Previous studies conducted with Department of Energy (DOE) experts have demonstrated the long-term economic value of these specific improvements and the work will be carried out in consultation with DOE. The goal is to establish state-of-the-art demonstration facilities in both polar regions by 2013.

Resupply Improvements ($5.0 million).

Complete funding for the construction of two two-million gallon fuel tanks at McMurdo Station will be provided. This project is part of the effort to double the fuel storage capacity at McMurdo in order to mitigate against a failed ship-borne resupply. This level of support will complete the piping and upgrades required to connect existing tanks and to bring the infrastructure into compliance with the USAP Spill Control and Countermeasures Plan. Additional funding will be needed to procure the fuel to fill the tanks. In light of recent and planned energy and fuel conservation initiatives an assessment will be done to determine how many additional tanks will be required. It may be possible to reduce the number of tanks from the five that were initially thought to be needed.

OPP also will assess the feasibility and benefits of shifting the McMurdo Station resupply effort from January to March, when sea ice conditions are normally less of an obstacle. This study could set the stage for implementation of the new resupply plan potentially as early as during FY 2011, subject to funding availability and the conclusions of the study.

Cyberinfrastructure and Communications ($8.50 million).
The science community will realize the greatest possible scientific benefit from large and varied polar data sets by infusing data management efforts with new concepts in computational thinking, data visualization and inter-operability, and virtual organizations. This is especially important as synthesis of the varied results of International Polar Year research begins. Funding will sustain communications capability from South Pole Station via the next-generation NASA satellite – Flight 3, or "F3". A change in NASA's charging scheme is expected to increase usage costs considerably.

Graduate Research Fellowships ***(+$200,000, to a total of $200,000).***
OPP will fund two new fellowships, targeted toward Diversity in Polar Science. These fellowships are primarily for persons from underrepresented groups in science who wish to pursue graduate research degrees in fields of science supported by OPP. Eligibility, application, and review criteria are the same as for applicants in other fields.

Program Evaluation and Performance Improvement

The Performance Information chapter describes the Foundation's performance evaluation framework, which is built upon the four strategic outcome goals in NSF's Strategic Plan: *Discovery*, *Learning*, *Research Infrastructure*, and *Stewardship*. Performance evaluation is conducted at all levels within the Foundation, using both qualitative and quantitative measures – including an agency-wide annual review of research and education outcomes by an external expert committee and periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. In FY 2010, OPP plans for Committees of Visitors to review Arctic Sciences, Antarctic Sciences, and Antarctic Infrastructure & Logistics as well as select aspects of the Polar Environment, Health & Safety (PEHS) Office. Aspects of PEHS requiring medical input are reviewed annually by a Medical Panel. Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are also factored into the performance assessment process.

Number of People Involved in Office of Polar Programs Activities

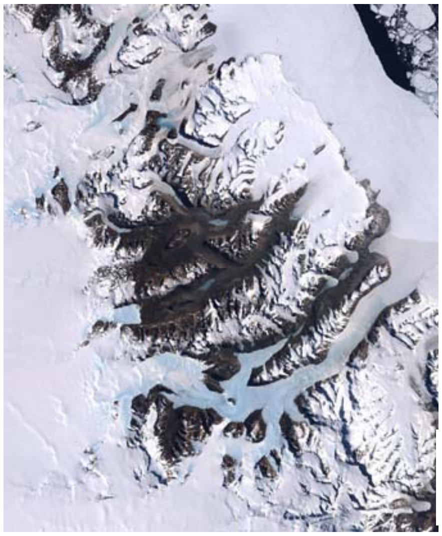
	FY 2008 Estimate	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate
Senior Researchers	1,019	1,120	1,155	1,157
Other Professionals	693	730	745	742
Postdoctorates	106	118	136	128
Graduate Students	390	415	460	445
Undergraduate Students	250	263	275	276
Total Number of People	2,458	2,646	2,771	2,748

Office of Polar Programs Funding Profile

	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate
Statistics for Competitive Awards:			
Number of Proposals	863	1,046	1,080
Number of New Awards	234	532	310
Regular Appropriations	234	287	310
ARRA	-	245	-
Funding Rate	27%	51%	29%
Statistics for Research Grants:			
Number of Research Grant Proposals	825	1,009	1,042
Number of Research Grants	201	498	278
Regular Appropriations	201	253	278
ARRA	-	245	-
Funding Rate	24%	49%	27%
Median Annualized Award Size	$148,364	$155,800	$154,900
Average Annualized Award Size	$183,616	$191,600	$192,680
Average Award Duration, in years	2.7	2.8	2.8

Recent Research Highlights

► **New Satellite Map of Antarctica:** The most detailed satellite map ever produced of Antarctica combines more than 1,100 hand-selected Landsat satellite scenes digitally compiled to create a single, seamless, cloud-free image. The map is the first major outcome of the International Polar Year (2007-2009), and represents the true spirit of the international collaboration between the United States and the United Kingdom. The map and raw data are freely available to the world community of scientists, educators, and the general public; it is available online from the U.S. Geological Survey, the NSF-supported Antarctic Geospatial Information Center, and resources such as Google Earth. The map is a critical snapshot of Antarctica's ice sheets – a fundamental tool for scientists. It will be used in every discipline from biology to geology to glaciology, to answer scientific questions and to plan fieldwork in the vast unexplored tracts of Antarctica.

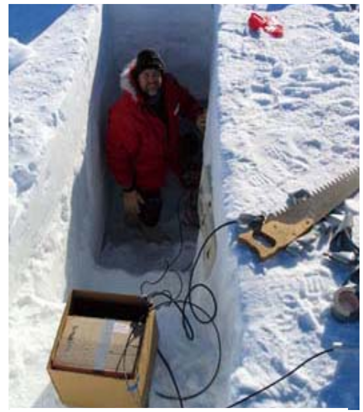


This image shows the McMurdo Dry Valleys, a major research focus for the US Antarctic Program. The region hosts the largest ice free areas of Antarctica. *Credit: Landsat Image Mosaic of Antarctica (LIMA) Project.*

► **Loss of Arctic Sea Ice Observed in 2007:** In September 2007, the extent of sea ice in the Arctic Ocean was 23 percent less than the previous record set in 2005. Results from an array of buoys deployed as part of the Arctic Observing Network showed an extraordinarily large amount of bottom melting in the Beaufort Sea associated with this retreat. This observation indicates local melting of sea ice was largely the result of excess heat in the ocean's surface waters, not excess heat in the atmosphere. A synthesis of satellite observations and weather forecast data is consistent with this conclusion. The conditions in the Beaufort Sea – more open water leading to more solar heat absorbed resulting in more melting and more open water – is a classic ice-albedo feedback signature. Understanding the nature of the changes in the Arctic sea ice cover is vital, since it is an indicator and amplifier of global climate change.

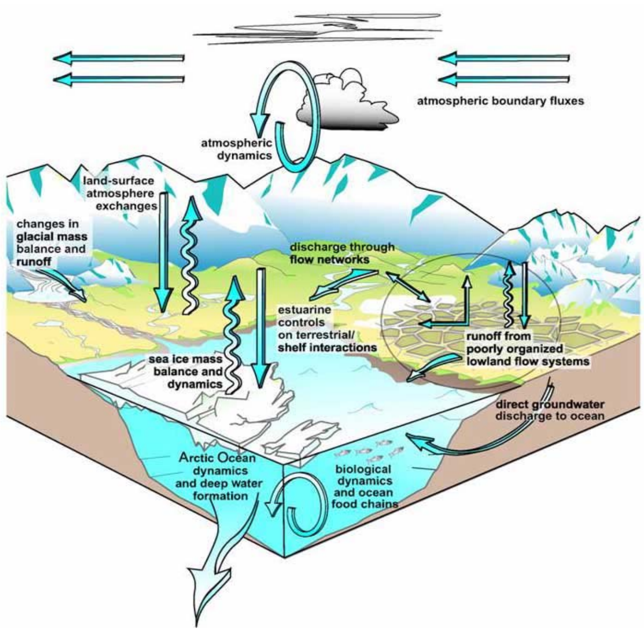
Melting sea ice in the Arctic Ocean. *Credit: J. Harbeck.*

► **Surprising Connection between Alaskan Storm and Antarctic Iceberg Calving:** Seismometers deployed on the Ross Ice Shelf and a number of icebergs adrift in the Ross Sea revealed that the dominant seismological signal is generated by sea swell in the tropical and extra-tropical Pacific Ocean. In one case, a severe storm in the Gulf of Alaska generated an ocean swell that caused the break-up of a giant iceberg floating near the coast of Antarctica more than 8,300 miles away. This work provides evidence, for the first time, that ocean storminess in parts of the world away from Antarctica could have an impact on the ice sheet. Previous work in the North Atlantic showed that a large amount of iceberg calving took place simultaneously all around the edge of the North Atlantic. The discovery of the link between storms in one part of the global ocean and iceberg calving in another part could provide a mechanism to explain this discovery.



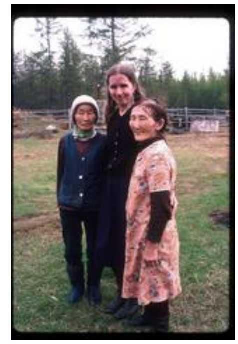
Trench in which seismometers were deployed on iceberg C-16. *Credit: Tim Parker.*

► **Is the Arctic Freshwater Cycle Intensifying?:** A team of researchers led by the University of New Hampshire wants to know if the Arctic Freshwater Cycle is intensifying, and, if so, why and what are the implications? To answer these questions, the team is investigating links among land, ocean, and atmosphere in the Arctic Hydrological Cycle. The team of engineers, chemists, hydrologists, oceanographers, atmospheric scientists, and global modelers attacked the problem by first establishing a hydrological budget for the Arctic, examining past data sets and publications for changes in various components of the system, and then looking for trends in the changes that suggest an acceleration of the process. They also conducted heuristic modeling studies to generate questions to pose to complex computer models. They conclude the system is changing and very probably doing so at an increasing pace. This may lead to significant impacts for humans and biotic systems in the arctic.



This view of the Arctic hydrological cycle shows key links among land, ocean, and atmosphere. Fully quantifying the coupling of these components within the Arctic and to the larger Earth system remains an important yet unresolved research issue. The hydrological cycle is inextricably connected to all biological and chemical processes occurring in the biosphere, atmosphere, and cryosphere. Hydrologic interactions with terrestrial and aquatic ecosystems and their biogeochemistry control all life in the pan-Arctic region. *Credit: Vörösmarty, C. J., L. D. Hinzman, B. J. Peterson, D. H. Bromwich, L. C. Hamilton, J. Morison, V. E. Romanovsky, M. Sturm, and R. S. Webb.*

► **Experiencing Climate Change: Assessing Knowledge, Resilience, and Adaptation among the Viliui Sakha:** George Mason University researchers are investigating the resilience of Arctic peoples to changes in their local environments due to global climate change. In particular, they want to see what information the Viliui Sakha - a group of native people in northeastern Siberia - need to gain a more holistic understanding of global climate change to bolster their ability to adapt. Viliui Sakha are native horse and cattle breeders inhabiting the Viliui River regions of northwestern Sakha Republic in Russia. The four-village, three-year study is a collaborative effort involving the active participation of the targeted communities, field assistants, native specialists, an in-country research team, and an international collaborator. In 2004, while surveying inhabitants of four villages, the principal investigator found that 90 percent of participants expressed their concern about local climate change, that it was causing unprecedented change in local areas, and that it threatened to undermine subsistence.

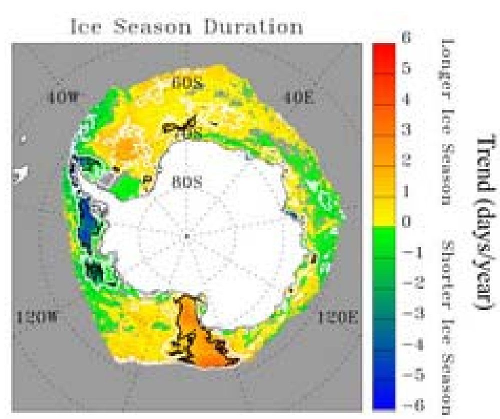


Researcher Susan Crate accompanied by Viliui Elders. *Credit: Susan Crate.*

► **Ocean Acidification and Polar Ecosystems:** Ocean acidification arises due to the ocean's absorption of carbon dioxide, followed by a series of naturally occurring reactions involving carbonate, bicarbonate, and the hydrogen ion. Calcium carbonate is an essential skeletal component for many marine organisms, including coral and shell-bearing invertebrates. Undersaturation of oceanic waters, with respect to carbonate, could promote shell dissolution or inhibit shell formation. Polar ecosystems are particularly vulnerable to ocean acidification because cold water holds more carbon dioxide. A team of researchers from California State University, the University of Rhode Island, and the University of California at Santa Barbara is studying the response of Southern Ocean pteropods, an important group of zooplankton, at the genetic level, to calcification stress. Research to date on sea urchin larvae reveals that shell-forming genes have highly elevated activity, and larval skeletons are less developed when the larvae are subjected to undersaturated seawater.

The pteropod Limacina helicina. *Credit: Russ Hopcroft, University of Alaska, Fairbanks.*

► **What Is Happening to the Antarctic Sea Ice Cover?:** The total amount of Antarctic sea ice in a given year isn't changing dramatically but there are big changes in particular regions. Previous studies have shown decreases in sea ice in the western Antarctic Peninsula and southern Bellingshausen Sea and increases in the Western Ross Sea region. Researchers from Columbia University, Clarkson University, and the College of William and Mary recently analyzed satellite observations from 1979-2004 to determine that sea ice is retreating a month earlier and advancing a month-and-a-half later in the former region and is retreating a month later and advancing a month earlier in the latter region. These trends are strongly correlated to changes in atmospheric pressure patterns. This study suggests that one consequence of climate change may be added regional change in Antarctic sea ice cover.



Trend (days/year) in ice season duration over 1979 to 2004. Ice season duration is defined as the time elapsed between the autumn ice edge advance and the subsequent spring ice edge retreat. The black/white contours delimit the 0.01/0/10 significance levels. Total changes over the 26 year period show the western Antarctic Peninsula/southern Bellingshausen Sea region to have a shorter ice season duration by 85 ± 20 days, a decrease caused by a later autumn sea ice advance (by 54 ± 9 days) and an earlier spring sea ice retreat (by 31 ± 10 days). In contrast, the western Ross Sea region shows a longer ice season duration (by 60 ± 10 days), an increase caused by an earlier autumn sea ice advance (by 31 ± 6 days) and a later spring sea ice retreat (by 29 ± 6 day) (Stammerjohn et al, JGR, in press). *Credit: Sharon Stammerjohn.*

ARCTIC SCIENCES **$108,700,000**

+$10,440,000 / 10.6%

Arctic Sciences Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY2009 Plan Amount	Percent
Total, ARC	**$91.19**	**$98.26**	**$92.00**	**$108.70**	**$10.44**	**10.6%**
Major Components:						
Research and Education Grants	47.60	56.95	85.00	61.95	5.00	8.8%
Facilities	43.59	41.31	7.00	46.75	5.44	13.2%
Research Support & Logistics	*43.59*	*41.31*	*7.00*	*46.75*	*5.44*	*13.2%*

Summary of FY 2010 Request

Arctic Sciences (ARC) is organized into several programs that support social science, earth system science and a broad range of natural science. Educational projects are also supported. The Research Support & Logistics program assists researchers with Access to the Arctic, improves safety and environmental stewardship, and increases the ability of researchers to share plans and results with local Arctic communities. In general, 59 percent of the ARC portfolio is available for new research grants. The remaining 41 percent funds continuing grants made in previous years, and research support and logistics.

The Arctic is at the forefront of global climate change. Observations have revealed an estimated 14 percent per decade reduction in sea ice extent in the Arctic, and significant summer melting of the Greenland Ice Sheet. These and many other phenomena are forcing change and uncertainty in traditional Arctic populations, present challenges and opportunities for industry and commerce, and have the potential to affect the global population through changes in sea level. Arctic Sciences funds a broad range of activities to provide an integrated understanding of environmental change in the Arctic, including study of significant, system-scale environmental change and its human dimension, as well as education.

The Research Support & Logistics program is driven by and responds to research and education funded by the Division. Funding is provided directly to grantees or to key organizations that provide or manage Arctic support and logistics. Emphasis will be placed on improving access to and the energy security of the remote facilities used by Arctic researchers and educators.

Support for the **Arctic Observing Network** (AON) remains level at $12.0 million in FY 2010. AON is a cornerstone in interagency and international efforts to provide a comprehensive data stream for modeling and other focused studies, by incorporating observing-system simulation experiments and through greater participation by Arctic communities and linkages to other nations' efforts.

Funding for **Energy Security** continues at $8.0 million in FY 2010 to provide logistical and other support to the research program, including potential fuel and transportation cost increases. This includes consideration of remote research support at the enterprise level, implementing building efficiencies, the use of renewable energy, and transportation options in the context of a system designed to meet the needs of a focused research program and reduce the carbon footprint.

Arctic Sciences will provide $35.45 million in support of **Climate Research,** the broad NSF program that emphasizes a systems approach to climate change. This activity builds on and goes beyond IPY synthesis activities to transform Arctic System Science by shifting greater attention to high-level synthesis informed by modeling and observations and using cyberinfrastructure to improve the ability to predict and model regional climate change.

Ice Sheet Modeling support will increase by $1.25 million, to a total of $3.0 million, to improve ice sheet modeling and dynamical modes of response to climate warming, a key focus area for research identified by the community.

Arctic Sciences **Cyberinfrastructure** funding will increase by $3.50 million, to a total of $4.0 million, to realize the greatest possible scientific benefit from large and varied polar data sets by infusing data management efforts with new concepts in computational thinking, data visualization and inter-operability, and virtual organizations. This is especially important as synthesis of the varied results of International Polar Year research begins.

Arctic Science will provide $750,000 to support **Climate Change Education**, the NSF-wide program to engage the full spectrum of its awardee community in a new, multidisciplinary, multi-faceted climate change education program. It will enable a variety of partnerships, including those among K-12 education, higher education, the private sector, and related non-profit organizations, in both formal and informal settings, as well as relevant education and/or climate-related policymakers. The program will support individual investigators and multidisciplinary teams of STEM researchers and educators in a range of activities, including those local, regional, and/or global in scope. Among a variety of other activities, these partnerships will establish model professional development opportunities for climate policy decision makers.

Social Sciences within the Arctic Sciences division will increase funding $500,000, to a total of $4.0 million, to build on results from the natural science component of the Bering Sea Ecosystem Study to explore the dynamic relationship between the Bering Sea ecosystem and the humans who constitute an integral component of that system of critical importance to their sustainability and in defining the vulnerability of indigenous communities and extractive industries.

ANTARCTIC SCIENCES **$72,500,000**
+$7,250,000 / 11.1%

Antarctic Sciences Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY2009 Plan Amount	Change Over FY2009 Plan Percent
Total, ANT	**$59.06**	**$65.25**	**$66.50**	**$72.50**	**$7.25**	**11.1%**
Major Components:						
Research and Education Grants	53.11	59.10	66.50	66.35	7.25	12.3%
Centers	4.45	4.00	-	4.00	-	-
STC: Center for Remote Sensing of Ice Sheets	*4.45*	*4.00*	-	*4.00*	-	-
Facilities	1.50	2.15	-	2.15	-	-
IceCube Neutrino Observatory	*1.50*	*2.15*	-	*2.15*	-	-

Summary of FY 2010 Request

Antarctic Sciences (ANT) funds research in all areas of science that can only be done, or is best done, in Antarctica. Antarctic Sciences enables research on Earth's physical, biological, geological, glaciological, oceanographic, and atmospheric processes in Antarctica as well as on interactions between the ice sheets, the underlying continent, the surrounding ocean, and the overlying atmosphere toward a comprehensive understanding of Antarctica's role in the evolution of Earth and life on Earth, as well as the Antarctic environment's role in the whole Earth system. In particular, a new programmatic emphasis fosters linkages across the disciplines in order to better advance understanding of Antarctic climate as a system. Antarctic Sciences also enables research in astronomy and astrophysics to advance understanding about high energy phenomena such as supernovae and events associated with black holes, about the nature of dark energy and dark matter which is now known to be a major component of the universe, as well as advance general understanding about the origin and evolution of the universe. In general, 40 percent of the Antarctic Sciences portfolio is available for new research grants. The remaining 60 percent is used primarily to fund continuing grants made in previous years.

Support increases for synthesis activities to advance understanding of the Antarctic system in a global context as well as advancing understanding of biotic systems during time of change. Other priorities include exploration, in collaboration with Swedish scientists, research questions related to oceanography in the Southern Ocean; funding to support development of instrumentation and equipment for making critical scientific observations; and operations and research funding for the IceCube Neutrino Observatory.

Antarctic Sciences is the NSF managing organization for the CRESIS Science & Technology Center – Center for the Remote Sensing of Ice Sheets – that aims to advance understanding of ice sheet dynamics and the contribution of major polar ice sheets to sea level rise in both the north and the south. Through new technologies and collaborative programs, CRESIS seeks to significantly improve models of ice sheet dynamics.

IceCube is the world's first high-energy neutrino observatory, located deep within the ice cap under the South Pole in Antarctica. It represents a new window on the universe, providing unique data on the engines that power active galactic nuclei, the origin of high energy cosmic rays, the nature of gamma ray bursters, the activities surrounding supermassive black holes, and other violent and energetic astrophysical processes. Since FY 2007, construction of the IceCube Neutrino Observatory has been sufficiently advanced to allow initial operations and research activities.

Antarctic Sciences will provide $28.81 million for **Climate Research** to participate in the broad NSF program that emphasizes a system approach to climate change. This activity builds on and goes beyond IPY synthesis activities and includes ecosystem response to change (including ocean acidification), atmospheric sciences, and advancing ice sheet dynamics research and modeling to reduce uncertainties in future sea level rise.

Remote Instrumentation funding will increase $3.0 million, to a total of $7.0 million, and fund development of instrumentation and equipment for making critical scientific observations with the potential to transform data collection, monitoring, and modeling in all areas of Antarctic science and to reduce the energy required to support field work. Examples of instrumentation and equipment include gliders, oceanographic drifters, and sensors and systems for airborne research.

Antarctic Sciences will provide $750,000 for **Climate Change Education**, the NSF-wide program to engage the full spectrum of its awardee community in a new, multidisciplinary, multi-faceted climate change education program. It will enable a variety of partnerships, including those among K-12 education, higher education, the private sector, and related non-profit organizations, in both formal and informal settings, as well as relevant education and/or climate-related policymakers. The program will support individual investigators and multidisciplinary teams of STEM researchers and educators in a range of activities, including those local, regional, and/or global in scope. Among a variety of other activities, these partnerships will establish model professional development opportunities for climate policy decision makers.

ANTARCTIC INFRASTRUCTURE & LOGISTICS $263,730,000 +$26,730,000 / 10.8%

Antarctic Infrastructure and Logistics Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY2009 Plan Amount	Change Over FY2009 Plan Percent
Total, AIL	**$240.08**	**$246.87**	**$15.50**	**$273.60**	**$26.73**	**10.8%**
Major Components:						
Facilities	240.08	246.87	15.50	273.60	26.73	10.8%
U.S. Antarctic Facilities & Logistics	*172.45*	*179.35*	*15.50*	*206.08*	*26.73*	*14.9%*
U.S. Antarctic Logistical Support	*67.63*	*67.52*	-	*67.52*	-	-

Summary of FY 2010 Request

Antarctic Infrastructure and Logistics: Operations and Science Support

Antarctic Infrastructure & Logistics supports research through a network of stations, labs, equipment, and logistics that enable research activities in Antarctica. This includes operation of a year-round inland research station at the South Pole; two year-round coastal research stations (McMurdo and Palmer) with extensive laboratory, transportation, housing, communication, and computing capabilities; summer camps as required for research; icebreaking research ships—the *Laurence M. Gould* and the *Nathaniel B. Palmer*; a fleet of ski-equipped LC-130 airplanes operated and maintained by the Air National Guard; U.S. Air Force inter-continental transport; small fixed wing aircraft and helicopters; and icebreakers for channel breaking and ship escort at McMurdo Station. The division uses a mix of government and civilian contract service providers for research support activities in Antarctica.

U.S. Antarctic Logistical Support

The U.S. Antarctic Logistical Support budget line funds support provided by the U.S. Department of Defense (DoD). DoD operates as a primarily logistical support provider on a cost-reimbursable basis. Major funding elements of DoD support include: military personnel, LC-130 flight operations, maintenance, and facilities support of the 109th Airlift Wing (AW) of the New York Air National Guard in Scotia, New York and Antarctica; transportation and training of military personnel supporting the U.S. Antarctic Program; support for air traffic control, weather forecasting, and electronic equipment maintenance; the charter of Air Mobility Command airlift and Military Sealift Command ships for the resupply of McMurdo Station; bulk fuel purchased from the Defense Logistics Agency; and reimbursement for use of DoD satellites for communications.

Funding remains level for **Science and Logistical Support** at $12.0 million in FY 2010, recognizing potential fuel, transportation, and labor cost increases. This includes increasing the number of LC-130 missions back to pre-FY 2009 levels and will involve funding significant maintenance for one of the NSF-owned aircraft.

Priority is given to continued implementation of **Energy Security** projects, such as improving the efficient use of utilities and capturing heat generated from station generators at McMurdo Station, Antarctica. Included is funding to complete the McMurdo Power Plant project to allow for more energy efficient power production. The total cost of this project is approximately $18.0 million, with the final increment of $1.25 million expected to be spent in FY 2010. Also included are funds to begin construction of the facilities needed to consolidate the three McMurdo airfields into one, including development of high-speed access and road networks ($50,000). This project is expected to take approximately two years to complete.

FY 2010 funding for **Energy Conservation** includes $9.25 million to continue implementation of a broad range of energy improvements to reduce energy usage and increase reliance on alternative energy, such as wind power at McMurdo, wind and solar power at South Pole, and improvements to the heat trace system for McMurdo Station and the waste heat loop systems for all Antarctic stations.

The Antarctic Infrastructure and Logistics Division is planning for additional costs of up to $7.50 million that may be needed to transition from one support contractor to another early in the fiscal year to fund the **Antarctic Support Contract**.

South Pole Communications costs will increase by $5.0 million, to a total of $7.0 million, to sustain communications capability from South Pole Station via the next-generation NASA satellite – Flight 3, or "F3". A change in NASA's charging scheme is expected to increase usage costs considerably.

Resupply Improvements for McMurdo Fuel Storage will continue, providing $5.0 million to complete funding for the construction of two two-million gallon fuel tanks. This project is part of the effort to double the fuel storage capacity at McMurdo Station in order to mitigate against a failed ship-borne resupply. This funding will complete the line piping and upgrades required to connect existing tanks and to bring the infrastructure into compliance with the USAP Spill Control and Countermeasures Plan. Additional funding will be needed to procure the fuel to fill the tanks. In light of recent and planned energy and fuel conservation initiatives an assessment will be done to determine how many additional tanks will be required to support the strategic resupply initiative. It may be possible to reduce the number of tanks from the five that were initially thought to be needed.

POLAR ENVIRONMENT, HEALTH & SAFETY $7,200,000 +$910,000 / 14.5%

Polar Environment, Health & Safety Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY2009 Plan Amount	Change Over FY2009 Plan Percent
Total, PEHS	**$5.91**	**$6.29**	**$0.00**	**$7.20**	**$0.91**	**14.5%**
Major Components:						
Non-Facility Research Infrastructure	5.91	6.29	-	7.20	0.91	14.5%
Polar Environment, Health & Safety	*5.91*	*6.29*	-	*7.20*	*0.91*	*14.5%*

Summary of FY 2010 Request

The Office of Polar Environment, Health & Safety (PEHS) within OPP manages and oversees the environmental, safety, and health aspects of research and operations conducted in polar regions. It ensures compliance with environmental, safety, and health related regulatory, statutory, and international treaty requirements. PEHS has overall responsibility for guiding the implementation of both environmental protection and stewardship to minimize the environmental impact of OPP-supported activities in polar regions. The office also develops and oversees programs to ensure the safety and health of all participants.

Funding will increase for safety and health program oversight and measures to safeguard the health and safety of researchers and support personnel. Increased funding will continue recognized environmental leadership in the international community through development of stewardship material, training, and management plans.

A priority for PEHS is establishment, through $1.0 million in funding, of an **Electronic Medical Records System** to lower health care costs and improve delivery of health care services.

U.S. COAST GUARD POLAR ICEBREAKING

$54,000,000
$0 / 0%

U.S. Coast Guard Polar Icebreaking Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY2009 Plan Amount	Change Over FY2009 Plan Percent
Total, USCG Icebreaking	**$50.89**	**$54.00**	-	**$54.00**	**-**	**-**
Major Components:						
Facilities	50.89	54.00	-	54.00	-	-
U.S. Coast Guard Polar Icebreaking	*50.89*	*54.00*	-	*54.00*	-	-

Summary of FY 2010 Request

From FY 2006 through FY 2008, NSF funded the operations and maintenance of the United States Coast Guard's (USCG) three polar icebreakers: *Polar Sea*, *Polar Star*, and *Healy*.

As directed by Congress, NSF and USCG have been reviewing the existing Memorandum of Agreement (MOA) that provides guidance for NSF reimbursement to USCG for maintenance and operation of the polar icebreakers. In addition, we continue to work together to address the implementation issues associated with maintenance and training requirements for the *Polar Sea* and *Healy*. As of FY 2009, *Polar Star* no longer falls under the MOA, and USCG will begin refurbishing this ship with the separate funding it received in FY 2009. The FY 2010 Request retains budget authority for operation and maintenance of *Polar Sea* and *Healy* with NSF because scientific research is still the critical and principal use for these vessels.

The USCG icebreaking cost is in addition to the cost of icebreakers and ice-capable ships engaged by the Arctic Sciences and the Antarctic Infrastructure & Logistics divisions.

INTEGRATIVE ACTIVITIES $271,120,000

+$29,780,000 / 12.3%

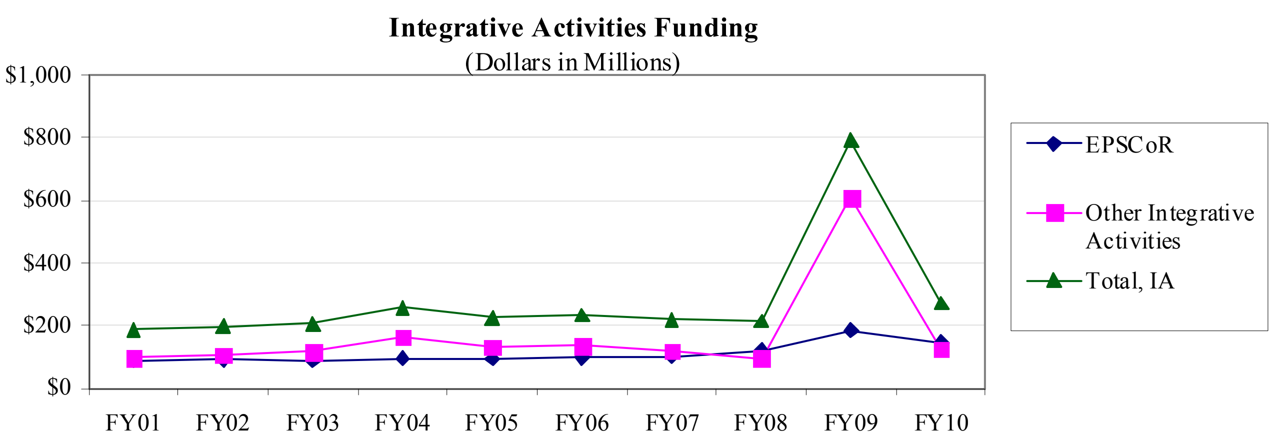
Integrative Activities Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, IA[1]	**$214.48**	**$241.34**	**$550.00**	**$271.12**	**29.78**	**12.3%**
EPSCoR	*120.00*	*133.00*	*50.00*	*147.12*	*14.12*	*10.6%*

[1] In FY 2010, management responsibilities for Parternships for Innovation (PFI) and Science of Learning Centers (SLC) are transferred to the Directorate for Engineering and the Directorate for Social, Behavioral and Economic Sciences, respectively. Funding for the PFI and SLC is removed for all years for comparability.

Integrative Activities (IA) supports emerging, cross-disciplinary research and education, recognizing the importance of integrative efforts to the future of science and engineering. IA is a source of federal funding for the acquisition and development of research instrumentation at U.S. academic institutions and for strengthening the research and educational infrastructure throughout the Nation. Additionally, IA invests in a number of integrative research and education centers and programs that enhance NSF research investments in discovery and workforce development.



IA in Context

IA programs are managed by a variety of organizations within NSF, which provides the flexibility to broaden support for emerging, cross-disciplinary research programs and activities. For example, the Science and Technology Centers: Integrative Partnerships (STC) program, which currently funds 17 centers that are managed cooperatively by six NSF directorates/offices and the Office of Integrative Activities, supports innovative, potentially transformative, complex research and education projects that require large-scale, long-term awards. STCs engage the Nation's intellectual talent through partnerships among academia, industry, national laboratories, and government. These collaborations create synergies that enhance: innovation and the timely transfer of knowledge and technology from the laboratory to appropriate industries; the launching of spin-off companies; the training of the next generation of scientists and engineers as well as educators; and the creation of job opportunities. STCs have impressive records of research achievement as well as strong partnerships with K-12/informal education communities and industry.

The Major Research Instrumentation (MRI) program is a Foundation-wide, crosscutting program that supports the acquisition and development of instrumentation to enable research in all areas of interest to NSF. MRI funding provides state-of-the-art instrumentation that is too costly to be supported through other NSF programs. Scientific advances in many fields are critically dependent on sophisticated instrumentation, and the MRI empowers the Nation's scientists and engineers to undertake leading-edge disciplinary and cross-disciplinary research. The MRI program enables the establishment of research-intensive learning environments that promote the development of a diverse workforce and the next generation of instrumentation, as well the creation of academic/private sector partnerships to create new products with wide scientific and commercial impact. Approximately $20.0 million supports teaching-intensive and minority-serving institutions, including Historically Black Colleges and Universities, Hispanic-Serving Institutions, Tribal Colleges and Universities, and community colleges, with proposal success rates that are comparable to those for research-intensive universities.

A leading-edge, 21st century communications effort is essential for public acceptance and support of science and engineering. "Traditional media" – television networks, newspapers, and magazines – are giving way to internet news sites, web logs, personal-device downloads, wireless transmissions, and the like, competing among a population that have become highly pluralized not only in its requirements for information, but also in its cultural demographics. In today's technological culture, opportunities for learning abound in both community and personal settings. The Office of Legislative and Public Affairs' effort, "Communicating Science Broadly Through Multi-media Platforms", creates products and processes that make learning and understanding science, technology, engineering, and mathematics part of everyday life.

The Experimental Program for Stimulation of Competitive Research (EPSCoR) maximizes cross-directorate interaction and ensures the integration of its efforts with the research and education directorates. Detailed information about EPSCoR is provided later in this chapter.

Integrative Activities Funding by Program
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Communicating Science Broadly[1]	*[$4.44]*	$4.00	-	$4.00	-	-
EPSCoR	120.00	133.00	50.00	147.12	14.12	10.6%
Major Research Instrumentation	93.87	100.00	300.00	100.00	-	-
Partnerships for Innovation[2]	*[9.19]*	*[9.19]*	-	-	-	N/A
Science and Technology Centers	0.59	1.30	-	13.40	12.10	930.8%
Science and Technology Policy Institute[3]	*[2.24]*	3.04	-	3.04	-	-
Science of Learning Centers[2]	*[14.89]*	*[12.5]*	-	-	-	N/A
Graduate Research Fellowship	-	-	-	3.56	3.56	N/A
Academic Research Infrastructure	-	-	200.00	-	-	N/A
Total, Integrative Activities	$214.48	$241.34	$550.00	$271.12	$29.78	12.3%

Totals may not add due to rounding.

[1] Communicating Science Broadly is presented in FY 2008 for information purposes only and is not included in the total for this year. This effort was funded through Research and Related Activities Program funding prior to being transferred to IA in FY 2009.

[2] In FY 2010, funding for the Partnerships for Innovation and the Science of Learning Centers programs is transferred to the Directorate for Engineering and the Directorate for Social, Behavioral and Economic Sciences, respectively, which have primary responsibility for funding and program management.

[3] In FY 2008, $2.24 million was transferred to the Office of Science and Technology Policy for the Science and Technology Policy Institute.

Office-wide Changes and Priorities

EPSCoR (+$14.12 million, to a total of $147.12 million).

With an increase of $14.12 million over the FY 2009 Current Plan, FY 2010 funding for EPSCoR will total $147.12 million, an increase of 10.6 percent above the FY 2009 level. This is in keeping with previous Congressional direction that EPSCoR funding levels should mirror overall changes in the Research and Related Activities (R&RA) budget. This increase, combined with the redirection of $8.82 million from Co-Funding, will raise the level for Research Infrastructure Improvement (RII) to a total of $114.44 million, or 22.94 percent over the FY 2009 Current Plan level. In FY 2010, EPSCoR investment priorities are: 1) improved competitiveness of EPSCoR jurisdictions in disciplinary and multidisciplinary research programs across NSF, including large scale and cross-cutting competitions; 2) strengthened cyberinfrastructure critical to advances in research and education in all EPSCoR jurisdictions; and 3) increased diversity that is essential to greater use of the human and institutional resources in EPSCoR jurisdictions.

Science and Technology Centers: Integrative Partnerships (+$12.10 million, to a total of $13.40 million).

FY 2010 funding of $13.40 million will support the start up of five new centers. In FY 2009, after ten years of funding, support for five centers from the Class of 2000 program ended. The STC research portfolio reflects the disciplines of science and engineering supported by the NSF. Some examples of continuing investment include cyber-security, advanced sensors and embedded networked sensing, revolutionary materials for information technology, and modeling and simulation of complex earth environments for improving their sustainability, and weather/climate prediction.

Graduate Research Fellowships (+$3.56 million, to a total of $3.56 million).

In support of the Presidential initiative to triple the number of new fellows, IA will invest new funding totaling $3.56 million for graduate research fellowships in FY 2010.

Major Research Instrumentation (No change for a total of $100.0 million).

Funding for MRI will be unchanged from the FY 2009 allocation. The MRI FY 2010 competition will be the third such competition within 12 months (preceded by FY 2009 competition in January 2009 and the ARRA-funded competition in mid-2009). During FY 2010, the MRI funding cap will be $4.0 million for single instrument acquisition requests submitted by eligible institutions.

In the FY 2008 MRI competition, NSF reviewed 810 proposals, requesting $515.80 million. MRI funds were used to make 225 awards totaling $93.90 million. Of those awards, minority-serving institutions received 24 awards totaling $9.30 million, and non-Ph.D.-granting institutions received 84 awards totaling $21.20 million. All institution types had comparable success rates, based on the number of proposals submitted. Approximately 225 competitive awards are anticipated in FY 2010.

Communicating Science Broadly (No change for a total of $4.0 million).

The requested $4.0 million supports a range of program activities encompassing internet technology, visualization, cable TV, radio, the entertainment industry, public awareness campaigns, and new outreach efforts, including new partnerships with research institutions, state and local governments, and businesses.

Science and Technology Policy Institute (No change for a total of $3.04 million).

In support of the Office of Science and Technology Policy request for the Science and Technology Policy Institute, and consistent with the STPI authorizing statue, NSF sponsors the STPI contract at $3.04 million.

Science of Learning Centers and Partnerships for Innovation

Two programs previously funded through the IA budget have been transferred to those directorates which have the primary responsibility for managing the programs. The Directorate for Social, Behavioral and Economic Sciences and the Directorate for Engineering now have the lead for funding and management oversight of the Science of Learning Centers and Partnerships for Innovation programs, respectively.

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH

$147,120,000
+$14,120,000 / 10.6%

Experimental Program to Stimulate Competitive Research Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Co-Funding	$46.98	$40.00	-	$31.18	-$8.82	-22.1%
Outreach and Workshops	0.23	1.50	-	1.50	-	-
Research Infrastructure Improvement	72.79	91.50	50.00	114.44	22.94	25.1%
Total, EPSCoR	**$120.00**	**$133.00**	**$50.00**	**$147.12**	**$14.12**	**10.6%**

Experimental Program to Stimulate Competitive Research (EPSCoR) (+$14.12 million to a total of $147.12 million). This request is in keeping with previous Congressional direction that EPSCoR funding levels should mirror overall changes in the Research and Related Activities (R&RA) budget. EPSCoR is explicitly focused on assisting NSF in its statutory function "to strengthen research and education throughout the United States." The primary goals of EPSCoR are to (1) provide strategic programs and opportunities for EPSCoR participants that stimulate sustainable improvements in their R&D capacity and competitiveness, and (2) advance science and engineering capabilities in EPSCoR jurisdictions for discovery, innovation, and overall knowledge-based prosperity. Its objectives are to: (1) catalyze key research themes that empower knowledge generation, dissemination, and application; (2) activate effective jurisdictional and regional collaborations that advance scientific research, promote innovation, and benefit society; (3) broaden participation in science and engineering (S&E) by institutions, organizations, and people within EPSCoR jurisdictions; and (4) use EPSCoR for development, implementation, and evaluation of future programmatic experiments that motivate positive change and progression.

EPSCoR employs a portfolio of three complementary strategies, Research Infrastructure Improvement (RII), Co-Funding of Disciplinary and Multidisciplinary Research, and Outreach and Workshops.

- RII Track-1 awards provide up to $4.0 million per year for up to five years. They are intended to improve the research competitiveness of jurisdictions by improving academic research infrastructure in areas of science and engineering supported by the National Science Foundation and critical to the particular jurisdiction's science and technology initiative or plan. These areas must be identified by the jurisdiction's EPSCoR governing committee as having the best potential to improve future R&D competitiveness.

  RII Track-2 awards provide up to $2.0 million per year for up to three years as collaborative awards to consortia of EPSCoR jurisdictions to support innovation-enabling cyberinfrastructure of regional, thematic, or technological importance. These awards facilitate the enhancement of discovery, learning, and economic development of EPSCoR jurisdictions through the use of cyberinfrastructure and other technologies, and are a vital complement to RII Track-1 awards.

- Through Co-Funding of Disciplinary and Multidisciplinary Research, EPSCoR co-invests with NSF directorates and offices in the support of meritorious proposals from individual investigators, groups, and centers in EPSCoR jurisdictions that are submitted to the Foundation's research and education programs, and crosscutting initiatives. These proposals have been merit reviewed and recommended for award, but could not be funded without the combined, leveraged support of EPSCoR and the research and education directorates.

- In its Outreach and Workshops activities, NSF EPSCoR invites requests for support of workshops, conferences, and other community-based activities designed to explore opportunities in emerging areas of science and engineering, and to share best practices in design and implementation in strategic planning, diversity, communication, cyberinfrastructure, evaluation, and other topics of importance to EPSCoR jurisdictions. The EPSCoR Office also supports outreach travel that enables NSF staff from all directorates and offices to work with the EPSCoR research community regarding NSF opportunities, priorities, programs, and policies. Such visits also serve to more fully acquaint NSF staff with the science and engineering accomplishments, ongoing activities, and new directions and opportunities in research and education in the EPSCoR jurisdictions.

In general, 50 percent of EPSCoR's portfolio is available for new research grants. The remaining 50 percent is used primarily to fund continuing grants made in previous years.

Program Evaluation and Performance Improvement

The Performance Information chapter describes the Foundation's performance evaluation framework, which is built upon the four strategic outcome goals in NSF's Strategic Plan: *Discovery, Learning, Research Infrastructure*, and *Stewardship*. Performance evaluation is conducted at all levels within the Foundation, using both qualitative and quantitative measures – including an agency-wide annual review of research and education outcomes by an external expert committee and periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. In FY 2009, EPSCoR will hold a Committee of Visitors as well as reserve site visits to review the progress of the program and its RII projects. Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are also factored into the performance assessment process.

Number of People Involved in EPSCoR Activities

	FY 2008 Estimate	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate
Senior Researchers	540	555	81	597
Other Professionals	234	155	23	167
Postdoctorates	86	95	7	102
Graduate Students	557	405	60	437
Undergraduate Students	452	411	60	444
Total Number of People	1,869	1,621	231	1,747

Recent Research Highlights

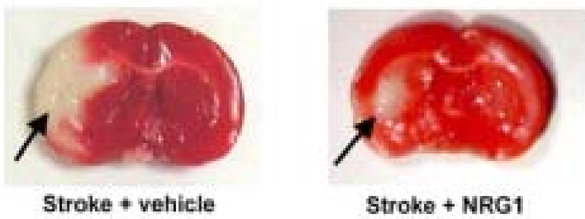
► **Mobile Robots: City-Climbers with Artificial Intelligence:** Moving up and down the side of a building is no longer the sole purview of cartoon heroes such as Spiderman. Researchers and students from the City College of the City University of New York are developing a new generation of miniature wall-climbing robots and artificial intelligence techniques. Unlike earlier wall-climbing robots, the City-Climber robots use aerodynamic attraction, which achieves good balance between strong adhesion force and high mobility and does not require perfect sealing. As a result, they can operate on both smooth and rough surfaces with reasonably large payloads. Equipped with a camera, motion sensor, rotary laser range sensor and computing board, the robot is capable of constructing a complete 3D-laser map of indoor environments in collaboration with three ground robots. Using artificial intelligence techniques, inspired from genetic improvements of living creatures, City Climbers will be equipped with software modules to allow them to spread uniformly over given areas. City-climber robot technology has wide applications in various defense, security, and inspection missions. Variant prototypes may be eventually used for tasks such as building inspections and window cleaning.

CityClimber prototype-IV on a brick wall. *Credit: Umit Uyar and Jizhong Xiao, CUNY City College of New York.*

► **Bioinformatics Workshop for Teachers:** Secondary and postsecondary teachers of science, mathematics, and technology are armed with the tools needed to better prepare and excite students about the computational sciences and biotechnology after attending a professional development workshop on bioinformatics. Participants were exposed to research, development, and application of computational tools and approaches for expanding their use in biological, medical, behavioral, and health related areas. The hands-on experiences in computational sciences and biotechnologies increased participants' awareness of and knowledge in the field while better preparing them to implement activities in the classroom and share the excitement of computational science with their students. They received research-based curriculum materials developed through Mississippi-EPSCoR (NSF) and the Human Genome Project (NIH). Contributors to the workshop included experts from BioRad Laboratories in California and research/education faculty from Jackson State University, Mississippi State University, the University of Mississippi and the University of Southern Mississippi.

Participants incorporating a green fluorescent protein into bacteria. *Credit: Mississippi EPSCoR*

► **Growth Factor Found to Extend Therapeutic Window for Stroke Victims:** A naturally occurring growth factor called neuregulin-1 could possibly extend the window for therapeutic treatments for stroke victims. With pilot funding from NSF, a research team led by the Center for Behavioral Neuroscience Science at Emory University examined the effects of administering neuregulin-1, a protective compound which neurons produce naturally in rats after they suffered strokes. Researchers discovered neuregulin-1 reduced cell death by 90 percent when compared to rats that did not receive it. The compound also protected neurons from damage even when administered as long as 13 hours after the stroke's onset. In further analysis of the affected brain tissue, researchers determined neuregulin-1 produces its protective effects by turning on or off nearly 1,000 genes that regulate cell death and inflammation. Neuregulin-1 also blocks the production of free radicals, compounds that have been implicated in cell injury and aging.



A simplified rat brain slice after stroke given either a placebo or neuregulin. *Credit: Byron Ford, Ph.D., Morehouse School of Medicine.*

► **Record Neutron Beam Intensity:** An NSF-funded instrument at the Center for High Resolution Neutron Scattering now holds the record for producing the world's most intense neutron beam. The instrument, called MACS, produces a beam that exceeds the competition by more than an order of magnitude. Neutrons are an ideal probe of materials at the nanoscale level. However, because neutrons interact weakly with materials, researchers need a very intense beam to study small samples. The instrument, which was funded by a MRI grant, was built at Johns Hopkins University with the involvement of graduate and undergraduate students. It comprises 357 graphite platelets that can be oriented to direct neutrons at the same sample. With 40 times more neutrons and 20 times better detection capability, MACS will be 100 to 1,000 times more efficient than a conventional spectrometer.

The MACS focusing device built with involvement of graduate and undergraduate students. *Credit: Hopkins.*

► **NSF Science and Technology Center Wins United Nations Prize:** NSF's Science and Technology Center for Sustainability of Semi-Arid Hydrology and Riparian Areas is one of two institutions to win the 2007 International Great Man-made River Prize. The prize is awarded by the United Nations Education, Science, and Culture Organization for remarkable scientific research work on water usage in arid areas, as well as areas subject to drought, and also for the development of agriculture to benefit humanity and the environment. The purpose of the technology center, headquartered at the University of Arizona, is to inform and support water professionals by conducting stakeholder-relevant research, education, and knowledge transfer activities. The goal is to create new or improved understanding of the complexities in, and impacts of, the interactions between physical, biological, economic and human factors in semi-arid hydrology.

Students measure evaporation rates in Patagonia, Arizona. *Credit: Jonathan Petti, SAHRA, University of Arizona, Tucson.*

► **Vast Facility in Appalachia Brings Students, Researchers Together:** NSF funds a major project to study rapid variability in distant cosmic radio sources. The scientific outcome may provide possible new leads on the nature of dark matter and the structure of the galaxy. What makes this project different from many others is the location of the research facility deep in the heart of Appalachia, a traditionally under-represented area for advanced scientific research. Two 26-meter radio dishes at the Pisgah Astronomical Research Institute in the Pisgah National Forest of western North Carolina provide an excellent platform for the research project. Each summer, the institute hosts dozens of high school students and teachers for a residential science program, giving the participants a better understanding of science, and spurring some of the students to later careers in the sciences. The program is run by the University of North Carolina at Asheville.

Cherokee High School principal, teachers, and students with Pisgah Astronomical Research Institute director Don Cline in front of one of PARI's 26-ft radio telescopes. *Credit: PARI.*

UNITED STATES ARCTIC RESEARCH COMMISSION $1,600,000 +$100,000 / 6.7%

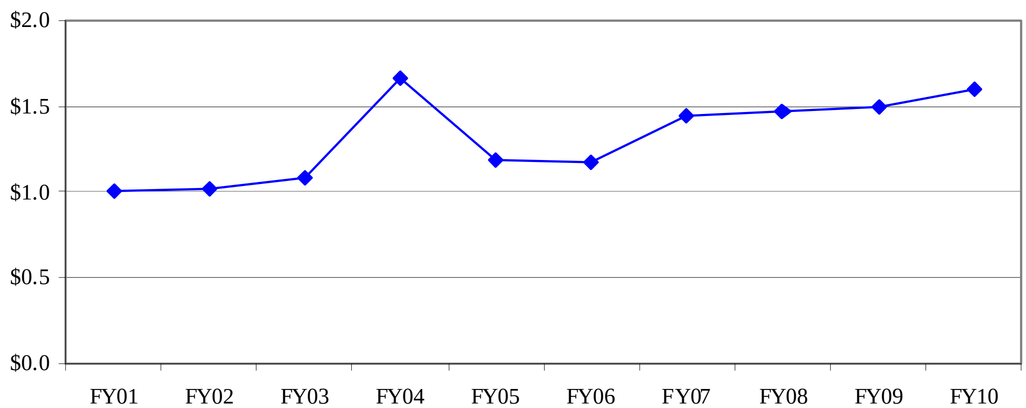
U. S. Arctic Research Commission Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Current Plan Amount	Change over FY 2009 Current Plan Percent
Total, USARC	**$1.47**	**$1.50**	**-**	**$1.60**	**$0.10**	**6.7%**

The United States Arctic Research Commission (USARC) was created by the Arctic Research and Policy Act of 1984, (as amended, P. L. 101-609), to establish the national policy, priorities, and goals necessary to construct a federal program plan for basic and applied scientific research with respect to the Arctic, including natural resources and materials, physical, biological and health sciences, and social and behavioral sciences. This request provides funds to promote Arctic research, to recommend Arctic research policy, and to communicate research and policy recommendations to the President and the Congress, as well as supporting close collaboration with the National Science Foundation (NSF) as the lead agency responsible for implementing Arctic research policy and supporting cooperation and collaboration throughout the Federal Government. In addition, USARC gives guidance to the Interagency Arctic Research Policy Committee (IARPC) to develop national Arctic research projects and a five-year plan to implement those projects. USARC also supports interaction with Arctic residents, international Arctic research programs and organizations, and local institutions, including regional governments, in order to obtain the broadest possible view of Arctic research needs. USARC is an independent federal agency, funded through NSF's appropriations, specifically as an activity in the Research and Related Activities account.

The USARC is requesting an increase of $100,000 above the FY 2009 Current Plan. Currently, there are four FTE funded at the USARC, with a total of seven compensated personnel authorized.

U.S. Arctic Research Commission Funding
(Dollars in Millions)



Note: The increase in FY 2004 reflects a one-time recovery of $370,000.

EDUCATION AND HUMAN RESOURCES

$857,760,000
+$12,500,000 / 1.5%

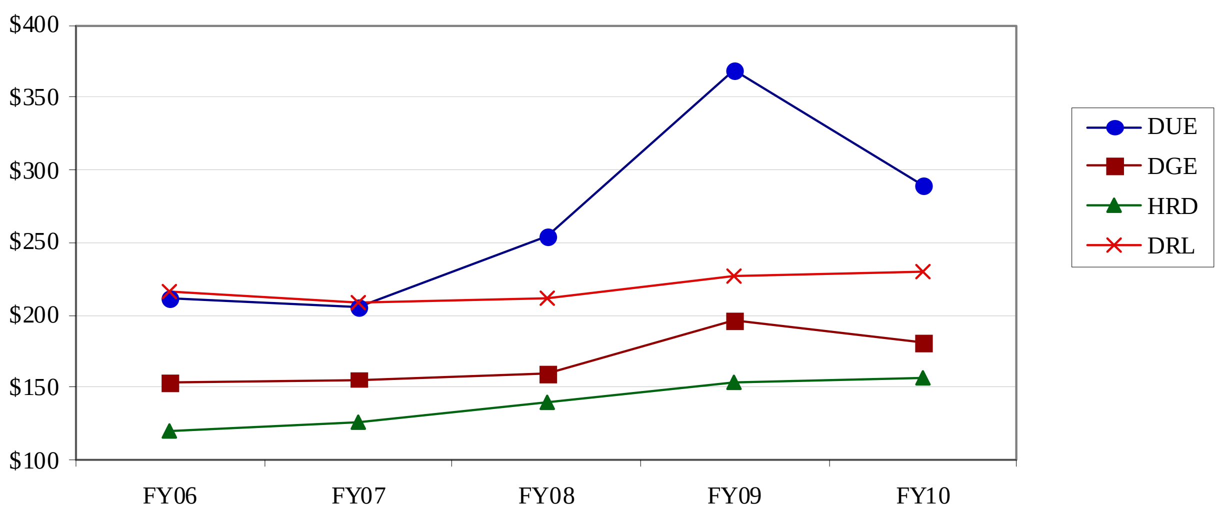
Education and Human Resources Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Research on Learning in Formal and Informal Settings (DRL)	$212.30	$226.50	-	$229.50	$3.00	1.3%
Undergraduate Education (DUE)	254.00	283.23	85.00	289.91	6.68	2.4%
Graduate Education (DGE)	159.59	181.50	15.00	181.44	-0.06	-0.0%
Human Resource Development (HRD)	140.37	154.03	-	156.91	2.88	1.9%
Total, EHR	**$766.26**	**$845.26**	**$100.00**	**$857.76**	**$12.50**	**1.5%**

Totals may not add due to rounding.

As the principal source of federal funding to promote science and engineering (S&E) education, the NSF Directorate for Education and Human Resources (EHR) promotes excellence in science, technology, engineering, and mathematics (STEM) education. The goal of EHR activities is to strengthen U.S. education at all levels, in both formal and informal learning settings, and to support continued U.S. economic and research preeminence. The EHR Directorate promotes excellence in STEM education through its highest priorities: the development of a diverse and well-prepared workforce of scientists, technicians, engineers, mathematicians, and educators; a well-informed citizenry; and access to the ideas and tools of science and engineering for all. The investment in education, research, and infrastructure enhances the quality of life of all citizens and the health, prosperity, welfare, and security of the nation while building the STEM workforce of the 21st century.

EHR Subactivity Funding
(Dollars in Millions)



Appropriation Language

For necessary expenses in carrying out science and engineering education and human resources programs and activities pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including services as authorized by 5 U.S.C. 3109, authorized travel, and rental of conference rooms in the District of Columbia, ~~$845,260,000~~*$857,760,000*, to remain available until September 30, ~~2010: *Provided further*, That not less than $55,000,000 shall be available until expended for activities authorized by section 7030 of Public Law 110-69.~~*2011*.

Education and Human Resources
FY 2010 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Supplemental	Carryover/ Recoveries	Rescission	Expired	Total Resources	Obligations Incurred/Est.
FY 2008 Appropriation	$725.60	$40.00	1.07	-0.10	-0.31	$766.26	$766.26
FY 2009 Current Plan (CP)	845.26					845.26	845.26
FY 2009 ARRA	100.00					100.00	100.00
FY 2010 Request	857.76					857.76	857.76
$ Change from FY 2009 CP							$12.50
% Change from FY 2009 CP							1.5%

Totals may not add due to rounding.

Explanation of Carryover

Within the **Education and Human Resources (EHR)** appropriation, a total of $2,764 was carried forward into FY 2009.

EHR in Context

The EHR FY 2010 Budget Request is aligned with several national directives: Presidential initiatives, the America COMPETES Act (ACA), and guidance from the National Science Board and the National Academies. It fosters connections among higher education, business and industry, K-12 systems both formal and informal, and professional societies to share in the production and productivity of the next generation of scientists and engineers to ensure national competitiveness in S&E.

To sustain its national leadership in STEM research, policy, and practice, EHR continues to emphasize its thematic priorities in FY 2010: Broadening Participation to Improve Workforce Development; Enriching the Education of STEM Teachers; Furthering Public Understanding of Science and Advancing STEM Literacy; Fostering Cyberlearning to Enhance STEM Education; Promoting Learning through Research and Evaluation; and Advancing Career Development Opportunities. These thematic areas encourage the community to identify commonalities of purpose and characteristics that link across numerous programs. The thematic structure emphasizes synergistic work among programs. The synergy will promote linkages and discussions among various stakeholder groups; advance our knowledge base in terms of breadth, depth, and coverage; ensure a systematic response to national issues in STEM education; and help define NSF's strategic leadership in STEM education.

EHR partners with the scientific and education communities directly to both situate the directorate's work in the broader societal and scientific context, and to advance shared commitments to STEM education research, development, practice, and workforce development. EHR scientific staff involvement with professional disciplinary and education societies' committees, working groups, symposia, and conferences is essential in identifying key needs and issues in STEM education. STEM education challenges and themes, including K-12 student achievement, higher education STEM enrollment trends, STEM teacher workforce preparation, and graduate enrollment patterns of interest to the Administration are tracked through a variety of reports. These include the National Science Board's Science and Engineering Indicators (NSB 08-01; www.nsf.gov/statistics/seind08/), the National Assessment of Educational Progress (http://nces.ed.gov/NATIONSREPORTCARD/), the reports of the Council of Graduate Schools (www.cgsnet.org/Default.aspx?tabid=177), and international comparative studies such as the Trends in International Mathematics and Science Study (TIMSS 2007; http://timss.bc.edu/TIMSS2007/index.html) and the Programme for International Student Assessment (PISA, www.pisa.oecd.org).

Directorate-Wide Changes and Priorities

Advance Technological Education (ATE)(+$12.38 million, to a total of $64.0 million).

ATE, housed in DUE, focuses on educating technicians who have the understanding, knowledge, and abilities to creatively support science and engineering. Support is also provided for professional development of the faculty who teach the technicians. Projects work closely with a variety of industries to learn about and meet the educational requirements of industry for technicians. For example, wind energy has become a key focus as a renewable energy source over the past decade. Last year alone, 3,200 new wind turbines were installed across the nation adding to the total of more than 25,000. The budget increase will fund approximately 10 additional awards in FY 2010.

Graduate Research Fellowships (GRF) (-$4.42 million, to a total of $102.58 million).

In FY 2010, approximately 1,654 new Fellows will be supported. In response to the Administration's plan to triple the number of NSF's new Graduate Research Fellows, EHR is contributing to NSF's commitment to encourage more highly talented students to pursue graduate education in science and engineering. Total funding for GRF is estimated to be $122.00 million, including EHR's contribution of $102.58 million. Although the EHR FY 2010 budget decreases, NSF-wide contributions will increase for this EHR-managed program. GRF is widely recognized as a unique fellowship award program because it supports the development of world-class scientists and engineers across all S&E fields supported by NSF as well as international research activity.

Climate Change Education (CCE) (-$4.50 million, to a total of $5.50 million).

EHR, the Directorates of Geosciences (GEO) and Biological Sciences (BIO), and the Office of Polar Programs (OPP) will support this new multi-disciplinary, multi-faceted climate change education program to enable a variety of partnerships, including those among K-12 education, higher education, the private sector, and related non-profit organizations, in formal and informal settings, as well as relevant education and/or climate-related policymakers. It will support individual investigators and multidisciplinary teams of STEM researchers and educators in a range of activities, including those local, regional, and/or global in scope. This includes partnerships to establish model professional development opportunities for climate policy decision makers. Although there is a decrease within EHR, the total FY 2010 request is $10.0 million including the EHR expected contribution of $5.50 million.

Integrative Graduate Education and Research Traineeships Program (IGERT) (+$4.86 million, to a total of $29.86 million).

IGERT is an NSF-wide program administered by DGE. This increase will provide funding for three new IGERT awards in the most critical science and engineering areas of national importance (e.g., activities will include a range from clean renewable energy and water to climate change education).

Louis Stokes Alliances for Minority Participation (LSAMP) (+$2.25 million, to a total of $44.75 million).

LSAMP's objective is to increase the number and quality of underrepresented minorities completing undergraduate degrees in STEM. With the increase in resources, LSAMP will support an additional LSAMP Bridge to the Doctorate award and enhance international research opportunities for underrepresented students and faculty through five supplemental awards.

STEM Talent Expansion Program (STEP) (+$1.83 million, to a total of $31.53 million).

STEP seeks to increase the number of students receiving degrees in established or emerging fields within science, technology, engineering, and mathematics. Awards are made both to provide for implementation efforts at academic institutions and to support research degree attainment in STEM. The increase will allow the establishment of two additional centers in FY 2010, in collaboration with the Research and Related Activities (R&RA) Directorates.

Project and Program Evaluation (PPE) (+$2.0 million, to a total of $12.0 million).

PPE is a strong focus of the EHR Directorate. Funded within the DRL, emphases include planning and oversight of third-party evaluations of EHR programs and thematic STEM evaluation studies; providing evaluation technical assistance throughout EHR and NSF; and providing training opportunities and tools to build capacity in the field. EHR's evaluation team coordinates data collection efforts for performance monitoring and responding to GPRA and other federal reporting requirements; disseminates broader information and evaluation findings to various stakeholders; and addresses directorate-wide knowledge management concerns for improved productivity. Increased funding will allow for continued longitudinal studies in FY 2010.

Research and Evaluation on Education in Science and Engineering (REESE) (+$1.0 million, to a total of $43.0 million).

REESE supports basic and applied research and evaluation that enhances understanding of STEM learning and teaching. Through its increased investment in FY 2010 the program will encourage proposals to examine the feasibility of studying major STEM education innovations or policies with national implications in such areas as teacher education and K-12 standards and assessment.

Program Evaluation and Performance Improvement

The Performance Information chapter describes the Foundation's performance evaluation framework, which is built upon the four strategic outcome goals in NSF's Strategic Plan: *Discovery*, *Learning*, *Research Infrastructure*, and *Stewardship*. Performance evaluation is conducted at all levels within the Foundation, using both qualitative and quantitative measures – including an agency-wide annual review of research and education outcomes by an external expert committee, periodic reviews of programs and portfolios of programs by external Committees of Visitors, and directorate Advisory Committees. Other performance indicators such as funding rates, award size and duration, and numbers of people supported on research and education grants are also factored into the performance assessment process.

All EHR programs require project-level evaluation, and findings from these are aggregated and considered in program-level strategic planning and refinement at the program and division level. In addition, program evaluations are ongoing to assess program quality and impact, and the results of these formative and summative evaluation activities are essential in the continued shaping of program directions and emphases. Finally, planning for EHR portfolio-wide evaluation is underway, so that the role of EHR investments in improving STEM education and workforce development can be examined in key priority areas.

To ensure the quality of EHR's processes for handling proposals and recommending proposals for awards, EHR convenes Committee of Visitors (COV) comprised of expert external evaluators to review all programs every three years. COV reviews are scheduled for both DUE (S-STEM, SFS, and EASE) and HRD (LSAMP, AGEP, CREST, HBCU-UP and T-CUP) in FY 2010.

Number of People Involved in EHR Activities

	FY 2008 Estimate	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate
Senior Researchers	7,643	7,952	280	8,000
Other Professionals	2,434	2,500	350	2,550
Postdoctorates	382	420	4	450
Graduate Students	7,553	7,710	1,650	8,403
Undergraduate Students	5,279	5,335	680	5,335
K-12 Students	12,454	12,454	500	12,470
K-12 Teachers	62,060	62,100	1,075	62,150
Total Number of People	97,805	98,471	4,539	99,358

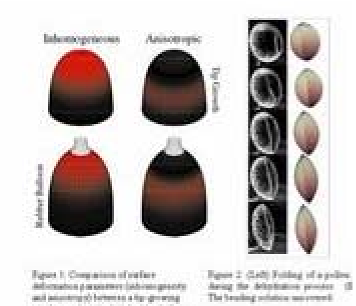
Recent Research Highlights

► **Working With K-12 Teachers Improves the Knowledge of Disciplinary Professors:** The main emphasis of NSF's Math and Science Partnership program is on improving K-12 student achievement in mathematics and science. A hallmark method of the program is engaging higher education professors who are experts in their science, mathematics and engineering disciplines to work in a variety of ways with practicing K-12 teachers, as well as with undergraduates who aim to become teachers. Researchers from the Math and Science Partnership of Greater Philadelphia found evidence of an unanticipated second type of impact on professors from their interaction with K-12 teachers – a positive impact on the professors' actual disciplinary knowledge and research. An online survey sent to participating higher education professors confirmed this secondary benefit: fully two-thirds of the respondents indicated a positive impact on their disciplinary knowledge and more than 90 percent of the respondents said the experience made them better teachers.

► **FunWorks: A Digital Library Designed by and for Middle School Students:** FunWorks is an innovative digital library that engages young people in the exploration of career opportunities in science, technology, engineering and mathematics. Developed by the Education Development Center, FunWorks is supported by NSF's National Science, Technology, Engineering and Mathematics Education Digital Library. The center first consulted up to 300 middle-school students from diverse backgrounds in Boston to research student website preferences and interest in science-related careers. Then a middle-school team consisting of four girls and four boys from a Boston community technology center worked with the center for five months to develop FunWorks. The final product is a dynamic digital library that uses "real world" contexts such as music and sports to present science-related careers to young people. By involving a diverse group of students throughout its development, FunWorks engages under-represented groups such as females, minority populations, students of poverty, and students with disabilities.

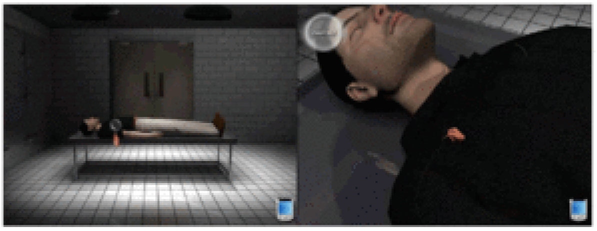
Home page of the FunWorks Web site. *Credit: Education Development Center, Inc.*

► **Balloons Help Scientists Understand Cell Growth:** How cells grow and form have implications on topics ranging from the invasiveness of cancer cells to the capacity of fungi to cause disease. The Integrative Graduate Education and Research Traineeship Program in Biomechanics at Harvard University brings together aspects of mathematical modeling, physics, biology, and genomics to develop simple and tractable frameworks for understanding cell growth. Project trainees demonstrate how types of cell growth may be tackled both experimentally and theoretically. For example, a breakthrough in understanding cell growth was achieved by studying cylindrical rubber balloons against what we already know about mechanical cell function and growth. A comparison of the deformation parameters for the surface revealed a striking similarity between the living cell and the physical analog demonstrated by the balloon. As a part of their training, the students in this program develop interdisciplinary skills to address a variety of biological problems successfully in novel ways. What emerged is a simple mechanical model of cell growth whose predictive power surpasses that of all previous models.



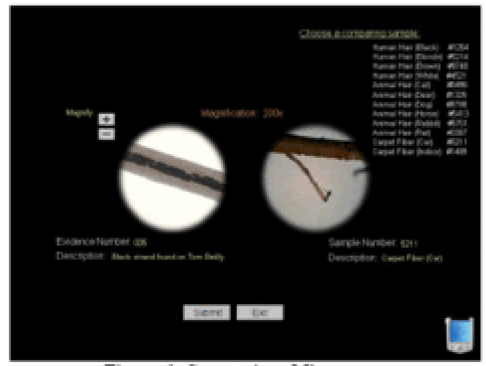
Tip folding and pollen growth. *Credit: Jacques Dumais.*

► **Intelligent Software Lets Students Experience Virtual Scientific Investigations:** An NSF-funded virtual curriculum developed by researchers at Temple University is increasing student understanding of forensic science and biological research, and the nature and methods of scientific inquiry. The software's engrossing scenarios bring to life the scientific method and help pique student interest in science.



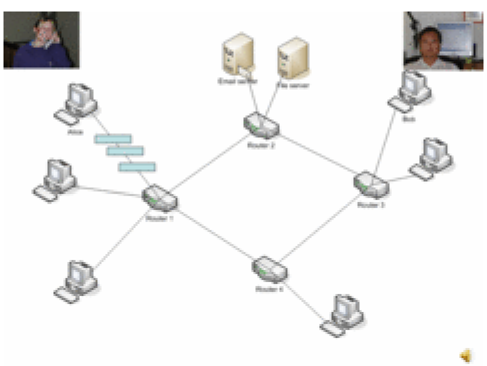
Simulated morgue with a virtual crime victim's body. *Credit: Brian Butz, Temple University.*

In the first learning scenario, students investigate a murder scene. They decide what evidence to collect – DNA, hair, fibers, blood – and draw conclusions about suspects. The intelligent system operates through a virtual supervisor who oversees students' actions and assures that they exercise due diligence in analyzing the evidence. The scenario introduces students to evidence gathering and analysis procedures used by scientists who study past events. Testing of the software with about 100 students in several high schools in Pennsylvania has yielded high marks from students in evaluation surveys.



Microscopic analysis of hair found on the virtual victim's body. *Credit: Brian Butz, Temple University.*

► **Graduate Fellows Bring Cyber-Enabled Learning to K-12 Classrooms:** An education project at the New Jersey Institute of Technology supports training for eight doctoral students per year to bring their doctoral research into K-12 classrooms. The project, "C2PRISM," stands for Computation and Communication: Promoting Research Integration in Science and Mathematics. Working one-on-one with eight high school teachers in five different New Jersey schools, the project seeks to improve graduate students' communication skills and enrich classroom instruction and learning. The graduate students come from a wide range of disciplines, and they influence about 1,316 K-12 students per year with simulations and games that engage students in active spatial and computational learning critical to the information technology fields. Interacting with graduate-level scientists prompts students to consider academic careers in science, technology, engineering and math fields, and classroom teachers have the opportunity to expand their use of new technologies within the context of their curriculum.



This is a representation of how packets of information (blue rectangles) must take an efficient route to be reassembled and decoded to be heard. *Credit: New Jersey Institute of Technology.*

► **Louis Stokes Alliances for Minority Participation Becomes 39 Strong:** The Louis Stokes Alliances for Minority Participation in science, technology, engineering and mathematics fields increased to 39 alliances across America in 2008, producing 25,000 graduates, mostly from populations underrepresented in those fields. More than 500 U.S. institutions participate in the program, including Historically Black Colleges and Universities, Hispanic Serving Institutions, Native American Institutions, and community colleges. Since 2002, the Pacific Alliance and the Islands of Opportunity have contributed more than 500 science, technology, engineering, and mathematics baccalaureate degrees to Native American and Native Hawaiian or Pacific Islander students. Successful strategies employed at alliance institutions for recruiting and retaining underrepresented minorities include peer and faculty mentoring, bridge programs, engaged academic learning communities, research experiences for undergraduates, collaborations with professional societies, and private and public sector research organizations. The quality of the academic support and research experiences at participating institutions has resulted in numerous awards and recognition for alliance students and faculty.

Advanced undergraduate students conducting soil sampling experiments in the tropics. *Credit: Islands of Opportunity-LSAMP.*

► **NSF-Funded CYBERCHASE Wins Emmy Award:** The NSF-funded CYBERCHASE program is accomplishing its mission to improve kids' problem-solving and mathematics skills and inspire confidence and enthusiasm toward math. CYBERCHASE, the ground-breaking multi-platform children's program on PBS KIDS GO! for grades 3-5, has been awarded the first Daytime Emmy Award for Outstanding Broadband Program - Children's. The new Emmy Award category recognizes children's programming distributed via broadband and portable delivery, including the Internet, cell phones, and personal media players. CYBERCHASE won the award for content tied to My Big Idea, a multi-platform activity that introduces viewers to the connection between mathematics and the invention process. Video segments feature both young inventors and the live-action stars of CYBERCHASE. Nearly 5 million viewers watch CYBERCHASE every week and CYBERCHASE Online has had more than 1.7 billion page views. CYBERCHASE's audience is more than one-third African-American or Hispanic; girls and boys watch in equal numbers.

The Emmy-Award winning CYBERCHASE team, featuring Jackie, Inez, Matt, and Digit. *Credit: Sandra Sheppard.*

► **Users Soar with TerraFly:** TerraFly, a new Internet-based technology developed at Florida International University for manipulating geospatial information, makes it possible for users to "fly over" vast land areas using only an ordinary Web browser. By using high-resolution imagery collected by the U.S. Geological Survey and other sources, users can experience an overhead view of almost any location in the U.S. at a one-meter resolution – without the expense of standard GIS application software. Florida International University's Center for Research Excellence in Science and Technology Program contributed major research and development efforts to the project. Spatial data sets come from varied sources and in many different formats, often requiring separate specialized geographic systems to view and extract information. TerraFly enables researchers to perform complex queries of geospatial data and delivers visualizations for users to "fly" through geospatial data using nothing but a typical Internet browser. Constituencies such as disaster managers are intended users.

A TerraFly web-browsable high-resolution aerial imagery layered with real street, business, and demographic data. *Credit: PI: Yi Deng.*

RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS **$229,500,000**
+$3,000,000 / 1.3%

Research on Learning in Formal and Informal Settings Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, DRL	**$212.30**	**$226.50**	**-**	**$229.50**	**$3.00**	**1.3%**
Discovery Research K-12	99.25	108.50	-	108.50	-	-
Informal Science Education	64.45	66.00	-	66.00	-	-
Research and Evaluation on Education in S&E	41.66	42.00	-	43.00	1.00	2.4%
Project and Program Evaluation	6.94	10.00	-	12.00	2.00	20.0%

Totals may not add due to rounding.

Summary of FY 2010 Request

The main goal of the Division of Research on Learning in Formal and Informal Settings (DRL) is to improve in the learning and teaching in the STEM disciplines. The division's programs fund activities in formal education settings ranging from early childhood through graduate school, and informal learning environments from museums to cyberspace. DRL is concerned with STEM learners of all ages and audiences of all types, ranging from STEM teachers to after-school program providers. Projects in DRL include efforts spanning basic research for hypothesis generation and description; design, development, and testing of resources and models for STEM learning; implementation and studies of the efficacy of learning resources; studies of scale-up and effectiveness; and syntheses for building theory and influencing policy and practice. The division is organized in three clusters: Lifelong Learning; Knowledge Building; and Resources, Models, and Tools. These clusters provide intellectual direction and operational coordination for the division's programs and activities.

Funding at the requested level enables DRL to position its entire portfolio of activities to address critical challenges and emerging new opportunities in STEM education. The reformulation and expansion of the research and evaluation focus will enhance the ongoing setting of priorities and emphases in all DRL activities, allowing for a greater impact of STEM education and learning improvements. The proposed FY 2010 budget will provide the collected programs and activities of DRL with the opportunity for dynamic and strategic impact on STEM learning.

Research and Evaluation on Education in Science and Engineering (REESE) (+$1.0 million, to a total of $43.0 million).

The REESE program supports basic and applied research and evaluation that enhances understanding of STEM learning and teaching. Through REESE investments evidence-based knowledge is accumulating in order to improve practice and policy, and interdisciplinary collaborations are brought to bear on complex educational research issues. With increased resources of $1.0 million in FY 2010, the program will encourage proposals to examine the feasibility of studying major STEM education innovations or policies with national implications in such areas as teacher education, K-12 standards, and assessment.

Project and Program Evaluation (PPE) (+$2.0 million, to a total of $12.0 million).
Increased funding will foster theoretical and methodological advances in STEM education program evaluation, and expand a coherent portfolio in program evaluation. Emphases will be in the areas of design, methodology, and measures for program-level evaluations. The program will enlarge its investment in multi-faceted and multiple methods evaluations that include feasibility studies, descriptive evaluations for program improvement, comparative evaluations to gauge program impact, and longitudinal studies. Program and portfolio evaluations and evaluative studies will be undertaken through grant and contract mechanisms with the goals of increased involvement of higher education experts and with greater emphasis on innovative methods.

UNDERGRADUATE EDUCATION

$289,910,000
+$6,680,000 / 2.4%

Undergraduate Education Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Curriculum, Laboratory and Instructional Development	$82.68	$85.41	-	$86.99	$1.58	1.8%
Workforce Development	123.45	136.82	60.00	144.70	7.88	5.8%
Math and Science Partnership	47.87	61.00	25.00	58.22	-2.78	-4.6%
Total, DUE	**$254.00**	**$283.23**	**$85.00**	**$289.91**	**$6.68**	**2.4%**
Selected Programs:						
Advance Technological Education	51.46	51.62	-	64.00	12.38	24.0%
Climate Change Education	-	10.00	-	5.50	-4.50	-45.0%
Robert Noyce Teacher Scholarship	55.05	55.00	60.00	55.00	-	-
STEM Talent Expansion	29.48	29.70	-	31.53	1.83	6.2%

Totals may not add due to rounding.

Summary of FY 2010 Request

The Division of Undergraduate Education (DUE) is the NSF focal point for transforming undergraduate STEM education to meet the needs of the 21st century. DUE's objective is to increase the quality and quantity of the science and engineering workforce, and the extent to which all undergraduate students are well-prepared for an increasingly technological global society. DUE programs emphasize innovation and ongoing improvement in curricula, teaching procedures, and laboratories, so that the next generation is continuously learning by using the tools and methods of inquiry used by working professionals. Collaborations are encouraged among institutions, and among higher education, industry, and K-12 sectors. DUE grants provide for faculty development; support for new instructional materials; offer opportunities to reform courses, laboratories, and curricula; and provide for the assessment of outcomes.

The FY 2010 funding request supports the significant expansion of DUE programs in workforce development, especially the Advanced Technological Education program, and will enable the establishment of larger scale funding within the STEM Talent Expansion program to develop innovative ways to approach building the pipeline of STEM students. Climate Change Education will also continue to be a significant priority.

Advanced Technological Education (ATE) (+$12.38 million, to a total of $64.0 million).

The ATE program enables educators from two-year colleges to lead programs that improve the skills of technicians and the educators who teach them. Some of its current projects and Centers focus on the delivery and management of energy. The FY 2010 budget request will support the expansion of its critical work with two-year colleges, and increase its capacity to fund clean energy related projects. For example, wind energy has become a key focus as a renewable energy source over the past decade. Last year alone, 3,200 new wind turbines were installed across the Nation adding to the total of more than 25,000. The budget increase will fund approximately 10 additional awards in FY 2010.

STEM Talent Expansion Program (STEP) (+$1.83 million, to a total of $31.53 million).

The STEP Program seeks to increase the number of students receiving degrees in established or emerging fields within science, technology, engineering, and mathematics. Awards are made both to provide for implementation efforts at academic institutions and to support research degree attainment in STEM. The America Competes Act authorized the establishment of centers within this program, to be jointly funded with one or more disciplinary directorates, to explore fundamental changes in undergraduate practice that promise to significantly improve recruitment and retention of students, and lead to improvement in their learning. The $1.83 million increase will permit the establishment of two additional centers in FY 2010 in collaboration with the R&RA Directorates.

Climate Change Education (CCE) ($4.50 million, to a total of $5.50 million).

CCE will build upon the activities funded within DUE in FY 2009 to establish this program on a basis of collaboration with OPP, BIO, and GEO. Although there is a decrease within EHR, the total FY 2010 request is $10.0 million. This program will enable a variety of partnerships, including those among K-12 education, higher education, the private sector, and related non-profit organizations, in formal and informal settings, as well as relevant education and/or climate-related policymakers. It will support individual investigators and multidisciplinary teams of STEM researchers and educators.

Math and Science Partnership (MSP) (-$2.78 million, to a total of $58.22 million).

Although there is a decrease in the FY 2010 Budget, DUE plans to meet its MSP goal to build capacity and integrate the work of higher education with that of K-12 to strengthen and reform science and mathematics education. This remains a priority area, anticipating growth in future years.

GRADUATE EDUCATION

$181,440,000
-$60,000 / -0.03%

Graduate Education Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, DGE	**$159.59**	**$181.50**	**$15.00**	**$181.44**	**-$0.06**	**-0.03%**
Graduate Research Fellowships	87.89	107.00	-	102.58	-4.42	-4.1%
Graduate STEM Fellows in in K-12 Education	46.40	49.50	-	49.00	-0.50	-1.0%
Integrative Graduate Education and Research Traineeships	25.29	25.00	-	29.86	4.86	19.4%
Science Masters	-	-	15.00	-	-	N/A

Totals may not add due to rounding.

Summary of FY 2010 Request

The Division of Graduate Education (DGE) supports U.S. graduate students and innovative graduate programs that prepare tomorrow's leaders in science and engineering (S&E). DGE meets its objectives through three graduate education programs that vary in their designs and in the options and opportunities provided to graduate students. The Graduate Research Fellowship program, one of the oldest programs at NSF, provides some of the Nation's most promising graduate students with great flexibility in selecting the university of their choice and gives them the intellectual independence to follow their research ideas unfettered by the exigencies of mode of support. The Graduate STEM Teaching Fellows in K-12 (GK-12) program supports graduate students in STEM disciplines and associated training that enables them to acquire additional skills that will broadly prepare them for professional and scientific careers. Through interactions with teachers and students in K-12 schools, graduate students improve their communication and teaching skills while enriching STEM education in these schools. The Integrative Graduate Education and Research Traineeships (IGERT) program, based on transformative interdisciplinary research, provides doctoral students with a strong collaborative research foundation, innovative educational programs to help them cross disciplinary boundaries, and development of personal and professional skills to prepare them for the careers of the future.

Each of the three DGE programs recognizes the growing significance of the changing global environment for future scientists and engineers, and each is taking steps to bring more international emphasis and provide more opportunities for students to expand their knowledge of research and education in other nations, as well as to learn about international issues affecting STEM careers. Each of the three DGE programs has a strong commitment to broadening participation and career development.

The FY 2010 Budget will provide support for career preparation of the scientists and engineers of the future with innovative programs and new opportunities. The excitement of cutting-edge research coupled with carefully shaped educational experiences draws young scientists and engineers into graduate study and provides them the foundation to acquire the skills to make contributions in areas critical to our future. Their career successes will be key to the competitiveness of our nation in a world in which innovation in such areas as energy and climate change will determine both our economic future and the well-being of our society.

Integrative Graduate Education and Research Traineeships (IGERT) (+$4.86 million, to a total of $29.86 million).

IGERT is a NSF-wide program that prepares U.S. doctoral students to lead the nation in emerging interdisciplinary areas of research by integrating research and education in innovative ways that are tailored to the unique requirements of the new interdisciplinary fields and new career options. The additional funding provided here will support up to three new IGERT awards in the most critical S&E areas of national importance (e.g., activities will include a range from clean renewable energy and water to climate change education). The proposed total NSF FY 2010 IGERT budget level of $68.88 million will allow further increases in the number of future graduate students supported, thus making a larger investment in the workforce of the future.

Graduate Research Fellowships (GRF) (-$4.42 million, to a total of $102.58 million).

EHR invests in the preparation, development, and advancement of world-class young investigators through the GRF program. The GRF program strategically invests in intellectual capital, providing support to individuals who are pursuing graduate education. Total funding for GRF increases to $122.0 million, including EHR's contribution of $102.58 million. Although the EHR FY 2010 budget decreases, NSF-wide contributions will increase for this EHR-managed program. In FY 2010, approximately 1,654 new Fellows will be awarded in support of the Presidential initiative to triple the number of new graduate research fellowships from 1,000 to 3,000 by FY 2013.

Graduate STEM Fellows in K-12 Education (GK-12) (-$0.50 million, to a total of $49.0 million).

The GK-12 Education program supports graduate students and training activities that enable the graduate students in NSF-supported STEM disciplines to acquire additional skills that will broadly prepare them for professional and scientific careers. Through interactions with teachers in K-12 schools, graduate students improve their communication and teaching skills while enriching STEM instruction in these schools. The decrease in funding will result in one fewer award in FY 2010.

HUMAN RESOURCE DEVELOPMENT

$156,910,000
+$2,880,000 / 1.9%

Human Resource Development Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Undergraduate/Graduate Student Support	$83.01	$87.50	-	$90.10	$2.60	3.0%
Research and Education Infrastructure	40.81	47.28	-	47.28	-	-
Opportunities for Women and Persons with Disabilities	16.56	19.25	-	19.53	0.28	1.5%
Total, HRD	**$140.37**	**$154.03**	**-**	**$156.91**	**$2.88**	**1.9%**
Selected Programs:						
Historically Black Colleges and Universities Undergraduate Program	29.74	31.50	-	32.00	0.50	1.6%
Louis Stokes Alliances for Minority Participation	40.47	42.50	-	44.75	2.25	5.3%

Totals may not add due to rounding.

Summary of FY 2010 Request

The Division of Human Resource Development (HRD) implements programs and activities that enhance the quantity, quality, and diversity of human capital engaged in U.S. science, technology, engineering, and mathematics (STEM). A principal focus of HRD is to ensure access to and full participation in STEM through increased, improved, and diversified opportunities; enhanced quality in the educational experience; and hands-on research experiences. In particular, HRD plays a central role in increasing opportunities in STEM education for individuals from historically underserved populations - minorities, women and persons with disabilities - and supports the development of the educators, researchers, and institutions dedicated to serving these populations.

HRD programs are funded through three budget lines. Included in the Undergraduate and Graduate Student Support line are the Historically Black Colleges and Universities Undergraduate Program (HBCU-UP), the Louis Stokes Alliances for Minority Participation (LSAMP), and the Tribal Colleges and Universities Program (TCUP). The Research and Education Infrastructure line includes the Alliances for Graduate Education and the Professoriate (AGEP) and the Centers of Research Excellence in Science and Technology (CREST) program. The Opportunities for Women and Persons with Disabilities line includes ADVANCE, the Research in Disabilities Education (RDE) program, and the Research on Gender in Science and Engineering (GSE) program.

In FY 2010, with its proposed increase, HRD will increase support for programs that identify, recruit, and train underrepresented scholars in the STEM disciplines. Collectively, support for these programs underscores HRD's mission of broadening participation and workforce development from the undergraduate level to terminal employment.

Louis Stokes Alliances for Minority Participation (LSAMP) (+$2.25 million, to a total of $44.75 million).
The LSAMP program supports sustained and comprehensive approaches to broadening participation at the baccalaureate level. These approaches facilitate the production of students who are well prepared in

STEM and motivated to pursue graduate education. Projects place emphasis on aggregate baccalaureate production; attention to individual student retention and progression to baccalaureate degrees; and aggregation of student progression to graduate school entry. In addition, expectations are placed on institutionalizing, disseminating, and promoting the replication of strategies and collaborative approaches that have shown success in the transition of undergraduate STEM students to graduate STEM programs. In FY 2010, LSAMP will continue to support institutional alliances that will produce a demonstrable "near-term" increase in the numbers of high quality STEM graduates with the promise of long-term change in the production of new Ph.D.s and their entrance into productive faculty or research careers. The proposed increase will support an additional LSAMP Bridge to the Doctorate award and enhance international research opportunities for underrepresented students and faculty through five supplemental awards.

Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) (+$500,000, to a total of $32.0 million).

In FY 2010, HBCU-UP will continue to meet its goal of strengthening the quality of undergraduate STEM programs at the nation’s HBCUs. Additional HBCU-UP funds will support two to four new HBCU/STEM teacher development projects to increase the numbers and high-quality preparation of teachers.

ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers (+$280,000, to a total of $1.53 million).

The ADVANCE program goal is to develop systemic approaches to increase the representation and advancement of women in academic science and engineering careers, thereby contributing to the development of a more diverse S&E workforce. The increase will be used to forge relevant instructional linkages through supplements with other broadening participation efforts.

H-1B NONIMMIGRANT PETITIONER FEES $100,000,000

The FY 2010 H-1B Nonimmigrant Petitioner Fees are projected to be $100.0 million, equivalent to the FY 2009 projection.

H-1B Nonimmigrant Petitioner Fees Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	Change over FY 2009 Estimate Amount	Percent
H-1B Nonimmigrant Petitioner Fees Funding	$121.12	$100.00	$100.00	-	-

Beginning in FY 1999, Title IV of the American Competitiveness and Workforce Improvement Act of 1998 (P.L. 105-277) established an H-1B Nonimmigrant Petitioner Account in the general fund of the U.S. Treasury for fees collected for each petition for alien nonimmigrant status. That law required that a prescribed percentage of funds in the account be made available to NSF for the following activities:

- **Computer Science, Engineering, and Mathematics Scholarships** (CSEMS). The program supported grants for scholarships to academically-talented, financially needy students pursuing associate, baccalaureate, or graduate degrees in computer science, computer technology, engineering, engineering technology, or mathematics. Grantee institutions awarded scholarships of up to $2,500 per year for two years to eligible students.

- **Grants for Mathematics, Engineering, or Science Enrichment Courses.** These funds provided opportunities to students for enrollment in year-round academic enrichment courses in mathematics, engineering, or science.

- **Systemic Reform Activities.** These funds supplemented the rural systemic reform efforts administered under the former Division of Educational System Reform (ESR).

In FY 2001, Public Law 106-311 increased the funds available by increasing the petitioner fees. Also, the American Competitiveness in the 21st Century Act (P.L. 106-313) amended P.L. 105-277 and changed the way petitioner fees were to be expended.

- The CSEMS activity continued under P.L. 106-313 with a prescribed percentage of H-1B receipts. The maximum scholarship duration was four years and the annual stipend was $3,125. Funds for this scholarship program totaled 59.5 percent of the total H-1B funding for NSF.

- Private-Public Partnerships in K-12: P.L. 106-313 directed the remaining 40.5 percent of receipts toward K-12 activities involving private-public partnerships in a range of areas such as materials development, student externships, and mathematics and science teacher professional development.

- Information Technology Experiences for Students and Teachers (ITEST) developed as a partnership activity in K-12 to increase opportunities for students and teachers to learn about, experience, and use information technologies within the context of STEM, including Information Technology (IT) courses.

In FY 2005, Public Law 108-447 reauthorized H-1B funding. NSF was provided with 40 percent of the total H-1B receipts collected. Thirty percent of H-1B receipts (75 percent of the receipts that NSF receives) are to be used for the Low-income Scholarship Program. Ten percent of receipts (25 percent of the receipts that NSF receives) are designated for support of the Grants for Mathematics, Science, or Engineering Enrichment Courses.

Low-income Scholarship Program. Eligibility for the scholarships was expanded from the original fields of computer science, engineering, and mathematics to include "other technology and science programs designated by the Director." The maximum annual scholarship award amount was raised from $3,125 to $10,000. NSF may use up to 50 percent of funds "for undergraduate programs for curriculum development, professional and workforce development, and to advance technological education." Because of the changes, the program was renamed in 2006 from CSEMS to Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM).

Since its inception the low-income scholarship program has received approximately 2,512 proposals from all types of colleges and universities and has made awards for 948 projects. Approximately 49,500 students have received scholarships ranging from one to four years, and many new grants have yet to award all their scholarships. In addition to scholarships, projects include student support activities featuring close involvement of faculty, student mentoring, academic support, and recognition of the students. Such activities are important in recruiting and retaining students in high-technology fields through graduation and into employment. Approximately 100 awards are anticipated in FY 2010.

ITEST Grants for Mathematics, Science, or Engineering Enrichment Courses. The ITEST program invests in K-12 activities that address the current concern about shortages of STEM professionals and information technology workers in the U.S. and seeks solutions to help ensure the breadth and depth of the STEM workforce, including education programs for students and teachers that emphasize IT-intensive careers. In FY 2008, the guidelines were revised to address the development, implementation, testing, and scale-up of models, as well as research studies to improve the STEM workforce and build students' capacity to participate in the STEM workforce, especially the information and communication technology (ICT) areas. The new ITEST solicitation extends the previous solicitation by placing greater emphasis on capturing and establishing a reliable knowledge base about the dispositions toward and knowledge about STEM workforce skills in U.S. students; the name of the program was also changed in this solicitation to Innovative Technology Experiences for Students and Teachers. New categories of awards include: (1) *Strategies projects* for the design, implementation, and evaluation of models for classroom, after-school, summer, virtual, and/or year-round learning experiences for students and/or teachers to encourage students' readiness for, and their interest and participation in the STEM workforce; (2) *Scale-Up projects* that support the implementation and testing of models that prepare students for information technology or the STEM workforce in a large-scale setting such as a state or at the national level; and (3) *Studies projects* that support research to enrich the understanding of issues related to enlarging the STEM workforce, including efficacy and effectiveness studies of intervention models, longitudinal studies, instruments, and studies to identify predictors of student inclination to pursue STEM career trajectories. The Strategies, Scale-up, and Studies projects replace the previous four components: youth-based projects, comprehensive projects, traditional project renewals, and the ITEST resource center. In 2009, Studies projects were modified and renamed Research projects. Also, conferences and workshops were added as a category to foster a research agenda focused on STEM workforce topics and stronger evaluation strategies to assess the impact of ITEST interventions on student motivation to enter the STEM workforce.

Since its inception, ITEST has received 1,105 proposals and funded over 140 projects that allow students and teachers to work closely with scientists and engineers on extended research projects, ranging from biotechnology to environmental resource management to programming and problem-solving. Projects draw on a wide mix of local resources, including universities, industry, museums, science and technology centers, and school districts in order to identify the characteristics that engage a wide range of young people in STEM, especially those not successful in traditional school settings. Through a projected $156 million federal investment, ITEST impacts an estimated 158,000 students (grades K-12), 4,700 teachers, and 1,770 parents/caregivers. In FY 2008, ITEST received 240 full proposals and funded 34 awards, the highest number of awards since the program's inception. The change in categories of awards resulted in smaller grant size, thus allowing for a larger number of awards.

In November 2005, Public Law 109-108 was signed and directed EHR to initiate a K-8 pilot program, which NSF called Academies for Young Scientists, using funds in the FY 2006 EHR appropriation. EHR used approximately $7 million of funds from its formal K-12 programming and approximately $7 million of funds from H-1B nonimmigrant petitioner fees for this effort. This effort called for proposals to develop stimulating, intensive STEM learning experiences that engage K-8 students; develop sustainable, district-based partnership demonstration projects; and promote strategies that further develop skills in K-8 STEM teachers. This activity was a demonstration project in FY 2006; no additional funds are requested.

H-1B Financial Activities from FY 1999 - FY 2008

(Dollars in Millions)

	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
Receipts	**$26.61**	**$48.61**	**$88.34**	**$61.04**	**$65.34**	**$0.57**	**$83.68**	**$105.32**	**$107.36**	**$104.43**
Obligations incurred										
Computer Science, Engineering, and Mathematics Scholarships	0.26	23.16	68.37	34.69	25.30	33.91	0.54	80.95	100.04	92.40
Grants for Mathematics, Engineering or Science Enrichment Courses	-	0.20	4.22	5.83	16.27	-	-	-	-	-
Systemic Reform Activities	-	1.70	3.70	3.97	5.00	2.50	2.72	-	-	-
Private-Public Partnership in K-12[1/]	-	-	2.22	12.82	-	20.87	22.69	18.45	45.90	28.72
Total Obligations	**$0.26**	**$25.06**	**$78.51**	**$57.31**	**$46.57**	**$57.28**	**$25.95**	**$99.40**	**$145.94**	**$121.12**
Unobligated Balance end of year	$26.35	$49.89	$59.72	$63.45	$83.90	$29.10	$89.58	$98.19	$63.37	$50.83

1/ P.L 106-313 directs that 15 percent of the H-1B Petitioner funds go toward K-12 activities involving private-public partnerships in a range of areas such as materials development, student externships, math and science teacher professional development, etc.

Explanation of Carryover

During FY 2009, significant amounts of receipts arrived late in the fiscal year and there was not adequate time to obligate the total amount. In FY 2008, NSF planned earlier solicitation deadlines for the S-STEM and ITEST programs so that awards from H-1B visa funds could be made earlier in the fiscal year. As a result, EHR brought forward fewer resources. Some carryover amount is expected each year since fourth quarter receipts arrive late during the month of September.

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

$117,290,000
-$34,720,000 / -22.8%

Major Research Equipment and Facilities Construction Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Major Research Equipment and Facilities Construction	$166.85	$152.01	$400.00	$117.29	$34.72	-22.8%

The MREFC account supports the acquisition, construction, and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Initial planning and design, and follow on operations and maintenance costs of the facilities are provided through the Research and Related Activities (R&RA) account.

MREFC Account Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate
Ongoing Projects									
AdvLIGO	$32.75	$51.43	-	$46.30	$20.96	$23.58	$15.17	$14.68	$0.24
ATST	-	7.00	146.00	10.00	20.00	15.20	8.30	12.70	17.00
ARRV	1.48	-	148.07	-					
ALMA	102.07	82.25	-	42.76	13.91	3.00	-		
EarthScope[1]	4.21	-	-	-					
IceCube	18.74	11.33	-	0.95	-				
NEON	-	-	-	-					
OOI	-	-	105.93	14.28	110.70	82.80	46.80	20.00	-
SODV[1]	0.02	-	-	-					
SPSM[1]	7.57	-	-	-					
Judgment Fund	-	-	-	3.00					
MREFC Account Total	$166.85	$152.01	$400.00	$117.29	$165.57	$124.58	$70.27	$47.38	$17.24

Totals may not add due to rounding.

[1]EarthScope and SODV received the final year of MREFC funding in FY 2007, and SPSM received final appropriations in FY 2008. Information on these projects can be found in the Facilities chapter of this document.

A modern and effective research infrastructure is critical to maintaining U.S. leadership in science and engineering (S&E). The future success of entire fields of research depends upon access to new generations of powerful research tools. Increasingly, these tools are large and complex, and have a significant information technology component.

In accordance with the plan outlined in *A Joint National Science Board-National Science Foundation Management report on Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation,* NSF developed guiding documentation for the MREFC process. NSF is releasing its

Facility Plan in conjunction with this Budget Request. These documents can be found on the NSF website[1].

In order for a project to be considered for MREFC funding, NSF requires that it represent an exceptional opportunity that enables research and education. In addition, the project should be transformative in nature in that it should have the potential to shift the paradigm in scientific understanding and/or infrastructure technology. The projects included in this budget request meet these criteria based on NSF and NSB review.

Projects under consideration for MREFC funding must undergo a multi-phase review and approval process that is described in detail in the *Large Facilities Manual*. As a general framework for priority setting, NSF assigns highest priority to ongoing projects, which are those that have received funding for implementation and where outyear funding for the full project has already been included in a Budget Request to Congress.

All of the projects in the MREFC account are undergoing or have undergone major cost and schedule reviews, as required by guidelines instituted by NSF over the last few years. In FY 2010, NSF requests continued funding for five ongoing projects: Advanced LIGO (AdvLIGO), the Atacama Large Millimeter Array (ALMA), the Advanced Technology Solar Telescope (ATST), the final year of funding for the IceCube Neutrino Observatory (IceCube), and the Ocean Observatories Initiative (OOI). In addition, NSF requests $3.0 million to reimburse the Department of Justice's Judgment Fund to cover a settlement associated with an adjustment to the contract for the upgrades to the LC-130s, a project funded through the MREFC account from FY 1999 through FY 2001.

NSF has implemented a "no cost overrun" policy, which will require that cost estimate developed at the Preliminary Design Stage have adequate contingency to cover all foreseeable risks, and that any cost increases not covered by contingency be accommodated by reductions in scope. NSF senior management is developing procedures to assure that the cost tracking and management processes are robust and that the project management oversight has sufficient authority to meet this objective. As project estimates for the current slate of projects are revised, NSF will identify potential mechanisms for offsetting any cost increases in accordance with this policy.

Appropriation Language

For necessary expenses for the acquisition, construction, commissioning, and upgrading of major research equipment, facilities, and other such capital assets pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including authorized travel, ~~$152,010,000,~~*$117,290,000*, to remain available until expended..

[1]*A Joint National Science Board-National Science Foundation Management report on Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*: www.nsf.gov/pubs/2005/nsb0577/nsb0577_1.pdf
NSF 2009 Facility Plan: http://www.nsf.gov/pubs/2009/nsf0939/nsf0939.pdf

Major Research Equipment and Facilities Construction
FY 2010 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Carryover/ Recoveries	Transfers	Rescission	Total Resources	Obligations Incurred/Est.
FY 2008 Appropriation	$220.74	$27.81	-	-$15.27	$233.28	$166.85
FY 2009 Current Plan (CP)	152.01	66.43	-	-	218.44	218.44
FY 2009 ARRA	400.00	-	-	-	400.00	400.00
FY 2010 Request	117.29	-	-	-	117.29	117.29
$ Change from FY 2009 CP						-$101.15
% Change from FY 2009 CP						-46.3%

Totals may not add due to rounding.

Explanation of Carryover:

Within the Major Research Equipment and Facilities Construction (MREFC) appropriation, a total of $66.43 million was carried forward into FY 2009 and will be applied to ongoing projects.

South Pole Station Modernization carried forward a total of $2.26 million into FY 2009. The carryover will be applied toward the logistics and warehousing facility at South Pole, completion of exterior activities for the elevated station, and demolition of the existing station and other construction as the project approaches its scheduled completion in 2010.

A total of $3.0 million was carried forward into FY 2009 for the National Ecological Observatory Network (NEON) in anticipation of two upcoming reviews for NEON.

A total of $5.91 million was carried forward into FY 2009 for the Ocean Observatories Initiative (OOI). These funds are expected to be obligated in summer 2009, upon the initiation of the cooperative agreement for the project.

A total of $7.90 million was carried forward into FY 2009 for the IceCube Neutrino Observatory (IceCube). The carryover will be applied toward data warehousing, systems upgrade, labor and materials, logistics support, and remaining construction costs.

A total of $47.36 million was carried forward into FY 2009 for the Alaska Region Research Vessel (ARRV). The carryover will be applied to planning, shipyard contract award, design verification, and ordering long lead equipment items.

The MREFC Account in FY 2010:

NSF's ongoing projects in FY 2010 include:

- Advanced LIGO,
- the Atacama Large Millimeter Array,
- the Advanced Technology Solar Telescope
- the IceCube Neutrino Observatory, and
- the Ocean Observatories Initiative.

Information on these projects follows. Information on the Alaska Region Research Vessel (ARRV), which received appropriations in FY 2009 necessary to complete the project, the National Ecological Observatory Network (NEON), and the request to reimburse the Department of Treasury's Judgment Fund, is also provided below.

Advanced Laser Interferometer Gravitational-Wave Observatory $46,300,000

The FY 2010 Budget Request for the Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO) is $46.30 million, which represents the third year of a seven-year project totaling an estimated $205.12 million.

Appropriated and Requested MREFC Funds for the Advanced Laser Interferometer Gravitational-wave Observatory

(Dollars in Millions)

FY 2008	FY 2009	FY 2010 Request	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	Total
$32.75	$51.43	$46.30	$23.58	$20.96	$15.17	$14.92	$205.12

Totals may not add due to rounding

Baseline History: NSF first requested FY 2008 construction funds for AdvLIGO through the MREFC account in the FY 2006 Budget Request to Congress. The original proposal received in 2003 estimated a total construction cost of $184.35 million. A baseline review in June 2006 established the project cost at $205.12 million, based upon known budget inflators at the time and a presumed start date of January 1, 2008. A second baseline review, held in June 2007, confirmed this cost, subject to changes in budget inflators. Final Design Review in November 2007 recommended that construction begin in FY 2008. The National Science Board approved the project at a cost of $205.12 million in March 2008, and the project began in April 2008.

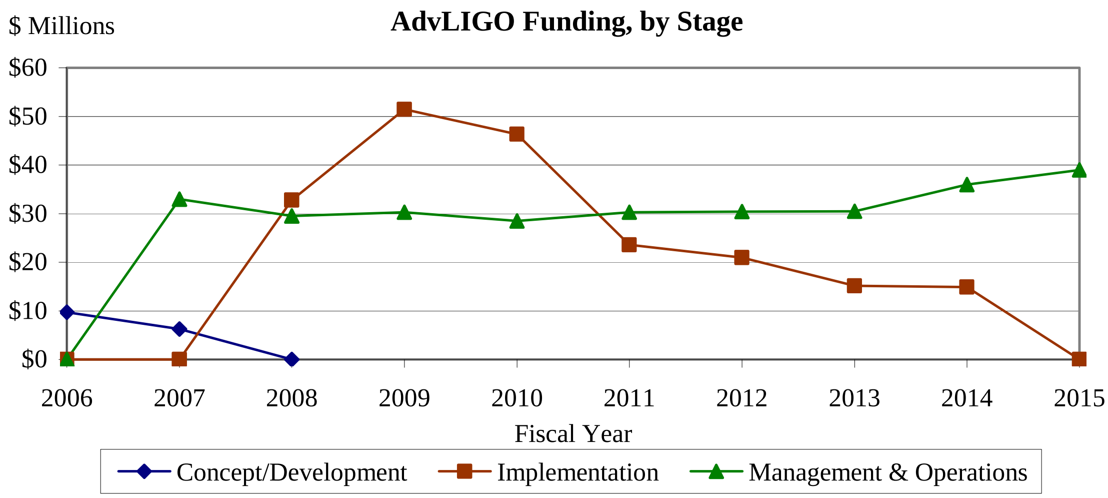
AdvLIGO is the planned upgrade of the Laser Interferometer Gravitational-Wave Observatory (LIGO) that will allow LIGO to approach the ground-based limit of gravitational-wave detection. LIGO consists of the world's most sophisticated optical interferometers, operating at two sites (Hanford, WA and Livingston, LA) 3,000 km apart. These interferometers measure changes in arm-lengths resulting from the passing wave-like distortions of spacetime called gravitational waves, caused by cataclysmic processes in the universe such as the coalescence of two black holes or neutron stars. LIGO is sensitive to changes as small as one-one thousandth the diameter of a proton over the 4-km arm-length; AdvLIGO is expected to be at least 10 times more sensitive. The LIGO program has stimulated strong interest in gravitational-wave research around the world, producing vigorous programs in other countries that provide strong competition as well as highly beneficial collaborations. LIGO has pioneered the field of gravitational-wave detection, and a timely upgrade is necessary to sustain progress in this area.

Total Obligations for AdvLIGO

(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	$40.74	-	-	-	-	-	-	-	-
Management & Operations	33.00	29.50	30.30	28.50	30.30	30.40	30.50	36.00	39.00
Subtotal, R&RA Obligations	$73.74	$29.50	$30.30	$28.50	$30.30	$30.40	$30.50	$36.00	$39.00
MREFC Obligations:									
Implementation	-	32.75	51.43	46.30	23.58	20.96	15.17	14.92	-
Subtotal, MREFC Obligations	-	$32.75	$51.43	$46.30	$23.58	$20.96	$15.17	$14.92	-
Total: AdvLIGO Obligations	**$73.74**	**$62.25**	**$81.73**	**$74.80**	**$53.88**	**$51.36**	**$45.67**	**$50.92**	**$39.00**

Totals may not add due to rounding.



Note: Management & Operations refers to the continued operations of LIGO during the construction phase and the onset of operations for the newly constructed AdvLIGO in FY 2015.

Active outreach programs have been developed at both the Livingston and Hanford sites. Teams at both sites have provided visual displays, hands-on science exhibits, and fun activities for visiting students and members of the public. In the last three years an average of over 2,000 students per year have taken advantage of this opportunity. More formal programs at the sites include participation in the Research Experiences for Teachers (RET) Program, a set of "scientist-teacher-student" research projects in support of LIGO, and participation in the Summer Undergraduates Research Fellowships/Research Experiences for Undergraduates (SURF/REU) programs for college students. Both sites have developed web-based resources for teachers that include information on research opportunities for schools and a set of standards-based classroom activities, lessons, and projects related to LIGO science. The LIGO Science Education Center at the Livingston site contains many Exploratorium exhibits and is the focal point for augmenting teacher education at Southern University and other student-teacher activities state-wide through the Louisiana Systematic Initiative Program.

Substantial connections with industry have been required for the state-of-the-art construction and measurements involved in the LIGO projects. Some have led to new products. Areas of involvement include novel techniques for fabrication of LIGO’s vacuum system, seismic isolation techniques, ultrastable laser development (new product introduced), high-power active optical components (new products introduced) development of new ultra-fine optics polishing techniques, optical inspection equipment (new product), and high-power active optical components (new products).

LIGO has extensive international ties. The LIGO Scientific Collaboration, which sets the scientific agenda for LIGO, is an open collaboration that has established formal ties with institutions from 11 foreign countries. Close collaboration is maintained with two other gravitational-wave observatories: GEO, a UK-German collaboration, and Virgo, a French-Italian collaboration. LIGO has signed an agreement with Virgo under which all data will be shared and analyzed cooperatively and all discoveries will be jointly credited. New technologies critical to AdvLIGO are being contributed by foreign institutions: the pre-stabilized laser source, funded and developed by the Max Planck Gesellschaft, and the mirror/test mass suspension systems, funded and developed by the GEO collaboration. The laser has essentially attained its design specifications; the suspension systems are being tested in European gravitational-wave facilities.

Project Report:

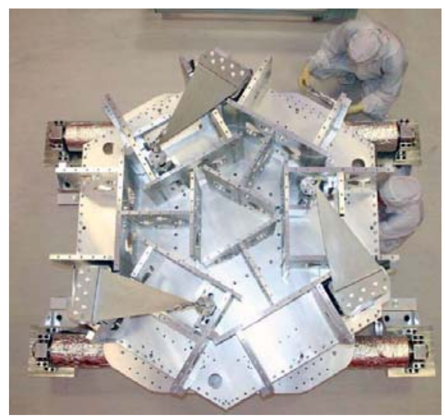
Management and Oversight:

- NSF Structure: NSF oversight is coordinated internally by a dedicated LIGO program director in the Division of Physics (PHY) in the Directorate for Mathematics and Physical Sciences (MPS), who also participates in the LIGO Advisory Team (LIGO PAT). The LIGO PAT includes staff from the Offices of Budget Finance and Award Management (BFA), General Counsel (OGC), and Legislative and Public Affairs (OLPA). Formal reporting consists of submitted quarterly and annual reports and brief monthly status reports to the LIGO program officer, who in turn reviews, edits, comments and submits the reports to the Deputy Director–Large Facility Projects. LIGO also submits periodic progress indicators within the provisions of the Government Performance and Results Act (GPRA) of 1993.

- External Structure: LIGO is managed by California Institute of Technology under a Cooperative Agreement. The project has a detailed management structure in place.

- Reviews:

  - Technical Reviews: NSF conducts annual scientific and technical reviews involving external reviewers and participates in meetings of the LIGO Scientific Collaboration (LSC) as well as making site visits to the Hanford, WA and Livingston, LA interferometers.
  - Management, Cost, and Schedule Reviews: (1) AdvLIGO construction proposal review in 2003; (2) first baseline review in June, 2006; (2) second baseline review in June, 2007; (3) final readiness review in November, 2007.
  - The first Advanced LIGO review of the active project was held in November 2008.
  - Advanced LIGO annual review in April 2009.
  - Continuing annual reviews by external panels throughout construction.



Top view of a seismic isolation system being constructed for use in Advanced LIGO. *Credit: LIGO Laboratory.*

Current Project Status:

The National Science Board approved funding for the Advanced LIGO in March 2008, and the project began in April 2008. Major initial activities include the placing of long lead-time orders and the preparation of the sites for the upgrade. The current performance is consistent with ending on budget. Total project contingency usage to date is $1.90 million of an initial $39.10 million, or 4.9 percent of contingency for 7 percent of the project completed.

Cost and Schedule:

The projected length of the project is seven years, with an 11-month schedule contingency. The risk-adjusted cost of $205.12 million includes a contingency budget of 23.7 percent.

Advanced Technology Solar Telescope $10,000,000

The FY 2010 Budget Request for the Advanced Technology Solar Telescope (ATST) is $10.0 million. FY 2010 represents the first year of a seven-year construction project. The total project cost (currently estimated at $250 to $260 million) will be finalized after a Final Design Review in May 2009.

Appropriated and Requested MREFC Funds for the Advanced Technology Solar Telescope
(Dollars in Millions)

	FY 2009	FY 2010 Request	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	FY 2016 Estimate	FY 2017 Estimate
Regular Appropriations	$7.00	$10.00	$20.00	$15.20	$8.30	$12.70	$17.00	$11.00	$8.40
ARRA Estimate	146.00	-	-	-	-	-	-	-	-
Total, ATST	**$153.00**	**$10.00**	**$20.00**	**$15.20**	**$8.30**	**$12.70**	**$17.00**	**$11.00**	**$8.40**

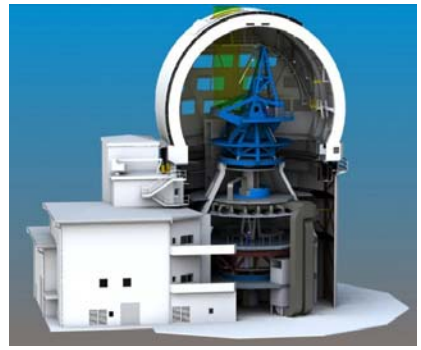
Baseline History: Beginning in 2001, NSF provided funds to the National Solar Observatory (NSO) for an eight-year design and development program for ATST and its initial complement of instruments through the Division of Astronomical Sciences (AST) and the Division of Atmospheric and Geospace Sciences (AGS). The current ATST design, cost, schedule, and risk were scrutinized in an NSF-conducted Preliminary Design Review (PDR) in October-November 2006. In addition to the $7.0 million provided for the ATST in FY 2009 to initiate construction through the MREFC account, NSF's FY 2009 funding includes $6.27 million provided through the Research and Related Activities (R&RA) account to support design activities to complete a construction-ready design. $3.10 million of these funds were provided through the American Recovery and Reinvestment Act of 2009 (ARRA) and will be used for risk reduction, prototyping, and design feasibility and for cost analyses in areas identified at preliminary and systems design reviews. The funds will also support several new positions to complete preparation for the start of construction. Funding of $146.0 million is also provided in FY 2009 through ARRA via the MREFC account to initiate construction, which will commence in FY 2010 contingent on approval of the NSF Director and the National Science Board in late summer 2009. The project will hold a Final Design Review (FDR) in May 2009, at which time a baseline "not-to-exceed" cost and schedule will be established. Requirements for environmental and cultural compliance should be completed by the end of FY 2009.

Total Obligations for ATST
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	$14.40	$2.44	$3.17	-	-				
Management and Operations	-	-	-	-	-				
ARRA Estimate			3.10	-	-				
Subtotal, R&RA Obligations	$14.40	$2.44	$6.27	-	-	-	-	-	-
MREFC Obligations:									
Implementation	-	-	7.00	10.00	20.00	15.20	8.30	12.70	17.00
ARRA Estimate	-	-	146.00	-	-				
Subtotal, MREFC Obligations	-	-	$153.00	$10.00	$20.00	$15.20	$8.30	$12.70	$17.00
Total: ATST Obligations	**$14.40**	**$2.44**	**$159.27**	**$10.00**	**$20.00**	**$15.20**	**$8.30**	**$12.70**	**$17.00**

Totals may not add due to rounding.

ATST will enable the study of magneto-hydrodynamic phenomena in the solar photosphere, chromosphere, and corona. Determining the role of magnetic fields in the outer regions of the Sun is crucial to understanding the solar dynamo, solar variability, and solar activity, including flares and mass ejections which can affect civil life on Earth and may have impact on the terrestrial climate.



Cutaway view of the ATST Facility.
Credit: National Solar Observatory.

The ATST project is a collaboration of scientists and engineers at more than 20 U.S. and international organizations. Potential additional partners include the Air Force Office of Scientific Research and international agencies and groups in Germany, the United Kingdom, Spain, and Italy.

Project Report

<u>Management and Oversight</u>

- NSF Structure: Oversight from NSF is handled by a program manager in the AST Division in MPS working with staff from the Offices of Budget, Finance and Award Management (BFA), General Counsel, and Legislative and Public Affairs, and AGS in GEO. The Deputy Director for Large Facilities in BFA also provides advice and assistance.

- External Structure: The ATST Project is managed by NSO. NSO operation and maintenance and ATST design and development are funded by NSF via a cooperative agreement with the Association of Universities for Research in Astronomy, Inc (AURA). The NSO Director serves as the Director of the ATST project; a senior NSO scientist is the Project Scientist; and an experienced full-time Project Manager coordinates the Project activities. Several councils and working groups provide input from the solar and space physics communities.

- Reviews:
    - Technical Reviews: Reviews have been conducted throughout the design and development phase. The preliminary design was found to be robust in an NSF-conducted Preliminary Design Review in October-November 2006. The Project has completed a comprehensive set of system-level design reviews for all major sub-systems.
    - Management, Cost, and Schedule Reviews: The ATST cost, schedule, and risk were scrutinized and validated at the Preliminary Design Review.
    - Upcoming Reviews: The Final Design Review will be held on May 18-21, 2009 in Tucson, Arizona.

<u>Current Project Status</u>

Current activities include finalizing the design and retiring the remaining areas of risk. The project has chosen the Haleakala High Altitude Observatory on the island of Maui as the ATST site. Preparation of the environmental impact statement is in its final stages. Consultation with Native Hawaiian stakeholders is ongoing. Application for final construction permits required for the ATST site will follow the publication of a record of decision. It is anticipated that the federal environmental and cultural compliance activities will be completed in FY 2009 and construction will begin in early FY 2010.

Costs and Schedule

The estimate of total project cost established at PDR in FY 2006 was approximately $250.0 million assuming an FY 2008 start. The baseline not-to-exceed cost will be established following the FDR. The technically-paced funding profile is front-loaded and extends for eight years. Assuming a construction start in FY 2010, operation will begin in FY 2016.

$3.10 million of ARRA funding within the R&RA Account will be used to fund the PDR and Systems Design Review committee recommended risk- reduction work, prototyping and design feasibility, and cost analyses. The completion with industry of the site architectural and engineering work and the foundation design is the highest priority item within this additional risk-reduction and vendor-contracting package. These studies drive the schedule for work on site and therefore drive the construction critical path. Other recommended work includes adaptive optics deformable mirror prototyping ($400,000) and wavefront sensor camera development ($400,000), and software and controls development. These risk-reduction efforts with industry flow directly from recommendations made by design and cost-review committees. This funding will also allow staff additions to the project team, including a contracts officer and mechanical engineer, to complete preparation and planning for construction.

$146.0 million of MREFC funding provided through the ARRA will initiate construction.

Risks

All major technical risks have been retired. Remaining technical risks will be addressed by the prototyping activities supported by ARRA funding. The remaining risk with respect to the environmental assessment is an unresolved discussion with the Federal Aviation Administration (FAA) regarding the potential obscuration of ground-air communication with commercial aircraft caused by the ATST building. Negotiations between the project, NSF, FAA, and consultants are ongoing to evaluate the impact and design mitigation systems should they be needed. A solution is anticipated by the time of publication of the final environmental impact statement this summer.

Future Operations Costs

Estimates for annual ATST operations cost are $12.0 to $14.0 million. A revised operations plan will be presented at FDR. Since ATST will become the flagship solar telescope of NSO and will render several telescopes obsolete, approximately $5.0 million per year of NSO operations cost will be recovered from the closure or divestment of redundant facilities.

Alaska Region Research Vessel $0.00

The FY 2010 Budget Request does not request funds for the Alaska Region Research Vessel (ARRV). The remaining project balance was provided through the American Recovery and Reinvestment Act of 2009 (ARRA) as shown in the table below. The estimated project cost is $199.50 million.

Appropriated and Requested MREFC Funds for the Alaska Region Research Vessel
(Dollars in Millions)

	FY 2007	FY 2008	FY 2009	FY 2010 Request	Total
Regular Appropriations	$9.43	$42.00	-	-	$51.43
ARRA Estimate	-	-	148.07	-	148.07
Total, ARRV	**$9.43**	**$42.00**	**$148.07**	**-**	**$199.50**

Totals may not add due to rounding.

Baseline History: NSF first requested construction funding for the ARRV through the MREFC account in FY 2007. The project received an initial appropriation of $9.43 million in that year followed by an additional appropriation of $42.0 million in FY 2008. In FY 2009, NSF delayed acquisition of the ARRV to incorporate updated pricing information into the construction plan. Rapid inflation in the shipbuilding industry made it difficult to accurately project the final construction cost for the ARRV. A revised project estimate was provided during the Final Design Review (FDR) held in October 2008. The new baseline incorporates an updated technical scope for the ship in order to meet current regulatory requirements, proper administrative support by the awardee, a realistic construction schedule, and independent, risk-adjusted cost estimates for construction. The final construction baseline against which progress will be monitored will be established once the construction contract is awarded to the shipyard in late FY 2009.

Total Obligations for the ARRV
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	$2.24	-	-	-					
Management and Operations	-	-	-	-	-	-	-	4.17	8.34
Subtotal, R&RA Obligations	$2.24	-	-	-	-	-	-	$4.17	$8.34
MREFC Obligations:									
Implementation	2.58	1.48	7.36	40.00	-				
ARRA Estimate	-	-	148.07	-	-				
Subtotal, MREFC Obligations	$2.58	$1.48	$155.43	$40.00	-	-	-	-	-
Total: ARRV Obligations	**$4.82**	**$1.48**	**$155.43**	**$40.00**	**-**	**-**	**-**	**$4.17**	**$8.34**

Totals may not add due to rounding.

The total estimated project cost from FDR and subsequent NSF evaluation of Panel recommendations is $199.50 million. $51.43 million was provided between FY 2007 and FY 2009; the full remaining project balance of $148.07 million was provided through the American Recovery and Reinvestment Act of 2009 (ARRA).

The ARRV will replace the R/V *Alpha Helix*, which, at 40 years of age prior to its decommissioning, was the oldest ship in the national Academic Research Fleet. Science activities in the Arctic have been limited by the capabilities of the *Alpha Helix*, which was restrictively small and could not operate in ice or in severe winter weather in the open seas. With its ice-strengthened hull, the ARRV has been designed to operate year round in the challenging waters of the Chukchi, Beaufort, and Bering Seas, as well as the open Gulf of Alaska, coastal Southeast Alaska, and Prince William Sound, including operations in seasonal ice up to 3.9 feet thick.

Satellite observations have shown that the perennial ice in the Arctic is thinning at a rate of 9 percent per decade, which is beginning to have major regional and global consequences. Research is urgently needed on topics ranging from climate change, ocean circulation, ecosystem studies, and fisheries research to natural hazards and cultural anthropology. Furthermore, the ARRV will provide a sophisticated and significantly larger platform for scientists, graduate, and undergraduate students to participate in complex multidisciplinary research activities and will enable the training of the next generation of scientists with the latest equipment and technology. Broadband satellite communications capable of relaying data, including high definition video from tools such as remotely operated vehicles that explore under the ice and the ocean depths, will bring research into the K-12 classroom and to the general public.

The construction phase of the project is being led by the University of Alaska, Fairbanks (UAF). A complete contract level design package has been completed by UAF's naval architect, The Glosten Associates, Inc. It is anticipated that the ARRV will greatly expand research capabilities in the region, going from a maximum of 160 ship operating days with the R/V *Alpha Helix*, up to 270-300 days with the ARRV. The vastly increased capability of the ARRV, both with regard to its ability to accommodate much larger interdisciplinary research teams and greatly enlarged geographical and seasonal ranges, will dramatically increase the number of proposals addressed to NSF for its utilization. Individual projects vary greatly in cost, as do the number of projects supported onboard at any given time. Assuming two simultaneous projects onboard for 3-4 weeks at a time and the average grant size in the Division of Ocean Sciences (OCE) in the Directorate for Geosciences (GEO), over $17.0 million in research would be supported annually.

This image is an artist's rendition of the ARRV, proposed to replace the R/V *Alpha Helix*, which, at 39 years is the oldest ship in the national academic research fleet.

Project Report

Management and Oversight:

- NSF Structure: NSF oversight is described in the Program's Internal Management Plan (IMP). The NSF Program Officer for Ship Acquisition and Upgrades has primary responsibility for oversight of the project and resides within the Integrative Programs Section (IPS) of the Division of Ocean Sciences (OCE), Directorate for Geosciences (GEO). Periodic oversight is provided by a Project Advisory Team (PAT) which includes staff from GEO and OPP, the Division of Acquisition and Cooperative Support (DACS), the Large Facilities Office (LFO), the Office of the General Counsel (OGC), and Office of Legislative Public Affairs (OLPA). Additional staff from IPS, the LFO, and DACS, as well as external consultants, help provide the Program Officer with routine project management and technical assistance.

- External Structure: UAF has established a project management office in Fairbanks, AK, a component of which will eventually include an on-site team that will remain in the shipyard throughout the construction process. The ARRV Oversight Committee (AOC), which includes community experts in research vessel design, construction, and operations, has been commissioned and convenes monthly to review project status and provide technical and science support advice to both UAF and NSF.

- Reviews:

  1. Final Design Review (FDR): FDR was completed in October 2008. The Panel advised that both the design and Project Execution Plan were "sound" and ready to proceed with construction. UAF presented a risk adjusted project baseline that was considered realistic based on market conditions just prior to FDR. NSF used Panel recommendations to increase confidence levels and account for recent global market volatilities to arrive at the final estimated project cost of $199.50 million.
  2. Acquisition Strategy Review: NSF conducted a final review of UAF's vessel and propulsion acquisition strategies in January 2009 based on Panel comments from FDR. Final NSF guidance was given to UAF and revised documents have been received and approved by NSF.
  3. Upcoming Reviews: NSF will conduct two internal reviews during Phase II to review UAF's shipyard selection process. If executed properly, NSF will provide concurrence with UAF's contractor selection prior to contract signing.

Current Project Status:

Following a successful final review of the acquisition strategies and the high likelihood of receiving funding in FY 2009, shipyard selection was authorized to begin with release of the Request for Information in early March, 2009. This will be followed quickly by a Request for Proposals (RFP) from those shipyards responding to the RFI and will culminate in a technical and financial evaluation of the shipyards. The Request for Cost Proposals will be released in July 2009.

A phased approach for project execution has been established within the cooperative agreement with UAF, where award of subsequent phases is contingent upon successful completion of the prior phases. Phase I (Project Refresh), which has primarily been an update of engineering drawings and specifications and preparing the Project Execution Plan, was awarded in FY 2007 at a cost $4.10 million, funded through the R&RA account. Phase II (Shipyard Selection) includes technical and financial evaluations, shipyard visits, and a "best value" selection process following receipt of cost proposals and will end with an award of a construction contract in late FY 2009. Phase III (Construction) is contingent upon successful completion of Phase II and will last thirty to thirty-six months. Phase IV (Transition to Operations) will include preliminary acceptance of the vessel by UAF, deep water science and ice trials, final outfitting, and transit to Alaska.

Cost and Schedule:

The total estimated project cost following FDR is approximately $199.50 million. The majority of this total is the fixed price contract with the shipyard which is estimated at $110.0 million, or 55 percent. UAF management, including purchase of propulsion units as Owner-Furnished Equipment, is $21.40 million, or 11 percent. Final outfitting, science trials, and delivery are $23.60 million, or 12 percent. Due to extreme global market volatility, the total required project contingency is $44.50 million, or 22 percent.

Construction is anticipated to take thirty to thirty six months, but the precise schedule will not be known until shipyard proposals are received. Delivery schedule will be an evaluation criteria during shipyard selection. Preliminary acceptance from the shipyard is anticipated for mid-FY 2013 followed by a year of science trials, final outfit, and transit to Alaska. The transition to operations is anticipated to take place in conjunction with a partial operating year in FY 2014 with the first full year of operations occurring in FY 2015.

Risks:

A formal risk assessment and management plan was developed by UAF in accordance with NSF guidelines and presented at FDR. Following FDR, the Risk Management Plan and Risk Register will be formally updated monthly by UAF and reviewed by NSF on a routine basis. Significant risks at this stage of the project include:

- Bid Risk: higher than anticipated shipyard bids due to market volatility and other contract requirements.
- Technical Risk: Any component of the vessel not meeting technical requirements of the specifications resulting in loss of capability or increased costs to correct after installation or delivery.
- Change Risk: shipyard contract disputes and claim potential associated with design development due to changing regulatory body requirements and owner initiated design changes.
- Schedule Risk: Extension of the construction and delivery schedule which would result in project cost increases due to inflation and UAF standing army costs.

Mitigation strategies have been employed by UAF and the risk analysis indicates that ample contingency is currently in place to handle these project risks. Bid risk will be retired in early FY 2010 following shipyard selection. Proper change and contingency management control processes are in place to facilitate the project coming on time and within budget.

Future Operations Costs:

Vessel operations will be governed by the terms of a separate cooperative agreement with UAF through the Ship Operations Program within IPS. Daily rate estimates for both the ship and technical services were provided by UAF at FDR. It is anticipated that OCE will pay for approximately 65 percent of the annual vessel operating costs ($8.40 million per year) based on historical data from other global ships within the academic research vessel fleet. 35 percent of the funding support for the ARRV will likely come from the Office of Polar Programs (OPP) and other federal agencies. In short, the ARRV will fold into an already well established framework for operating the academic research vessel fleet.

Atacama Large Millimeter Array $42,760,000

The FY 2010 Budget Request for the Atacama Large Millimeter Array (ALMA) is $42.76 million, which represents the ninth year of an eleven year project totaling an estimated $499.26 million.

Appropriated and Requested MREFC Funds for the Atacama Large Millimeter Array

(Dollars in Millions)

FY 2006[1] & Earlier	FY 2007	FY 2008	FY 2009	FY 2010 Request	FY 2011 Estimate	FY 2012 Estimate	Total
$190.97	$64.30	$102.07	$82.25	$42.76	$13.91	$3.00	$499.26

[1]An additional $31.99 million was appropriated through the MREFC account prior to FY 2005 for concept and development.

Baseline History: A $26.0 million, three-year Design and Development Phase was originally planned for a U.S.-only project, the Millimeter Array. NSF first requested funds for the design and development for this project in FY 1998. In June 1999, the U.S. entered into a partnership via a Memorandum of Understanding (MOU) with the European Southern Observatory (ESO), a consortium of European funding agencies and institutions. The MOU committed the partners to construct a 64 element array of 12 meter antennas. NSF received $26.0 million in appropriations between FY 1998 and FY 2000. Because of the expanded managerial and technical complexity of the joint U.S./ESO project, now called ALMA, an additional year of Design and Development was provided by Congress in FY 2001 at a level of $5.99 million. In FY 2002, $12.50 million was appropriated to initiate construction of ALMA; the U.S. share of the cost was estimated to be $344.0 million. The National Research Council (NRC) of Canada joined ALMA as a partner in 2003. In 2004, Japan entered under the provisions of a MOU between NSF, ESO, and the National Institute of Natural Sciences of Japan.

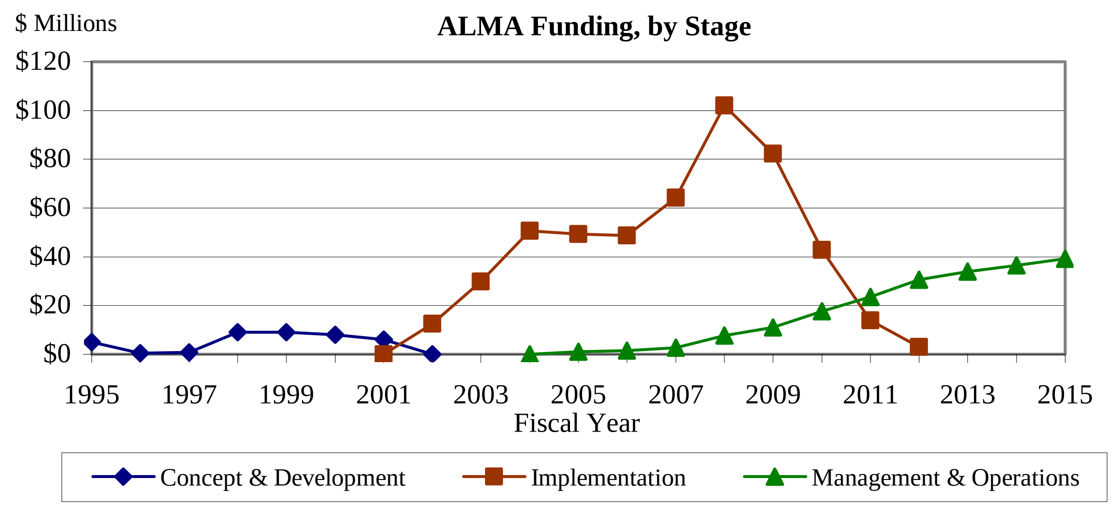
The ALMA Board initiated rebaselining in the fall of 2004 under the direction and oversight of the Joint ALMA Office (JAO) Project Manager. The project was at that point sufficiently mature that the baseline budget and schedule established in 2002, prior to the formation of the partnership, could be refined based on experience. The rebaselining process took approximately one year, scrutinizing cost and schedule throughout the project, assessing technical and managerial risk, and ultimately revising the assumptions on the scope of the project. The new baseline plan developed by the JAO assumed a 50-antenna array as opposed to the original number of 64, extended the project schedule by 24 months, and established a new U.S. total project cost of $499.26 million. The FY 2009 Request was increased by $7.50 million relative to the re-baselined profile in order to allow more strategic use of project contingency to buy down near-term risk, as recommended by the 2007 annual external review. The increase in FY 2009 was offset by a matching decrease in FY 2011.

The global ALMA project will be an aperture-synthesis radio telescope operating in the wavelength range from 3 to 0.4 mm. ALMA will be the world's most sensitive, highest resolution, millimeter-wavelength telescope, combining sub-arcsecond angular resolution with the sensitivity of a single antenna nearly 100 meters in diameter. The array will provide a testing ground for theories of planet formation, star birth and stellar evolution, galaxy formation and evolution, and the evolution of the universe itself. The interferometer is under construction at 5,000 meter altitude near San Pedro de Atacama in the Second Region of Chile, the ALMA host country.

Total Obligations for ALMA
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	6.50	-	-	-	-	-	-	-	-
Management & Operations	6.21	7.64	11.00	17.57	23.50	30.65	33.92	36.41	39.17
Subtotal, R&RA Obligations	$12.71	$7.64	$11.00	$17.57	$23.50	$30.65	$33.92	$36.41	$39.17
MREFC Obligations:									
Concept & Development	31.99	-	-	-	-	-	-	-	-
Implementation	255.27	102.07	82.25	42.76	13.91	3.00	-	-	-
Subtotal, MREFC Obligations	$287.26	$102.07	$82.25	$42.76	$13.91	$3.00	-	-	-
Total: ALMA Obligations	**$299.97**	**$109.71**	**$93.25**	**$60.33**	**$37.41**	**$33.65**	**$33.92**	**$36.41**	**$39.17**

Totals may not add due to rounding.



Once completed, ALMA will function as the most capable imaging radio telescope ever built and will bring to millimeter and submillimeter astronomy the high-resolution aperture synthesis techniques of radio astronomy. ALMA will image at 1 millimeter wavelength with the same 0.1 arcsecond resolution achieved by the Hubble Space Telescope at visible wavelengths, and will form a critical complement to the leading-edge optical, infrared, ultraviolet, and x-ray astronomical instruments of the twenty-first century.

ALMA will help educate and train U.S. astronomy and engineering students; at least 15 percent of ALMA's approximately 1,000 yearly users are expected to be students. There is already substantial involvement by graduate students in applied physics and engineering at universities participating in the ALMA Design and Development program, providing an opportunity to broaden participation in science and engineering by members of under-represented groups.

Extensive public and student ALMA outreach programs will be implemented in North America, Europe, and Chile as ALMA approaches operational status. A visitors' center will be constructed at the 2,800 meter-altitude Operations Support Facility gateway to the ALMA site near San Pedro de Atacama in northern Chile. The project also supports a fund for the Antofagasta (II) Region of Chile that is used for economic, scientific, technical, social, and cultural development, particularly within the nearby towns of San Pedro de Atacama and Toconao.

The first Vertex antenna formally accepted by the ALMA Observatory at the site in Chile. *Credit ALMA/ESO/NAOJ/NRAO*

North America and Europe are equal partners in the core ALMA instrument. Japan joined ALMA as a third major partner in 2004, and will deliver a number of enhancements to the baseline instrument. The North American side of the project, consisting of the U.S., Canada and Taiwan, is led by Associated Universities Incorporated/National Radio Astronomy Observatory (AUI/NRAO). Funding and execution of the project in Europe is carried out through the European Southern Observatory (ESO). Funding of the project in Japan is carried out through the National Institutes of Natural Sciences of Japan and project execution is the responsibility of the National Astronomical Observatory of Japan.

From an industrial perspective, ALMA instrumentation will push gallium arsenide and indium phosphide transistor amplifier technology to high frequencies, will challenge production of high-density, high-speed integrated circuits for computational uses, and is expected to stimulate commercial device and communication technologies development.

Peer-review telescope allocation committees will provide merit-based telescope time but no financial support. NSF will not provide awards targeted specifically for use of ALMA. Most U.S. users will be supported through NSF or NASA grants to pursue research programs that require use of ALMA.

Construction progress continues in FY 2009, both at the site in Chile and within the ALMA partner countries. The most significant events for the project in FY 2008 were delivery of six production antennas to Chile, delivery of the two antenna transporters and installation of the first receiver system in an antenna. In FY 2010 the first antennas will be delivered to the final, high-altitude site and science commissioning will begin. Early science operations are expected to commence in FY 2011 and completion of the construction project and the start of full science operations are planned to occur around the end of FY 2012.

Project Report:

Management and Oversight:

- NSF Structure: Programmatic management is the responsibility of the ALMA Program Manager in the Division of Astronomical Sciences (AST) in the Directorate for Mathematical and Physical Sciences (MPS). An NSF advisory group consisting of representatives from the Office of General Counsel, the Office of Budget, Finance, and Award Management, the Office of International Science and Engineering, and the Office of Legislative and Public Affairs, serves as a standing ALMA Project Advisory Team (PAT). The NSF Deputy Director for Large Facility Projects (DDLFP) is a member of the PAT and provides advice and assistance.

- External Structure: An international ALMA Management Advisory Committee (AMAC) advises AST and the ALMA Board. Management of the NRAO effort on ALMA is carried out under a cooperative agreement with AUI. Oversight of the full international project is vested in the ALMA Board, whose membership includes an NSF member; coordination and management of the merged international efforts is the responsibility of the Joint ALMA Office (JAO), whose staff includes the ALMA Director, Project Manager, and Project Engineer.

- Reviews:

  - Technical reviews: The JAO holds frequent technical and schedule reviews at appropriate design and fabrication milestones. For example, a series of reviews to assess the robustness and risks to the schedule was held in November 2008 through January 2009. Reviews of the regional centers that assemble and test receiver electronics are planned for FY 2009 and FY 2010. A function of the AMAC is to conduct project-wide external reviews and to audit internal reviews on behalf of the ALMA Board.
  - Management, Cost, and Schedule reviews: NSF, through the ALMA Board, holds external reviews of the broad Project and in targeted areas. A review of the Operations Plan was conducted in February 2007. A project-wide annual review, held in December 2008, assessed management, cost and schedule performance, status, issues, and risks. NSF also directly charges external assessments, both broad-based e.g. through its review of the performance of the managing organization (AUI), and of specific areas as warranted. For example, an external review of safety was held in October 2008. The project-wide annual reviews will continue and a science operations readiness review will be held in FY 2010.
  - Upcoming reviews: Receiver integration center operational readiness review in April 2009. Review of Chilean labor management performance in June 2009. Review of schedule and schedule drivers in July 2009. Annual External Reviews in November 2009 and late 2010. Operations review in 2010.

<u>Current Project Status:</u>

- Major project milestones attained in FY 2008 included:

  - Full acceptance and occupation of the technical building at the high-altitude site
  - Installation of the first quadrant of the digital correlator at the high site
  - Acceptance of the mid-level facilities including offices, warehouse, test and maintenance laboratories and control room
  - Delivery of the second through sixth North American antennas to Chile
  - Delivery of the two antenna transporters
  - Delivery of the first North American and East Asian receivers to Chile
  - Astronomical spectra obtained with the prototype antennas and test receivers at the antenna test facility in Socorro, New Mexico

- Major milestones for FY 2009 are expected to include:

  - Acceptance of the first North American and Japanese antennas
  - Continued delivery of North American antennas at a rate of one every two months.
  - Delivery of the first three European antennas to Chile
  - Delivery of the second quadrant of the correlator
  - Delivery of the third and fourth North American and East Asian receivers
  - Test interferometry at the mid-level facility in Chile using two antennas

- Major milestones for FY 2010 are expected to include:

  - Acceptance of the first European antennas
  - Continued delivery of North American antennas at a rate of one every two months.
  - Acceptance of the eighth through fourteenth North American antennas and the remaining three Japanese antennas
  - Transport of several antennas to the final, high-altitude site in Chile (may be very end of FY 2009)
  - Start of commissioning

Cost and Schedule:

The current schedule performance is slightly behind plan due to equipment delivery delays, in particular delivery of the first antennas and receivers. Consequently, the major milestones of early-science and full-science are forecast to be delayed by six to nine months although schedule recovery is possible. Cost performance is very good at this stage in the project – cost variance is -1 percent and schedule variance is -6 percent relative to the 2005 baseline – with approximately 40 percent contingency remaining in the uncommitted budget.

Risks:

- Full handover of the first North American and Japanese antennas will enable the other delivered antennas to be tested and accepted swiftly. The schedule for production of the European antennas should begin to stabilize once the first few antennas are delivered to Chile.
- While fabrication of the individual receiver components is making good progress, their integration into complete receiver systems and subsequent testing are the pacing items for the schedule and will be one of the key challenges for the project in the coming 12 months.
- The supply of 5MW of electricity to operate the full array has not been finalized due to the unstable power economy in Chile and South America. The original plan for gas-fed generators was eliminated following the cessation of gas exports from Bolivia and Argentina. Consequently, project management is pursuing alternative options of electricity supply via a 160km-long overhead line to the nearest grid access point or multi-fuel on-site power generation.
- For operations, the principal challenge is to ramp-up the staffing to 200 technically qualified personnel over the next two years.

Future Operations Costs:

Operations and maintenance funds phase in as initial site construction is completed and antennas begin to be delivered. Funds will be used to manage and support site and instrument maintenance, array operations in Chile, early science (FY 2011) and eventually full science operations, and in support of ALMA observations by the U.S. science community. Full ALMA science operations are anticipated to begin around the end of FY 2012. An Operations Plan and a proposal for North American operations were externally reviewed in FY 2007 and a funding profile through FY 2011 was authorized by the National Science Board in December 2007. The operations estimates for FY 2012 and beyond are based on current cost projections. The anticipated operational lifespan of this project is at least 30 years.

IceCube Neutrino Observatory $950,000

The FY 2010 Budget Request for the IceCube Neutrino Observatory is $950,000, which represents the final year of a nine-year project totaling an estimated $276.63 million. $242.07 million of the total project cost has been funded through NSF's MREFC account, and the balance of $34.56 million has been provided by foreign partners in the project.

Appropriated and Requested MREFC Funds for the IceCube Neutrino Observatory
(Dollars in Millions)

FY 2004 & Earlier	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010 Request	Total
$81.29	$47.62	$49.85	$28.65	$22.38	$11.33	$0.95	$242.07

Total may not add due to rounding.

Baseline History: Congress provided an initial appropriation for IceCube of $15.0 million in FY 2002 and $24.54 in FY 2003 for "Start-up Activities", including development of an Enhanced Hot Water Drill. NSF requested construction funding for IceCube in the FY 2004 Budget Request, and the total cost of the project (including start-up activities) was estimated to be $271.77 million at that time ($242.07 from NSF and the balance from the international partners). NSF carried out a comprehensive external baseline review of the entire project, including cost, schedule, technical and management review, in February 2004; this rebaselining effort confirmed the U.S. total project cost of $242.07 million.

The total project cost is now $276.63 million, $4.86 million more than the initial estimate. This change is due to an increase in the value of the contributions made by foreign partners, which is now at $34.56 million. NSF's cost, however, remains constant at $242.07 million.

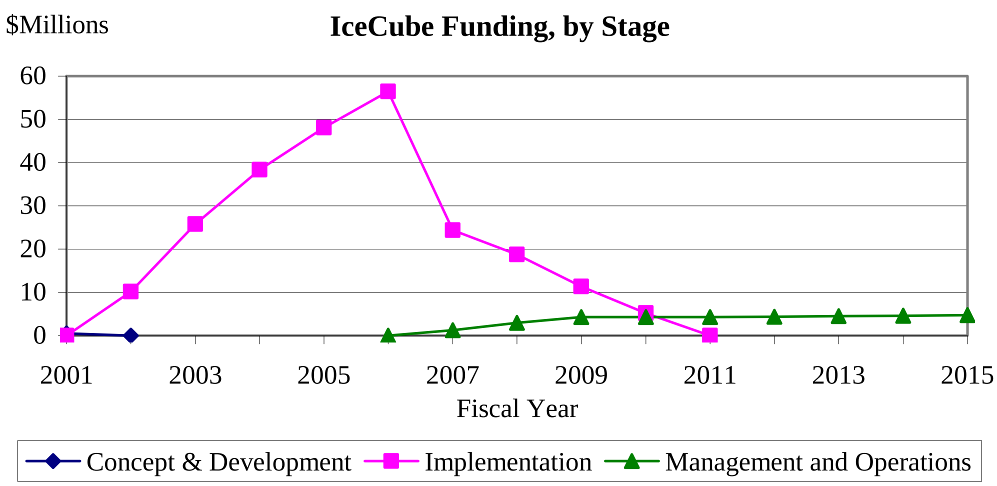
IceCube is the world's first high-energy neutrino observatory, located deep within the ice cap under the South Pole in Antarctica. It represents a new window on the universe, providing unique data on the engines that power active galactic nuclei, the origin of high energy cosmic rays, the nature of gamma ray bursters, the activities surrounding supermassive black holes, and other violent and energetic astrophysical processes. Approximately one cubic kilometer of ice is being instrumented with photomultiplier (PM) tubes to detect neutrino-induced, charged reaction products produced when a high energy neutrino interacts in the ice within or near the cubic kilometer fiducial volume. An array of Digital Optical Modules (DOMs), each containing a PM and associated electronics, will be distributed uniformly from 1.5 km to 2.5 km beneath the surface of the South Pole ice cap, a depth where the ice is highly transparent and bubble-free. When completed, IceCube will record the energy and arrival direction of high-energy neutrinos ranging in energy from 100 GeV (10^{11} electron Volts [eV]) to 10 PeV (10^{16} eV).

IceCube post-doctoral researcher Dr. Ryan Bay of UC-Berkeley takes a depth measurement during deployment of an IceCube string of digital optical modules. *Credit: John Jacobsen, University of Wisconsin-Madison, 2009*

Total Obligations for IceCube
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	$0.50	-	-	-					
Operations & Maintenance (OPP)	1.00	1.50	2.15	2.15	2.15	2.20	2.25	2.30	2.35
Operations & Maintenance (PHY)	0.25	1.50	2.15	2.15	2.15	2.20	2.25	2.30	2.35
Subtotal, R&RA Obligations	$1.75	$3.00	$4.30	$4.30	$4.30	$4.40	$4.50	$4.60	$4.71
MREFC Obligations:									
Implementation	203.16	18.74	11.33	5.20	-				
Subtotal, MREFC Obligations	$203.16	$18.74	$11.33	$5.20	-	-	-	-	-
Total: IceCube Obligations	**$204.91**	**$21.74**	**$15.63**	**$9.50**	**$4.30**	**$4.40**	**$4.50**	**$4.60**	**$4.71**

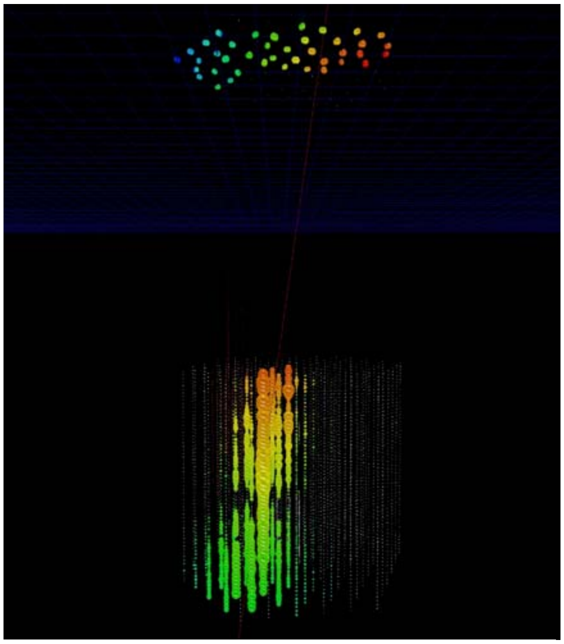
Totals may not add due to rounding.



The principal tasks in the IceCube project are: production of the needed DOMs and associated electronics and cables; production of an enhanced hot water drill and a DOM deployment system capable of drilling holes for and deploying DOM strings in the ice at the Pole; refurbishment and outfitting of the IceCube Laboratory (ICL) at the South Pole; the actual drilling of the deep-ice holes, deployment of the needed DOMs, and their commissioning and verification; installation of a surface array of air shower detectors ('IceTop') to both calibrate and eliminate background events from the IceCube DOM array; construction of data acquisition, handling, archiving, and analysis systems; and associated personnel and logistics support.

IceCube construction is being carried out by the IceCube Collaboration, led by the University of Wisconsin (UW). The IceCube Collaboration consists of 12 U.S. institutions and institutions in three other countries: Belgium, Germany, and Sweden. NSF's foreign partners are contributing approximately $34.56 million to the project, as well as a pro rata share of IceCube Operations & Maintenance costs based on the number of PhD-level researchers involved. NSF's share of the Operations & Maintenance costs is estimated at approximately $4.30 million. The Department of Energy, through its Lawrence Berkeley National Laboratory, is also participating.

NSF will support activities at U.S. institutions working on more refined and specific data analyses, data interpretation (theory support), and instrumentation upgrades through ongoing research programs. The annual support for these research activities will be provided through the R&RA account and is currently estimated at approximately $4.0 million once the facility reaches full operation.



High-energy muons in showers can penetrate deep into the ice, passing through both IceTop and the deep detectors of IceCube. The picture here shows the reconstruction of such a coincident event. Two color time intervals are illustrated, one for the surface array and one for the deep ice detectors. *Credit: IceCube Collaboratory*

IceCube provides a vehicle for helping to achieve national and NSF education and outreach goals. Specific outcomes include the education and training of next-generation leaders in astrophysics, including undergraduate students, graduate students, and postdoctoral research associates; K-12 teacher scientific/professional development, including development of new inquiry-based learning materials and using the South Pole environment to convey the excitement of astrophysics, and science generally, to K-12 students; increased diversity in science through partnerships with minority institutions; and enhanced public understanding of science through broadcast media and museum exhibits (such as the Adler Planetarium) based on IceCube science and the South Pole environment. Education and outreach activities so far have been supported principally by participating institutions, leveraged by the IceCube construction and research activities. NSF expects to support education and outreach under separate R&RA grants to universities and other organizations that are selected following standard NSF merit review.

Project Report:

Management and Oversight:

- NSF Structure: Oversight responsibility for IceCube construction is the responsibility of OPP, and a project coordinator manages and oversees the NSF award. Support for operations, research, education, and outreach will be shared by OPP and MPS as well as other organizations and international partners. Besides annual progress reviews and other specialized reviews (e.g., a safety review), the project provides monthly progress reports and quarterly reports. NSF conducts site visits, weekly teleconferences with the project managers, and internal NSF project oversight and management meetings.

- External Structure: The UW management structure for the IceCube project includes leadership by a project director and a project manager. At lower levels, project management includes international participation as well as participation by staff at collaborating U.S. institutions. This framework was put in place during the start-up phase of IceCube and provided a sound basis for initiation of full construction with FY 2004 funding as soon as the project was baselined. UW has in place an external Scientific Advisory Committee, an external Project Advisory Panel, and a high-level Board of Directors (including the UW Chancellor) providing awardee-level oversight of the project.

- Reviews: NSF carried out a comprehensive external baseline review of the entire project (including cost, schedule, technical, and management) in February 2004. There was a follow-up external cost review in Fall 2004. Comprehensive external reviews are held each spring following the annual deployment season; such reviews were held in May of 2005, 2006, 2007, and 2008. The next review is scheduled for May 2009.

Current Project Status:

- In FY 2008, the high end of the season's goal of deploying 14-18 new DOM strings was met with deployment of the 18th string, bringing the total number of operational strings to 40 – half of the 80 originally envisioned for the project. In FY 2009, the project exceeded planning goals by successfully installing 19 additional strings, including one "deep ice" prototype string. This string is at the same depth as other strings in the array, but the DOMs are concentrated lower on the string, allowing measurements to lower energy. If this string performs as expected, the project may seek to similarly situate five of the remaining strings.

Cost and Schedule:

- IceCube is 88.9 percent complete in terms of earned value, well within the originally proposed budget and approximately on schedule. Contingency is $7.80 million, or approximately 26.3 percent of the value of the remaining work. Contingency continues to be carefully managed to ensure the successful completion of the project.

- Projected out-year milestones (FY 2010-2011) are based on current project planning and represent a general outline of anticipated activities. These activities are also dependent on weather conditions and the Antarctic logistics schedule. These include:
  - Continue DOM and IceTop module production and testing, and continue to drill, deploy, test, and commission strings (up to 21 more strings) and the corresponding IceTop modules, including installation and testing of the associated data acquisition (DAQ) elements; and,
  - Ramp up to full operation and scientific exploitation of IceCube in FY 2011.

Risks:

- The enhanced hot water drill used to melt the 2.5 km water columns, into which the strings of DOMs are deployed, continues to perform well, with fuel efficiency better than planned and with a penetration rate that meets specifications. Of the DOMs deployed thus far, 98.5 percent are now working at or better than design specifications. Based on performance thus far, a mean-time-to-failure analysis predicts a survival fraction of just over 97 percent after 15 years, better than the original 95 percent reliability specification for the project and slightly higher than the assessment a year ago. Installation of the IceTop surface array is proceeding according to schedule, with elements deployed on the surface at each string location. DOM production and cold-testing facilities in the U.S. and Europe continue to work with high efficiency, producing reliable DOMs that continue to meet or exceed requirements.

- Based on the above achievements, the project has retired major technical risks. A key factor to the success of IceCube, and a remaining risk, is the logistics support chain required to transport all material and personnel to the South Pole, and this, too, continues to perform at a very high level.

Future Operations Costs:

Operations and maintenance in support of scientific research began in FY 2007, and will ramp up in subsequent years to full science operations in FY 2011 following completion of drilling and DOM deployment in that year. The associated costs are and will continue to be shared by the partner funding agencies – U.S. (NSF) and non-U.S. – on a pro rata basis according to the number of PhD researchers involved (currently about 55:45). In FY 2010, the U.S. share of operations and maintenance is $4.30 million.

The annual cost of the data analysis that will be carried out by the collaborating U.S. and foreign institutions is estimated at $8.0 million, of which $4.0 million will come from NSF for the U.S. groups, and which is outside of support for operations and maintenance (e.g., the data acquisition and data handling systems, data quality monitoring, information technology (IT) upgrades).

The general operations of South Pole Station, reported in a separate section, also contribute to supporting IceCube. The cost of IceCube operations shown in the table herein includes only those that are project-specific and incremental to general South Pole Station operations. Progress in IceCube operations will be reviewed annually, as it is for the MREFC construction project. The expected operational lifespan of this project is 25 years beginning FY 2011.

The National Ecological Observatory Network $0.00

The FY 2010 Budget Request does not request MREFC funds for the construction of the National Ecological Observatory Network (NEON).

Appropriated and Requested MREFC Funds for the National Ecological Observatory Network
(Dollars in Millions)

	FY 2007	FY 2008	FY 2009	FY 2010 Request	Total
Regular Appropriations	$4.00	$3.00	-	-	$7.00
Rescission[1]	-$4.00	-	-	-	-$4.00
ARRA	-	-	-	-	-
Total, NEON	**-**	**$3.00**	**-**	**-**	**$3.00**

[1/] $4.0 million of the FY 2007 appropriated funds for NEON were rescinded per PL 110-161.

Baseline History: In 2004 the National Research Council (NRC) evaluated the original NEON design of loosely confederated observatories and recommended that it be reshaped into a single integrated platform for regional to continental scale ecological research. Congress appropriated MREFC funding for NEON in FY 2007 and FY 2008. Project planning will continue through FY 2010; a Preliminary Design Review (PDR) is expected in June 2009 and Final Design Review (FDR) in early FY 2010. Confirmed baseline estimates for construction are anticipated during FY 2010. A formal baseline review will occur in FY 2010 as part of a Final Design Review (FDR). Assuming a successful FDR, NSF will request additional MREFC construction funding for NEON in a future budget submission.

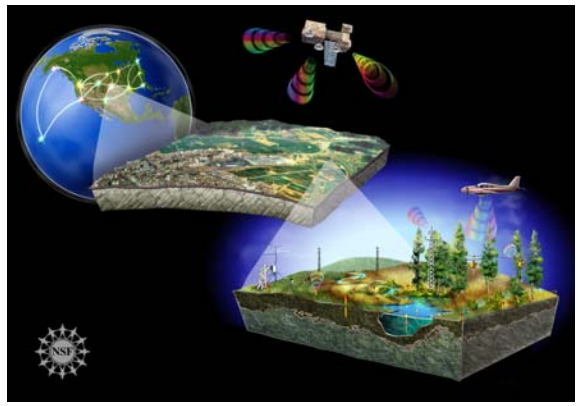
NEON would consist of geographically distributed field and lab infrastructure networked via cybertechnology into an integrated research platform for regional to continental scale ecological research. Cutting-edge sensor networks, instrumentation, experimental infrastructure, natural history archive facilities, and remote sensing would be linked via the internet to computational, analytical, and modeling capabilities to create NEON's integrated infrastructure.

Total Obligations for NEON
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES				
					FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	$17.75	$13.83	$13.30	$13.50	$13.73	$7.00	$3.00	-	-
Management and Operations	-	-	-	-	-				
Subtotal, R&RA Obligations	$17.75	$13.83	$13.30	$13.50	$13.73	$7.00	$3.00	-	-
MREFC Obligations:									
Implementation	-	-	-	-					
Subtotal, MREFC Obligations	-	-	-	-	-	-	-	-	-
Total: NEON Obligations	**$17.75**	**$13.83**	**$13.30**	**$13.50**	**$13.73**	**$7.00**	**$3.00**	**-**	**-**

Totals may not add due to rounding.

Since NSF supports 63 percent of the fundamental environmental biology research at U.S. academic institutions, advances in the field of ecology and the infrastructure to enable those advances depend largely on support from NSF. Current research infrastructure is inadequate to enable studies to address the complex phenomena driving ecological change in real time and at the scales appropriate for studying many grand challenge questions in ecology. As a continent-wide research instrument, NEON will support a large and diverse group of organizations and individuals; foremost are the scientists, educators, and engineers who will use NEON infrastructure in their research and educational programs. A NEON cyberinfrastructure gateway will provide resources to support formal and informal public education and provide opportunities for citizens to participate in scientific investigations. Data from standard measurements made using NEON will be publicly available.



NEON will be a collaborative research platform of geographically distributed infrastructure connected via the latest information technology. By combining in-situ sensing with remote sensing observations, NEON will address pressing environmental questions on regional to continental scales. *Credit: NSF.*

Coordination with other federal agencies occurs through the NEON Federal Agency Coordinating Committee. A Memorandum of Understanding (MOU) between NSF and the U.S. Geological Survey (USGS) will facilitate the sharing of satellite remotely sensed data, in-situ verification, and archival storage of NEON aerial remote sensing data by USGS. NEON infrastructure deployment sites are located on USDA Forest Service, USDA Agricultural Research Site, Bureau of Land Management, and National Park Service lands. These agencies are cooperating agencies on the NSF (Lead Agency) environmental assessment. Discussions about collaboration have also taken place between NSF and several other federal agencies, including: Department of Energy (DOE), National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA). In addition, the Jet Propulsion Laboratory (JPL) is designing the hyperspectral sensor for the NEON airborne observation platform.

Private organizations, e.g., the Heinz Center, Nature Serve, and the Science and Engineering Alliance, participated in the NEON design and development activities. While the bulk of NEON's infrastructure and instrumentation will be "commercial off the shelf", NEON's scientific and networking design requires certain technological innovations. Consequently, BIO is providing funds for advanced R&D activities in the areas of sensors and cyberinfrastructure.

Project Report:

Management and Oversight:

- NSF Structure: The NEON Program is managed in the Office of the Assistant Director (OAD) as part of Emerging Frontiers. OAD/BIO provides overall policy guidance and oversight, and the location of the NEON program in Emerging Frontiers fosters its interdisciplinary science connections. The NEON program is managed by a dedicated program officer. A business oversight team chaired by the NEON program officer advises and assists with the business framework of the project. A BIO-NEON committee, which includes the Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management (BFA), and a cross-NSF Program Advisory Team (PAT) formulates program planning for NEON. The NEON program officer is the COTR for the NEON environmental assessment and is assisted by the NEON Environmental Assessment Team (EA) that provides technical advice on environmental assessment, NEPA compliance, and NSF environmental policy.

- External Structure: The NEON Project is funded through cooperative agreements with NEON, Inc. The NEON, Inc.'s CEO provides overall leadership and management. A project manager at NEON, Inc. oversees all aspects of the project design, review, construction, and deployment. The NEON, Inc.'s director of computing is responsible for oversight of the cyberinfrastructure and embedded sensor development. The NEON, Inc. Board of Directors, a Science, Technology, and Education Advisory Committee (STEAC) and a Program Advisory Committee (PAC), composed of members of the NEON user community, help ensure that NEON will enable frontier research and education.

- Reviews:

  - Technical reviews: The NEON Observatory Design (including site selection and deployment design) Review was successfully completed in February 2009.
  - Management, Cost, and Schedule reviews:
    - The Conceptual Design Review (CDR) was held in November 2006.
    - A combined PDR/ FDR of the airborne observation platform was successfully completed in February 2009.
    - A PDR for entire project will be held in June 2009.
    - An FDR is scheduled for the first quarter of FY 2010.

<u>Current Project Status:</u>

The NEON, Inc. Project Office is currently completing the final design, NEON project execution plan (PEP), and maintenance and operations plan. The site selection and associated deployment plan is complete and has been merit reviewed. The NEPA environmental assessment is underway through an NSF contract with CH2 M Hill. In FY 2010 the final design and baseline, scope, schedule, and the risk-adjusted cost will be reviewed. Sufficient contingency will be built into the project design and budget to cover known risks.

<u>Cost and Schedule:</u>

Prior to certification of construction-readiness following a final baseline review, support is requested through the R&RA account for the NEON Project Office, for the NEON, Inc. Consortium that is the implementing organization for the project, and for ongoing R&D projects. The appropriated FY 2008 MREFC funds will continue to be carried over. In FY 2010, based on the outcome of the FDR and approval of a construction award by the NSB, these MREFC funds will be used to begin construction of a Fundamental Instrumentation Unit and embedded cyberinfrastructure in one NEON domain core site. Additional MREFC construction funding will be requested in a future budget submission.

<u>Risks:</u>

- Technical: Dependence on commercial off-the-shelf technology will be mitigated by long-lead purchase orders and alternative vendors. Production quality, embedded and system-level cyberinfrastructure (CI) will be addressed by a combination of "In-house" design, commercial, contracts, and targeted research (e.g., cyber-dashboard).

- Deployment: Environmental assessment and permitting may impact schedule and costs. These risks are being addressed through the direct contracting of the environmental assessment by NSF. In addition two national firms have been hired by NEON, Inc. for engineering and permitting, NEON, Inc. has alternative sites if the primary sites have significant risk, the US Forest Service allocated two FTEs to assist with environmental compliance issues on Forest Service lands, and local scientists are involved in site selection and analysis.

- Remote Sensing: A potential risk is the long-term availability of satellite (e.g., LANDSAT and MODIS) borne sensors. This risk is mitigated through a partnership with the USGS EROS Data Center that has the federal responsibility for curation and management of LANDSAT and MODIS images and having alternative satellite sensor sources to purchase images (e.g., SPOT - France, AWIFS – India, Terra and Aqua - US). The proposed NEON airborne observatory platform sensor system design and aircraft availability provide technical and implementation risk. To minimize this risk the design is being developed by JPL; similar instrument packages are being prototyped by NASA and Carnegie Mellon Institute at Berkley University. The designed sensor system fits multiple aircraft, including commercial aircraft. Experienced flight design engineers from Conklin & de Decker Aviation Company are contracted by NEON, Inc. to provide the baseline operations plans, aircraft analysis, and assessment of commercial companies that could support NEON flight operations and experienced research aircraft pilots serve on the design team.

Future Operations Costs

Management and operations costs are being finalized and will be reviewed at the PDR and subsequent FDR. NEON is reliant on sensors and cyberinfrastructure that have a defined lifecycle. Operations costs include scheduled replacement and refreshing of sensor, instrumentation and cyberinfrastructure technology.

Ocean Observatories Initiative $14,280,000

The FY 2010 Budget Request for the Ocean Observatories Initiative (OOI) is $14.28 million, which is a six year construction project totaling an estimated $386.42 million.

Appropriated and Requested MREFC Funds for the Ocean Observatories Initiative
(Dollars in Millions)

	FY 2007	FY 2008	FY 2009	FY 2010 Request	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	Total
OOI Regular Appropriations and Requests	$5.12	$5.91	-	$14.28	$110.70	$82.80	$46.80	$20.00	$285.61
Rescission	-5.12								-$5.12
ARRA			105.93						$105.93
Total, OOI	-	$5.91	$105.93	$14.28	$110.70	$82.80	$46.80	$20.00	$386.42

$5.12 million of the FY 2007 appropriated funds for OOI were rescinded per PL 110-161.

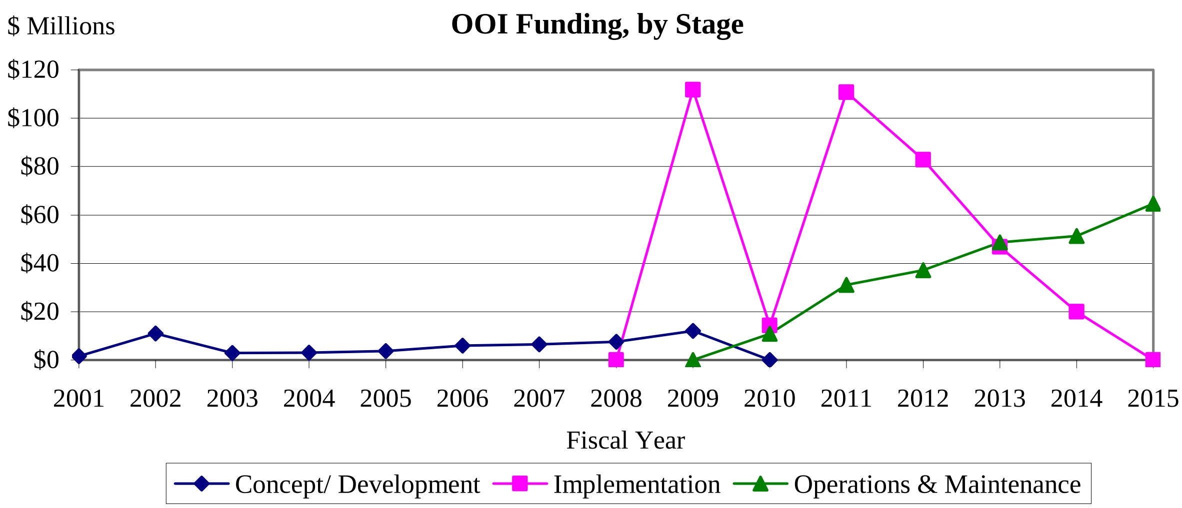
The proposed OOI will consist of an integrated observatory network that will provide the oceanographic research and education communities with continuous, interactive access to the ocean. The OOI will have three elements: 1) deep-sea buoys with designs capable of deployment in harsh environments such as the Southern Ocean; 2) regional cabled nodes on the seafloor spanning several geological and oceanographic features and processes; and 3) an expanded network of coastal observatories. A cutting edge, user-enabling cyberinfrastructure will link the three components of the OOI and facilitate experimentation using assets from the entire OOI network.

<u>Baseline History</u>: NSF first requested construction funding for OOI through the MREFC account in FY 2007 and received initial appropriations of $5.12 million in that year. The OOI has undergone a series of technical reviews, with the Final Design Review (FDR) conducted on November 6-7 and 12-14, 2008. The FDR panel determined that OOI was ready to move to construction assuming some adjustments to the baseline with respect to schedule and overall project contingency. Following the FDR, in an effort to focus OOI more specifically on high priority science issues related to climate change, ocean acidification, carbon cycling and ecosystem health, NSF initiated a rapid turn-around process to develop a modified network design in January 2009, referred to as the Variant Design. NSF convened an additional Science Review Panel and a Cost/Schedule Review Panel in March 2009 to consider the revised scope to ensure it continued to support the science goals of OOI. It is this Variant Design that is being recommended for construction. The Science Review Panel determined that the science motivating OOI continues to be important, vital, and transformative, and it supported proceeding with the Variant Design. The Cost-Schedule Panel expressed high confidence that the modified project scope, as expressed in the Variant Design, can be completed within the proposed total project cost, which includes ~30 percent contingency, and by the project completion date.

Total Obligations for OOI
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	$49.56	$7.50	$12.00	-					
Management and Operations				10.90	31.10	37.20	48.70	51.30	64.70
Subtotal, R&RA Obligations	$49.56	$7.50	$12.00	$10.90	$31.10	$37.20	$48.70	$51.30	$64.70
MREFC Obligations:									
Implementation	-	-	5.91	14.28	110.70	82.80	46.80	20.00	
ARRA	-	-	105.93	-					
Subtotal, MREFC Obligations	-	-	$111.84	$14.28	$110.70	$82.80	$46.80	$20.00	-
Total: OOI Obligations	**$49.56**	**$7.50**	**$123.84**	**$25.18**	**$141.80**	**$120.00**	**$95.50**	**$71.30**	**$64.70**

Totals may not add due to rounding.



NOTE: FY 2009 implementation funding includes $105.93 million provided through the American Recovery and Reinvestment Act.

Deployed in critical parts of the global and U.S. coastal ocean, OOI's 24/7 telepresence will capture climate, carbon, ecosystem, and geodynamic changes on the time scales on which they occur, rather than when research vessels are able to be in the area. Data streams from the air-sea interface through the water column to the seafloor will be openly available to educators and researchers in any discipline, making oceanography available to citizens and scholars who might never go to sea. Science themes for OOI include the ocean carbon cycle and its response to global change, ocean acidification, the impact of climate variability on ocean circulation, coastal ocean dynamics and ecosystem response, and the impact of tectonically driven fluid flow on the carbon cycle, deep ocean ecosystems and earthquakes.

The education and public engagement infrastructure of OOI will complement and leverage existing ocean education efforts, and build off of the cyberinfrastructure to provide an interactive digital presence to educators and the public alike. Educational links will be made with the Division of Ocean Sciences (OCE) Centers for Ocean Science Education Excellence (COSEE). In addition, with the establishment of the National Integrated Ocean Observing System (IOOS), there will be an unprecedented need for a

STEM workforce and oceanographers skilled in the use and manipulation of large, oceanographic, time-series datasets. The facilities comprising OOI will provide the ideal platforms to train this new generation of oceanographers.

Some of the component technologies that are part of OOI are currently in use or in development as part of the telecommunication and exploration industries. These groups have been engaged in drafting components of the OOI Network Design as well as in reviews of OOI planning. Industry will also be important participants in the construction and implementation phase of OOI, as well as in the future development of sensors critical to the evolution of the OOI network. Most recently, industry input has been solicited in a sensor workshop, which brought together industry representatives with the OOI Project Team to discuss OOI sensor requirements.

OOI will be coordinated with the IOOS to support operational mission objectives of agencies such as the National Oceanic and Atmospheric Administration (NOAA), the U.S. Navy, the National Aeronautics and Space Administration (NASA), and the U.S. Coast Guard.

Science proposals using the OOI network will be solicited as part of the normal competition for funds in OCE. The research envisioned for OOI encompasses a broad range of disciplines, and therefore no special research program will be established. Instead, proposals will be reviewed and competed with other research proposals submitted to OCE.

Project Report:

<u>Management and oversight:</u>

- NSF Structure: The project is managed and overseen by a Program Manager in OCE in the Directorate for Geosciences (GEO). The Program Manager receives advice and oversight support from an NSF Project Advisory Team (PAT) that includes representatives from GEO, the Directorates for Biological Sciences (BIO) and Engineering (ENG); the Office of Budget, Finance and Award Management (BFA); the Office of International Science and Engineering (OISE); the Office of General Counsel (OGC); and the Office of Legislative and Public Affairs (OLPA). The Deputy Director for Large Facility Projects (DDLFP) in BFA is also a member of the PAT and provides advice and assistance.

- External Structure: For the construction phase of OOI, management, coordination, and oversight of OOI is the responsibility of the OOI Project Director operating from the Ocean Observatory Project Office (systems integrator) at the Consortium for Ocean Leadership (Ocean Leadership), established through a cooperative agreement with NSF in 2004. This Project Director is accountable to NSF, the Ocean Leadership Board of Trustees, and an external scientific and technical advisory committee. The OOI Project Advisory Committee membership is drawn from individuals with expertise in ocean observing science and engineering. Subawards have been issued by Ocean Leadership to establish three Implementing Organizations (IOs). These IOs provide the detailed management and oversight for implementation of the regional cabled observatory (led by the University of Washington), cyberinfrastructure (led by the University of California-San Diego/Scripps Institute of Oceanography), and coastal/global observatories (led by Woods Hole Oceanographic Institution). These IOs report directly to the Project Office, which ensures cooperation and coordination between the IOs.

- Reviews:

  - Technical reviews: NSF organized a series of external science reviews for OOI, including the Blue Ribbon Review in July 2006, which assessed whether the ocean observing network proposed in the OOI Conceptual Network Design (CND) would provide the capabilities for the ocean researchers to answer high priority science questions that require *in situ*, real-time measurements across the three scales of OOI. A second Blue Ribbon Review in October 2007 assessed whether the OOI Preliminary Network Design provided the experimental capabilities needed to address the scientific scope outlined for OOI. These science reviews provided a general endorsement of OOI, supplemented by a series of recommendations for improvement. These reviews also served as input to the paired design reviews (Conceptual and Preliminary). NSF convened a Blue Ribbon Review in March 2009 to assess a modified OOI network design and its ability to provide transformative research capabilities for the ocean science community. This OOI Variant Design is a modification to the existing network design that more closely focuses OOI infrastructure on climate processes, carbon cycling, ocean acidification, and ecosystem health. The Blue Ribbon Review panel noted that the OOI, as described by the Variant Network Design, remains a worthy investment, providing a transformative capability for the ocean science community.

  - Management, Cost, and Schedule reviews:
    - The OOI Conceptual Design Review (CDR), held August 2006, reviewed the scope and system level implementation plans for OOI, including management plans and budgeting. It discussed whether all major risks with this project have been identified and whether appropriate initial system development specifications (performance requirements, major system components, and interfaces) have been established for each sub-element of OOI.
    - The Preliminary Design Review (PDR) in December 2007 assessed the robustness of the technical design and completeness of the budget and construction planning for the OOI. The PDR panel also reviewed progress made by the OOI Project Team on the findings of the CDR.
    - The FDR in November 2008 assessed whether OOI's project plans were fully ready for construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.
    - A Cost-Schedule Review Panel in March 2009 assessed whether the OOI Variant Design project plans were fully ready for construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.

  - Upcoming reviews:
    - Semi-annual external reviews of the OOI will be scheduled and conducted when construction begins.

<u>Current Project Status:</u>

The OOI project addressed key high priority recommendations from the FDR and is continuing planning efforts in anticipation of a 4th quarter 2009 construction start, pending NSB approval.

<u>Cost and Schedule:</u>

In FY 2009, OOI receives ARRA funding in the amount of $105.93 million to initiate construction. These funds will support a suite of efforts across the OOI project in the first two years of construction, including production engineering and prototyping of key coastal and global components (moorings, buoys, sensors), award of the primary cable contract, completion of the shore station, data sensing and acquisition digital capabilities, and instrument agent development. Initiation of such activities during FY 2009 and FY 2010 will provide risk reduction and cost savings (inflation) for the project.

Requests in FY 2010 and beyond, totaling $274.58 million, as well as funding appropriated in prior years, will enable the acquisition of OOI instruments and sensors, production of key infrastructure elements such as the coastal and open ocean moorings, and the deployment of these assets.

Risks:

- Oversight risk: The complexity of the OOI and the need for the Project Office and Implementing Organizations to coordinate and integrate construction activities and network implementation under the schedule, cost, and scope constraints of the project presents a project risk. OOI relies heavily on open lines of communication and effective cooperation between the managing entities (Project Office and IOs) and NSF. Both the PDR and the FDR panels were very supportive of the management structure. To ensure effective management and oversight, monthly and annual reports provided by the Project Office and IOs will be closely monitored by the OOI Program Manager and Contracts Officer for deviations from established baselines (using Earned Value Management) and annual site visits and reviews will be used to gain a more detailed impression of the integrative nature of the project teams. In addition, weekly teleconferences with the program staff from both the Project Office and IOs will help ensure that all groups are up to date with current activities. OOI semi-annual to annual programmatic reviews will be conducted by NSF, in addition to assessments by an external scientific oversight committee. Lastly, NSF's OOI Program Director will attend the Project Office's own internal reviews to ensure that OOI implementation is proceeding according to established principles as outlined in the Cooperative Agreement.

- Scope contingency: The Project Team has been directed to develop an appropriate level of contingency for OOI as dictated by a comprehensive (top-down and bottom-up) risk analysis. Should this contingency be exhausted, reductions in the scope of the OOI network plan will be required. These potential reductions, or scope contingency, must be implemented based on clearly articulated scientific priorities. Any changes to scope (as well as cost or schedule) will follow the OOI Change Control Process, which has a tiered evaluation process for evaluating and determining any change to the project.

- Risks Related to the OOI Cyberinfrastructure - The OOI Cyberinfrastructure will not only provide the network integration needed to achieve the scientific goals of OOI, but a robust, user-friendly cyberinfrastructure will be essential to develop a vigorous OOI user community. Ensuring the "usability" of the cyberinfrastructure was a key topic of discussion at the preliminary and final design reviews. Addressing recommendations from the FDR, the CI Implementing Organization was required by NSF to incorporate continued engagement of the user community during development and testing of the cyberinfrastructure. Additionally, continued involvement of Office of Cyberinfrastructure (OCI) Program Managers, via the PAT, and participation in reviews of the OOI network, will help mitigate risks associated with development and construction of the OOI cyberinfrastructure.

Future Operations Costs:

A steady state of $65.0 million in operations support (2015 dollars) is anticipated, and the expected operational lifespan of this project is 25 years.

Judgment Fund **$3,000,000**

Background: In 1998, a project was initiated both to modify and to upgrade and maintain three NSF-owned LC-130s to meet Air Force safety and operability standards that differ from those of the previous U.S. Navy operators. Modifications specified by the Air Force included avionics, airframe, safety, propulsion, and record data; storage and project administration costs were also included. Ski-equipped LC-130 aircraft are the backbone of the U.S. Antarctic Program's (USAP) air transport system and also support NSF's research in the Arctic. In FY 1998 $4.30 million from the Research and Related Activities (R&RA) account was provided for early engineering design, and between FY 1999 and FY 2002 $32.90 million from the Major Research Equipment and Facilities Construction (MREFC) account was expended for the modifications. The work included scheduled maintenance requirements.

Project Management: The contract for the modifications was awarded and administered by the Air Force C-130 Systems Program Office at Warner Robins Air Logistics Center (Warner Robins, GA; WRALC), which is the C-130 engineering authority for the Air Force. The solicitation also sought Programmed Depot Maintenance services in accordance with Air Force standard operating procedures. In March 1999, the Air Force awarded the contract for the work to Raytheon Services E-Systems. The contract was subsequently transferred to L-3 Communications, Inc. (L3) when it acquired Raytheon Services E-Systems.

The Warner Robins Air Logistics Center served as the procurement office with oversight and contract administration responsibilities. The contract was assigned for administration in accordance with FAR 42.202 to the Defense Contract Management Command, Dallas. NSF, responsible for the management of the USAP, served as the funding agency for the contract. To date, NSF has reimbursed WRALC for all its fees and costs relating to the performance and administration of the contract. The Defense Contracts Management Agency (DCMA) accepted the three aircraft on behalf of the Government.

Request for Equitable Adjustment: In June 2002, L3 Communications informed WRALC that it was experiencing substantial financial loss on the contract. In September 2002, L3 Communications indicated they would be submitting a request for equitable adjustment (REA) in the amount of $14.9 million. In January 2004 the contractor submitted a proposal to settle the REA in the amount of $2,999,941. In support of its proposal, the contractor submitted certified cost and pricing data for the proposed settlement amount.

Settlement Funding: In response to the contractor's settlement proposal, WRALC conducted a legal review and litigation risk assessment for the contractor's REA. It concluded that the Government was partly liable for L3 Communications' $14.9 million of uncompensated incurred costs based on the legal theories of defective specifications, mistake in bid caused by the Government providing late, defective, or unsuitable property, data and information, superior knowledge, constructive change, estoppel, detrimental reliance, and quantum meruit (i.e., "reasonable value of services"). The WRALC further concluded that the Government's litigation exposure came to about $7.5 million, including various fees and costs to litigate the matter. The WRALC recommended that the Government settle the matter for $3.0 million, as proposed by L3 Communications.

As a result of the WRALC legal review and litigation risk assessment, the Air Force and NSF discussed how the agencies would fund the costs to settle the REA submitted by L3 Communications or satisfy a judgment against the Government. Based on the facts provided by WRALC, NSF did not disagree with the Air Force's legal review and litigation risk assessment. Based on the review and assessment presented by WRALC, NSF agreed in principal that a settlement for $3.0 million in this case would best serve the interest of the Government.

In light of the Air Force's stated willingness to bear partial responsibility for the additional costs, NSF and WRALC officials, over the course of several months, endeavored to find a legal basis that would allow the Air Force to contribute funds to settle the contractor's REA. Based on an opinion issued by the Office of Legal Counsel in the Department of Justice, NSF advised the Air Force that a performing agency has the discretion to pay for actual costs, without seeking reimbursement from the ordering agency if the interagency agreement was based on authority other than the Economy Act.

On July 16, 2004, the Air Force informed NSF that under the Economy Act it was unable to use its appropriated funds to settle the REA even though NSF had relied on authorities other than the Economy Act when agreeing to fund the contract that Air Force would administer. It also notified NSF that "under the circumstances, we believe that referring the matter to the Department of Justice for an opinion would not be helpful." The Air Force did not articulate a policy, budgetary, or operational rationale for its decision.

Because the NSF lacked the necessary funding in its budget and the agencies had reached an impasse on whether the Air Force could contribute funds to the settlement, the Air Force denied the contractor's claim. L3 Communications appealed the agency's decision to the Armed Services Board of Contract Appeals (ASBCA). Pursuant to a settlement agreement, the Air Force agreed to pay the contractor $2,999,941 in return for L3 Communications agreeing to settle all present and future disputes, claims, and appeals, arising under or related to the contract. The ASBCA issued an opinion awarding the contractor $2,999,941 to be paid from the Judgment Fund, established under 31 U.S.C. § 1304.

On March 15, 2005, the Judgment Fund Branch, Department of the Treasury, requested that the NSF reimburse the Judgment Fund for the settlement amount. In response, NSF requested funds for this reimbursement in the FY 2007 Budget Request, but funding was not provided in the final appropriations action for that year (P.L. 110-5). NSF's FY 2008 Budget Request did not include a request for this activity since action on the FY 2007 Budget Request had not yet been taken by Congress at the time the FY 2008 Request was submitted.

Current Status: During FY 2008, the Financial Management Service of the Department of Treasury requested that NSF reimburse the Judgment Fund for the settlement amount. The FY 2010 Budget Request of $3.0 million funds the necessary reimbursement to the Judgment Fund.

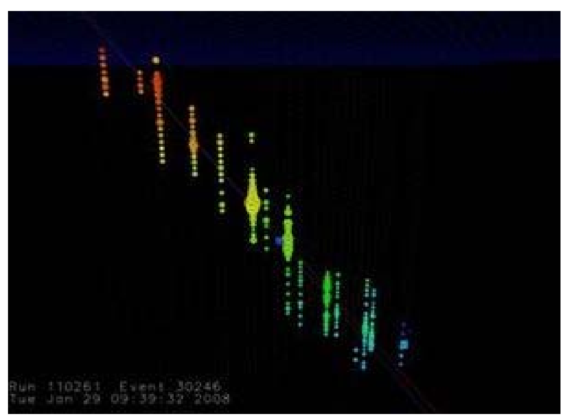
Recent Research Highlights

► **NSF Dedicates New Research Station at the South Pole:** The United States has dedicated a new scientific station at the geographic South Pole, the third since 1957, officially ushering in a new support system for sophisticated large-scale experiments in disciplines ranging from astrophysics to environmental chemistry and seismology. The elevated station is the most imposing structure ever built at the pole. The 12-year effort for planning and construction required extraordinary effort to complete in such an inhospitable environment. The project required 925 flights by ski-equipped LC-130 aircraft flown by the New York Air National Guard. At 26,000 pounds of cargo per flight, a total of 24 million pounds of cargo were transported. The elevated station consists of a series of interconnected modules mounted on steel support beams above the snow surface. The new station reasserts NSF's vital role in managing the U.S. Antarctic Program to meet the needs of the U.S. research community.

The Amundsen-Scott South Pole Station was dedicated on January 12, 2008. *Credit: National Science Foundation.*

► **Construction of the IceCube Neutrino Telescope Reaches Halfway Point:** Construction of the IceCube Neutrino Telescope by the University of Wisconsin-Madison at the U.S. Amundsen Scott South Pole Station has reached the halfway point. The telescope opens a new window for extragalactic astronomy and astrophysics, exploring a range of neutrino energies that are not available from any terrestrial source built by nuclear and particle physicists. IceCube discoveries have the potential to improve scientists' understanding of the universe's content and evolution (for instance, discovering the nature of Dark Matter). The engineering and science associated with the IceCube project represents an exciting opportunity to engage learners of all ages in the discovery process. IceCube scientists and staff eagerly shared their experiences at the South Pole Station via Web sites and blogs, in interviews with their hometown newspapers, and by visiting schoolrooms and participating in science fairs and exhibitions after the field season.

Steam rising from the IceCube heating plant. *Credit: Jim Haugen, University of Wisconsin-Madison, 2008.*



Down-going event detected on January 29, 2008, by 36 of the 40 strings of Ice Cube's in-ice Digital Optical Modules. The colors indicate the time of detection: the red indicates earlier time, the blue - later time. *Credit: Troy Straszheim and Eric Blaufuss, University of Maryland, 2008.*

► **McMurdo Station's Crary Lab and South Pole Station Exceed Energy Efficiency Guidelines:** A new ruling requires federal facilities to comply with strictly defined energy efficiency standards and exceed them by 30 percent. NSF undertook a professional assessment of its main facilities. The South Pole Elevated Station has an efficiency factor of 42 percent better than the new regulations, even in the harsh environment of Antarctica. The Cray Lab efficiency factor was computed as 3 percent better than the base requirement, impressive considering its inherently older technologies. Improvement initiatives underway are expected to boost performance up to 30 percent better than goal. Environmental stewardship is a critical goal of the U.S. Antarctic Program, and ensuring that its structures are energy efficient is critical to meeting this goal.

South Pole Elevated Station, which exceeded new federal standards for energy efficiency even in the harsh environment of Antarctica. *Credit: Jerry Marty.*

STEWARDSHIP

The NSF Strategic Plan for FY 2006-2011 defines Stewardship, the Foundation's fourth strategic goal along with the other strategic goals (Discovery, Learning, and Research Infrastructure), as supporting excellence in science and engineering research and education through a capable and responsible organization. Excellence in NSF's stewardship is essential to achieving the Foundation's mission and accomplishing its goals.

The activities that advance NSF's Stewardship goal are funded through five appropriations accounts. Additional details on each account are provided in the respective chapters.

Agency Operations and Award Management (AOAM) increases by $24.37 million, or 8.3 percent, to $318.37 million in FY 2010. These resources include funding for personnel compensation and benefits, information technology (IT) that supports administrative activities, staff travel, training, rent, and other operating expenses necessary for effective management of NSF's research and education activities.

Office of Inspector General (OIG) increases by $2.0 million, or 16.7 percent, to $14.0 million in FY 2010. These resources include funding for personnel compensation and benefits, contract audits, training and operational travel, office supplies, materials, and equipment.

National Science Board (NSB) increases $310,000 over FY 2009, or 7.7 percent, to $4.34 million in FY 2010. These resources include funding for personnel compensation and benefits, contracts, training and operational travel, office supplies, materials, and equipment.

Program Accounts - Research and Related Activities (R&RA) and **Education and Human Resources** (EHR) – Stewardship funding from program accounts increases $9.58 million, or 9.5 percent, to $110.95 million in FY 2010. Program funded Stewardship activities include Intergovernmental Personnel Act (IPA) agreements and certain Foundation-wide activities such as major studies, evaluations, outreach efforts, information technology investments that are directly related to the mission of the Foundation, and NSF contributions to interagency e-Government activities.

Stewardship by Appropriations Account

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Agency Operations and Award Management	$282.04	$294.00	-	$318.37	$24.37	8.3%
Office of Inspector General	11.83	12.00	2.00	14.00	2.00	16.7%
National Science Board	3.82	4.03	-	4.34	0.31	7.7%
Research & Related Activities	56.15	87.52	-	96.21	8.69	9.9%
Education and Human Resources	7.46	13.85	-	14.74	0.89	6.4%
Subtotal, Program Support	63.61	101.37	-	110.95	9.58	9.5%
Total	$361.31	$411.40	$2.00	$447.66	$36.26	8.8%

Totals may not add due to rounding

NSF WORKFORCE

NSF Workforce
Full-Time Equivalents (FTE)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
AOAM FTE Allocation						
Regular	*1,270*	*1,295*	-	*1,310*	*15*	*1.2%*
Student	*40*	*40*	-	*40*	-	-
Subtotal, AOAM FTE Allocation	*1,310*	*1,335*	-	*1,350*	*15*	*1.1%*
AOAM FTE Usage (Actual/Projected)						
NSF Regular	1,224	1,260	-	1,305	45	3.6%
NSF Student	32	40	-	40	-	-
Subtotal, AOAM FTE[1]	1,256	1,300	-	1,345	45	3.5%
Office of the Inspector General[2]	67	64	-	67	3	4.7%
National Science Board[3]	16	16	-	17	1	6.3%
Arctic Research Commission[4]	4	4	-	4	-	-
Total, Federal Employees	1,343	1,384	-	1,433	49	3.5%
IPAs	157	195	-	210	15	7.7%
Detailees to NSF	3	6	-	6	-	-
Contractors (est.)	609	553	-	598	45	8.1%
Total, Workforce	2,112	2,138	-	2,247	109	5.1%

[1]Additional information regarding FTEs funded through the AOAM appropriation are available in the AOAM chapter.
[2]The Office of Inspector General is described in a separate chapter and is funded through a separate appropriation.
[3]The National Science Board is described in a separate chapter and is funded through a separate appropriation.
[4]The U.S. Arctic Research Commission is described in a separate chapter and is funded through the R&RA appropriation.

In FY 2010, NSF's total federal workforce will increase by 19 FTE and 15 IPAs over the FY 2009 level. The staffing profile in the table above shows that a small but significant percentage of the NSF workforce – 195-210 people or approximately 9 percent – consists of temporary employees hired through the authority provided by the Intergovernmental Personnel Act (IPA). IPAs do not count as federal FTE. A smaller number of visiting staff – roughly 40 people annually – are employed through NSF's own Visiting Scientist, Engineer, and Educator Program (VSEE). VSEEs count as federal FTE and are included in the *Federal Employees* total (see table above). The use of IPAs and VSEEs, commonly referred to as rotators, has been a defining characteristic of NSF since its inception in 1950.

IPAs are considered federal employees for many purposes during their time at NSF, even though they remain employees of their home institutions. They are not paid directly by NSF and are not subject to federal pay benefits and limitations. NSF reimburses the home institution for the IPA's salary and benefits using the traditional grant mechanism. IPAs are also eligible to receive *per diem*, relocation expenses, and reimbursement for any income foregone because of their assignment at NSF (i.e., lost consulting fees). VSEEs, by contrast, receive a salary directly from NSF (through the AOAM appropriation), although they continue to receive benefits through their home institutions, which are reimbursed by NSF. While at NSF, rotators function in a manner virtually identical to the Foundation's permanent staff – leading the merit review process, overseeing awards, and shaping future program directions.

INFORMATION TECHNOLOGY INVESTMENTS

Information Technology (IT) Investments by Appropriation
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Agency Operations and Award Management	$43.63	$30.00	-	$30.00	-	-
Program Related Technology	16.62	52.00	-	56.00	4.00	7.7%
R&RA	*14.46*	*44.72*	-	*48.16*	*3.44*	*7.7%*
EHR	*2.16*	*7.28*	-	*7.84*	*0.56*	*7.7%*
Total	$60.25	$82.00	-	$86.00	$4.00	4.9%

Totals may not add due to rounding

Information Technology (IT) Investments by Appropriation and Activity
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Agency Operations and Award Management (AOAM)						
Administrative Applications Services and Support	$17.09	$11.39	-	$13.40	$2.01	17.6%
Associated Infrastructure Services and Support	24.72	15.98	-	13.70	-2.28	-14.3%
Security and Privacy Services and Support	1.82	2.63	-	2.90	0.27	10.3%
Subtotal, AOAM	$43.63	$30.00	-	$30.00	-	-
Program Related Technology						
Mission-Support Applications Services	12.95	34.09	-	39.13	5.04	14.8%
Associated IT Operations and Infrastructure	0.45	15.29	-	14.02	-1.27	-8.3%
Related Security and Privacy Services	3.00	2.62	-	2.85	0.23	8.8%
Other	0.22	-	-	-	-	N/A
Subtotal, Program Related Technology	$16.62	$52.00	-	$56.00	$4.00	7.7%
Total, Information Technology Investments	$60.25	$82.00	-	$86.00	$4.00	4.9%

Totals may not add due to rounding

Total funding for NSF's Information Technology (IT) investments in FY 2010 is $86.0 million, an increase of 4.9 percent over FY 2009. Of this amount, $56.0 million is for Program Related Technology (PRT) activities and is funded with direct program resources from the R&RA and EHR accounts. PRT funds IT activities that relate directly to NSF's programmatic investments, such as Research.gov, eJacket, FastLane, and Reviewer Management. The remaining $30.0 million in IT investments is funded with AOAM resources and will support routine administrative activities, such as human resources, financial statement preparation, procurement, etc. Further information on AOAM funded IT activities can be found in the Agency Operation Award Management chapter of this Request.

PROGRAM-FUNDED STEWARDSHIP

R&RA and EHR Program Support funds account for about a quarter of the total Stewardship portfolio. There are two activities that comprise Program-Funded Stewardship – IPA costs and Program Related Administration. More detailed information on these costs is shown in the tables below.

Summary of Program-Funded Stewardship
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
IPA Costs	$35.61	$41.28	-	$46.86	$5.58	13.5%
Program Related Administration	28.01	60.09	-	64.09	4.00	6.7%
Program Related Technology	*16.62*	*52.00*	-	*56.00*	*4.00*	*7.7%*
Other Program Related Administration	*11.39*	*8.09*	-	*8.09*	-	-
Total, Program Funded Stewardship	$63.62	$101.37	-	$110.95	$9.58	9.5%

Totals may not add due to rounding.

IPA Costs

The following table breaks down the IPA costs by appropriation into basic compensation, travel, and other benefits.

IPA Costs by Appropriation
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
R&RA						
IPA Compensation	$25.98	$28.69	-	$32.95	$4.26	14.8%
IPA Lost Consultant & Per Diem	3.07	3.39	-	3.90	0.51	15.0%
IPA Travel	2.72	3.01	-	3.45	0.44	14.6%
Subtotal, R&RA Costs	31.77	35.09	-	40.30	5.21	14.8%
EHR						
IPA Compensation	3.05	4.90	-	5.20	0.30	6.1%
IPA Lost Consultant & Per Diem	0.54	0.88	-	0.93	0.05	5.7%
IPA Travel	0.25	0.41	-	0.43	0.02	4.9%
Subtotal, EHR Costs	3.84	6.19	-	6.56	0.37	6.0%
Total, IPA Costs	$35.61	$41.28	-	$46.86	$5.58	13.5%

Totals may not add due to rounding.

Program Related Administration

Program Related Administration includes funding for certain Foundation-wide activities such as major studies, evaluations, outreach efforts, NSF contributions to interagency e-Government activities, and grants management applications that benefit the research community, such as a reviewer management system to more effectively plan for and find the thousands of scientific experts required to support the merit review process.

Program Related Technology (PRT) (+$4.0 million, to a total of $56.0 million.)
PRT investments support NSF program staff as they formulate and announce program opportunities; accept proposals; conduct the merit review process; make awards to fund proposals that have been judged the most promising by the rigorous and objective merit-review process; monitor program performance and results; and disseminate results of NSF funded research. Major activities funded through PRT include Research.gov, Reviewer Management, eJacket, and FastLane. In FY 2010, NSF will complete the realignment begun in FY 2009 to tie mission-related IT investments more directly to NSF's programs. The FY 2010 program-related technology request includes funding to fulfill the accountability and transparency requirements of the American Recovery and Reinvestment Act of 2009 (ARRA) and to help ensure that ARRA funds are awarded in a timely manner. The request also includes the related support services necessary to operate mission-related investments (e.g. training, customer support, maintenance, security, and privacy).

Mission-Support Applications Services (+$5.04 million, to a total of $39.13 million).

- $2.0 million to improve and add services to Research.gov based on feedback from NSF staff, the research community, and other partner research agencies. This includes adding more information and features in response to stakeholder needs and requests and to fulfill new legislative or government-wide requirements. Examples include:
  - Expand the Research Spending and Results service to provide greater transparency and more information on federally funded research.
  - Add services to support the day-to-day work of the NSF staff for the merit review process and proposal, award, post-award, and program management activities.
  - Implement new Government-wide standards for grant financial reporting and research project reports.
- $3.04 million increase for critical mission applications and services such as eJacket and other tools for program staff to manage proposal and program portfolios. This includes improving capabilities for NSF staff to perform essential business functions related to proposal and award processing and management. Examples include:
  - Provide NSF program staff with better tools to plan and manage programs such as a Research.gov Desktop.
  - Enhance proposal processing capabilities such as implementing the ability to electronically recommend proposals for awards using eJacket.
  - Improve access to proposal, award, and related information and eliminating paper by electronically archiving records.

Related Security and Privacy Services (+$230,000, to a total of $2.85 million).
Continued investment to secure mission-related applications and to protect sensitive information.

Associated IT Operations and Infrastructure (-$1.27 million, to a total of $14.02 million).
Decrease reflects anticipated cost savings realized in FY 2010 from one-time FY 2009 investments in IT operations and infrastructure that are not required in FY 2010.

Other Program Related Administration (no change to a total of ($8.09 million).

Other IT Program Related Administration includes funding for Foundation-wide activities such as major studies, evaluations, and NSF contributions to interagency e-Government activities. These activities include verification and validation of performance information; surveys of scientists, engineers, and educators who submit proposals for NSF awards; the Waterman Award which recognizes an outstanding young researcher in any field of science or engineering supported by NSF; AAAS fellowship program and internships; and external evaluations of major programs such as the Science and Technology Centers program and Major Research Instrumentation.

Mission-Critical IT-based Business Processes funded within Program Related Technology

The mission related functions and enabling technology described in this section are:

- Supporting Proposal Solicitation, Submission and Management
- Facilitating the Merit-Based Proposal Review and Evaluation Process
- Supporting Proposal Processing and Award Management
- Enabling Public Dissemination of Research Information and Results
- Enhancing Management of Program Operations

Supporting Proposal Solicitation, Submission and Management

Major Systems and Investments: FastLane, Research.gov

Capabilities and Users:

- Over 250,000 scientists, educators, technology experts, and administrators including the Nation's top researchers use FastLane to conduct business with NSF.
- Proposers use FastLane to prepare, view, modify, and submit proposals online. In FY 2008 alone, FastLane, NSF's web-based external grants management system, successfully supported the electronic submission and processing of more than 54,000 proposals.
- Research.gov provides a menu of services focused on the needs of research institutions.
  - For example, Research.gov provides the ability for Sponsored Projects Offices and Principal Investigators (PIs) to check the status of their proposals as they are received and reviewed by NSF including the history of their submissions and panel summaries and reviews (PIs only).
  - Research.gov offers a grants policy library, research news and highlights section, and access to research grant award information for NSF and NASA in one place. Research.gov is also NSF's mechanism for implementing government-wide post-award reporting requirements.
  - Most recently, NSF implemented the new Federal Financial Report enabling NSF awardees to submit grant financial reports to NSF using the new government-wide standard.
  - Additional planned capabilities for FY 2009 and FY 2010 include new tools for NSF staff to manage programs and portfolios of proposals and awards and online capabilities for awardees to submit progress/project reports.

Facilitating the Merit-Based Proposal Review and Evaluation Process

Major Systems and Investments: Reviewer management capabilities

Capabilities and Users:

- Reviewer management capabilities will enhance the Foundation's capability to support the merit review process by providing better information and tools that support each stage of the reviewer management lifecycle.

- Currently, there is limited capability to support the identification, selection, assignment, and tracking of individuals who serve as reviewers. FY 2010 funding will provide tools that enable NSF program officers to quickly find reviewers based on field of expertise and other important criteria, and easily identify potential conflicts of interest.
- These capabilities will be made available to NSF staff through Research.gov. Future reviewer management capabilities include improving reviewer capability for collaborative proposals and large interdisciplinary and cross-cutting panels; improving panel setup and coordination; streamlining travel, scheduling, and financial reimbursement; and providing a post-review collaborative environment.

Supporting Proposal Processing and Award Management

Major Systems and Investments: Research.gov, eJacket, resource management systems

Capabilities and Users:

- FY 2010 funding will support current plans to provide a new Research.gov Desktop for NSF staff. The Research.gov Desktop will offer staff additional tools to help them manage their portfolios of proposals and awards.
- In FY 2008, eJacket successfully supported 206,000 electronic reviews and 340,000 items of electronic correspondence. One of NSF's performance goals is to inform 70 percent of proposal applicants whether their proposals have been declined or recommended for funding within six months of deadline or target date or receipt date, whichever is later. In support of this goal, FY 2010 funding will enable the Foundation to fully automate the recommend phase by adding the capability to electronically recommend proposals for award using eJacket.
- FY 2010 funding will be used to plan for the modernization of NSF's financial management and property systems. NSF is currently in the planning phases of a financial management and property modernization project. The goal is to move NSF from its current and aging legacy financial, grant financial, budget formulation, and property support systems toward a consolidated and fully integrated system.

Enabling Public Dissemination of Research Information and Results

Major Systems and Investments: Research.gov, FastLane

Capabilities and Users:

- The Public Access to Research Results project directly links information on NSF-funded awards to citations of journal articles that have been published as a result of the award. These results are provided in the form of citations entered by PIs into FastLane and made available to members of the public via the Award Search feature of the NSF web site and the Research.gov web portal.
- Along with publication citations, the public can view detailed award information and award abstracts through Research.gov Research Spending and Results. NASA joined NSF in this effort so the public can now find award information for NSF and NASA in one place on Research.gov.
- FY 2010 funding will be used to enhance the Research.gov Research Spending and Results service. The goal is to fully disclose research grant award data in support of the Federal Funding Accountability and Transparency Act of 2006 and the E-Government Act of 2002 which requires federal agencies to make information accessible and searchable by the public for free. The expanded service adds information for awards made prior to the Transparency Act and includes capabilities to easily search for awards made with ARRA funding.

Enhancing Management of Program Operations

Major Systems and Investments: Program operation capabilities

Capabilities and Users:
- In FY 2010 and beyond, NSF is committed to developing comprehensive information technology systems, with an emphasis on tools for assisting personnel performing mission-support functions.
- To ensure critical mission-related processes are conducted efficiently, effectively, and with integrity; NSF seeks to design, recruit, hire, train, and retain a diverse, capable, and motivated science and engineering workforce
- NSF organizations now conduct annual workforce and staff planning efforts to align near-term workforce plans with NSF strategic objectives and to identify strategic program positions to be filled in the upcoming year. NSF staff conducts extensive outreach to the community to identify candidates for NSF program positions.

NSF's business cases can be found at: www.nsf.gov/policies/foia.jsp.

E-Government Activities

NSF is providing funding contributions in FY 2009 and FY 2010 to these E-Government Activities:

NSF FY 2009 Funding for E-Government Initiatives

	FY 2009	FY 2009		Appropriations Account		
Initiative	**Agency Contributions**	**Agency Svc. Fees**	**NSF Total**	**AOAM**	**R&RA**	**EHR**
Grants.gov	$757,094	-	**$757,094**	-	$651,101	$105,993
Grants Management LoB	174,360	-	**174,360**	-	149,950	24,410
E-Authentication	-	-	**-**	-	-	-
E-Travel	-	150,038	**150,038**	150,038	-	-
Geospatial LoB	15,000		**15,000**		12,900	2,100
E-Training	-	370,000	**370,000**	370,000	-	-
E-Rulemaking	-	5,100	**5,100**	5,100	-	-
Business Gateway	-	-	**-**	-	-	-
Recruitment One-Stop (USA Jobs)	-	4,871	**4,871**	4,871	-	-
E-HRI	-	48,724	**48,724**	48,724	-	-
Integrated Acquisition Environment	-	18,866	**18,866**	18,866	-	-
Human Resources Mgmt. LoB	65,217	-	**65,217**	-	56,087	9,130
Financial Management LoB	44,444	-	**44,444**	-	38,222	6,222
Budget Formulation/Execution LoB	95,000	-	**95,000**	-	81,700	13,300
IAE-Loans and Grants	89,973	-	**89,973**	-	77,377	12,596
E-Payroll (incl. Shared Services)	-	304,704	**304,704**	304,704	-	-
Total	$1,241,088	$902,303	**$2,143,391**	$902,303	$1,067,337	$173,751

Totals may not add due to rounding.

NSF FY 2010 Funding for E-Government Initiatives

Initiative	FY 2010 Agency Contributions	FY 2010 Agency Svc. Fees	NSF Total	Appropriations Account AOAM	R&RA	EHR
Grants.gov	$757,094	-	**$757,094**	-	$651,101	$105,993
Grants Management LoB	174,360	-	**174,360**	-	149,950	24,410
E-Travel	-	150,038	**150,038**	150,038	-	-
Geospatial LoB	15,000		**15,000**		12,900	2,100
E-Training	-	370,000	**370,000**	370,000	-	-
E-Rulemaking	-	5,100	**5,100**	5,100	-	-
Business Gateway	-	-	-	-	-	-
Recruitment One-Stop (USA Jobs)	-	4,871	**4,871**	4,871	-	-
E-HRI	-	48,724	**48,724**	48,724	-	-
Integrated Acquisition Environment	-	18,866	**18,866**	18,866	-	-
Human Resources Management LoB	65,217	-	**65,217**	-	56,087	9,130
Financial Management LoB	44,444	-	**44,444**	-	38,222	6,222
Budget Formulation/Execution LoB	95,000	-	**95,000**	-	81,700	13,300
IAE-Loans and Grants	89,973	-	**89,973**	-	77,377	12,596
E-Payroll (incl. Shared Services)	-	304,704	**304,704**	304,704	-	-
Total	$1,241,088	$902,303	**$2,143,391**	$902,303	$1,067,337	$173,751

Totals may not add due to rounding.

The total for all NSF FY 2010 inter-agency E-Government and Line of Business contributions for the initiative funding levels reported, and including any new development items, is not currently projected by the Federal CIO Council to change significantly from the FY 2009 aggregate level. Specific levels presented here are subject to change, as redistributions to meet changes in resource demands are assessed.

Benefits realized through the use of these activities are:

- *Grants.gov*

  The Grants.gov project was conceived as a single source to search and apply for funding opportunities from all Federal grant-making agencies using common forms, processes, and systems. Consistent with previous OMB guidance, the National Science Foundation (NSF) has been posting all funding opportunities and associated application packages to Grants.gov. With NSF's full implementation of Grants.gov, the research community can now find all NSF funding opportunities on Grants.gov. In addition, the community has been afforded the ability to use either Grants.gov or NSF's long-established capabilities through our FastLane web site, for proposal submission. In FY 2009, NSF published all of its funding opportunities on Grants.gov and published associated application packages for all of those opportunities. In FY 2009, NSF plans to allocate $757,094 for Grants.Gov, an increase of $239,331 over the previously planned amount of $517,763. The additional funding is to invest in increased system and customer support capacities based on the anticipated surge in funding opportunities posted, and users accessing the system resulting from ARRA funding.

- *Grants Management Line of Business (GM LoB)*

  NSF oversees active awards equaling over $5 billion annually. NSF anticipates the key benefit of GM LoB to be common place for grantees to track the status of applications, find award information, and submit grant progress and financial reports. Automated business processes available through Consortia will decrease agency reliance on manual and paper-based processing. GM LoB will lead to a reduction in the number of systems of record for grants data across NSF and the government and will foster the development of common reporting standards, improving NSF's ability to provide agency- and government-wide reports on grant activities and results.

As a GM LoB Consortium lead, NSF has developed Research.gov, a Web portal containing government-wide resources and tools for research institutions to conduct grants business with federal research agencies. Research.gov aims to ease the grants administrative burden on applicants and awardees by providing a menu of services focused on the needs of research institutions.

Research.gov provides:

- Research Spending and Results Service enabling the general public to search for detailed research grant award information including Principal Investigator, Award Abstract, and Publication Citations;
- Research Headlines and Events highlighting research activities from NSF and partner agencies;
- Policy library providing access to federal and agency-specific policies, guidelines, and procedures;
- Grants Application Status Service enabling principal investigators and sponsored project office staff to check the status of grant applications submitted to participating agencies;
- Federal Financial Report Service enabling grant recipients to complete and submit grant financial reports using the new government-wide federal financial report standard; and
- Institutions and User Management Service allowing institution administrators to add users and managed their profiles.

By leading the GM LoB Consortium, NSF will receive the following benefits:

- Avoiding costs related to developing and implementing online grants management services;
- Supporting federal agencies' efforts to promote their common research mission;
- Fulfilling federal mandates (Public Law 106-107, E-Government Act, and the Federal Funding Accountability and Transparency Act); and
- Organizing information into a single access point throughout the grants management business process.

Service to constituents will be improved through the standardization and streamlining of government-wide grants business processes. The public will receive time savings as a result of quicker notification and faster payments due to an automated system for grants processing. Furthermore, GM LoB will minimize complex and varying agency-specific requirements and increase grantee ease of use on federal grants management systems. Constituents will benefit from having fewer unique agency systems and processes to learn; grantees will benefit from ease in learning how to use the system and reduced need to rely on call center technical support.

- *Geospatial Line of Business*

  Although NSF is not currently a provider of a geospatial data, it does consider proposals for support of fundamental research that utilize or enhance the value of geospatial information. NSF recognizes the importance of the LoB in establishing a more collaborative and performance-oriented culture within the Federal geospatial arena that should optimize investments in data and technology and yield many long-term benefits to the nation.

- *Business Gateway*

  By creating a single portal for business information, such as regulatory compliance information, Business Gateway directly benefits NSF's "customers" (e.g., research firms, universities, etc.), many of whom are subject to complex regulatory requirements across multiple agencies. NSF's constituents could potentially receive significant benefits from Business Gateway including time and cost savings, assistance in compliance with the Small Business Paperwork Relief Act (SBPRA), and reduction in burden hours. Through increased outreach, more constituents will be able to realize these benefits.

NSF will also benefit in specific ways from participation in the Business Gateway activity. The web search technology on Business.gov will provide NSF with user statistics about information most sought by customers, which will enable the agency to improve the management of web content related to business compliance. By making forms available on Forms.gov, NSF saves agency time in forms management, and is expected to produce significant savings in paper and postage. Currently, NSF does not have any funding allocated as a contribution to the Business Gateway activity – the same contribution level as FY 2009. However, NSF's contribution is subject to change pending any changes in resource demands among the e-Government activities.

- *Human Resources Management Line of Business (HR LoB)*
  The HR LoB services and activities provide NSF with best-in-class HR services and systems. Through NSF's adoption of an approved service provider, the agency can achieve the benefits of advanced HR solutions without the costs of developing and maintaining its own HR systems. NSF's involvement in the HR LoB allows NSF to help shape the government-wide solution and benefit from the best practices and lessons learned as developed by the HR LoB task force and other agencies.

- *Financial Management Line of Business*
  The FM LoB uses a Shared Service Provider (SSP) to promote standard business processes and common system configurations. Reliance on SSPs helps keep capital investment and risk to a minimum. NSF's involvement with FM LoB will enable it to benefit from future system and internal control modernization efforts. In the short-term, key tools such as a Request for Proposal (RFP) framework and Service Level Agreement (SLA) guides will be provided to NSF.

- *Budget Formulation and Execution Line of Business*
  NSF has realized benefits from the BFE LoB's leadership in encouraging best practices across all aspects of federal budgeting – from budget formulation and execution to performance to collaboration to human capital needs.

  To help agencies assess, document, and communicate their budget systems requirements, BFE LoB created a decision matrix and recently evaluated nine budget systems against the matrix. This evaluation is available for all agencies to use and provides cost savings to agencies by eliminating the need for agencies to review these systems individually. NSF has used this matrix as a starting point in defining and prioritizing specific system needs.

- *Integrated Acquisition Environment- Loans and Grants*
  All agencies participating in the posting and/or awarding of Loans & Grants are required by the Federal Funding Accountability and Transparency Act (FFATA) to disclose award information on a publicly accessible website. Cross-government cooperation with OMB's Integrated Acquisition Environment activity allows NSF to meet the requirements of the FFATA by assigning a unique identifier, determining corporate hierarchy, and validating and cleaning up incorrect or incomplete data.

AGENCY OPERATIONS AND AWARD MANAGEMENT $318,370,000
+$24,370,000 / 8.3%

Summary of Agency Operations and Award Management by Function

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2010 Request	Change over FY 2009 Plan Amount	Percent
Human Capital					
Personnel Compensation & Benefits	$174.28	$191.50	$208.65	$17.15	9.0%
Management of Human Capital	9.57	10.15	12.24	2.09	20.6%
Operating Expenses	12.04	14.68	15.55	0.87	5.9%
Travel	6.62	8.49	9.00	0.51	6.0%
Subtotal, Human Capital	202.51	224.82	245.44	20.62	9.2%
Technology and Tools					
Information Technology	43.63	30.00	30.00	-	-
Space Rental	22.27	25.00	26.00	1.00	4.0%
Other Infrastructure	13.38	14.18	15.18	1.00	7.1%
Subtotal, Technology and Tools	79.28	69.18	71.18	2.00	2.9%
Future NSF HQ	-	-	1.75	1.75	N/A
Total, AOAM	$281.79	$294.00	$318.37	$24.37	8.3%

Totals may not add due to rounding.

AOAM NSF Workforce

(Full-Time Equivalent (FTE) and Other Staff)

	FY 2008 Actual	FY 2009 Current Plan	FY 2010 Request	Change over FY 2009 Plan Amount	Percent
NSF AOAM -- Regular	1,224	1,295	1,310	15	1.2%
NSF AOAM -- Student	32	40	40	-	-
Subtotal, FTE Allocation	1,256	1,335	1,350	15	1.1%
Detailees to NSF	3	6	6	-	-
Total, Workforce	1,259	1,341	1,356	15	1.1%

Appropriation Language

For agency operations and award management necessary in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875); services authorized by 5 U.S.C. 3109; hire of passenger motor vehicles; not to exceed $9,000 for official reception and representation expenses; uniforms or allowances therefore, as authorized by 5 U.S.C. 5901-5902; rental of conference rooms in the District of Columbia; and reimbursement of the Department of Homeland Security for security guard services; ~~$294,000,000.~~$318,370,000. *Provided*, That contracts may be entered into under this heading in fiscal year ~~2009~~2010 for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year.

Agency Operations and Award Management
FY 2010 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Carryover/ Recoveries	Rescission	Transfers	Expired	Total Resources	Obligations Incurred/Est.
FY 2008 Appropriation	$281.79	$0.25	-	-	-	$282.04	$282.04
FY 2009 Current Plan (CP)	294.00	-	-	-	-	294.00	294.00
FY 2010 Request	318.37	-	-	-	-	318.37	318.37
$ Change from FY 2009 CP							$24.37
% Change from FY 2009 CP							8.3%

Totals may not add due to rounding.

Summary of FY 2010 Request

Human Capital (+$20.62 million, to a total of $245.44 million).

- $208.65 million for Personnel Compensation and Benefits (PC&B), an increase of $17.15 million ($5.20 million for salary of additional FTE), which supports an increase in the usage of full-time equivalents to 1,305 regular employees, which is slightly less than the 1,310 requested allocation. The difference between the FY 2010 FTE allocation and usage is attributable to position turnover and attrition. The increase also reflects comparability and locality pay ($4.52 million) and costs related to employee benefits.
- $12.24 million for Management of Human Capital, which represents an increase of $2.09 million over the FY 2009 Current Plan. The additional funds will be used to address critical human capital needs of the Foundation such as workforce and workload analysis, recruitment, succession planning, and career development.
- $15.55 million, an increase of $870,000 in general operating expenses including costs of supplies, equipment, and other operating expenses necessary for the management of NSF's award processing. This increase will also support assistance in award oversight and monitoring, A-123 review, and the costs associated with additional staff.
- $9.0 million for travel, an increase of $510,000 over the FY 2009 Current Plan for award oversight activities, science and engineering meetings, and strategic training. The increase in the travel request reflects the Foundation's focus on oversight review.

Technology and Tools (+$2.0 million, to a total of $71.18 million).

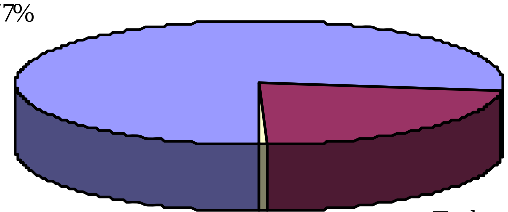
- $30.0 million for Information Technology (IT), an amount which is unchanged from the FY 2009 Current Plan. These funds will support the maintenance, operation, development and security of administrative systems, including those that support human resources, financial statement preparation, property management, and procurement. IT investments that directly support the Foundation's programmatic investments will be funded via the Program Related Technology line item discussed in the Stewardship chapter.
- $26.0 million for Space Rental, an increase of $1.0 million over the FY 2009 Current Plan. The increase is required to offset rising GSA rental costs and real estate taxes, increased utility costs, plus funding of additional leased office space that will be needed to accommodate additional staff in FY 2010.
- $15.18 million for Other Infrastructure, an increase of $1.0 million over the FY 2009 Current Plan. These funds support building maintenance and facility support, physical security, office and conference room equipment, supplies and furniture, office renovations, the transit subsidy and library resources. The additional resources are needed to renovate NSF's intranet.

Future NSF HQ (+$1.75 million, to a total of $1.75 million).

- $1.75 million to initiate a multi-year project designed to address NSF's upcoming lease expiration which occurs in 2013. Initial resources will be used to conduct a space and IT analysis, gather data and begin preliminary planning for NSF's future headquarters space design and mission requirements.

Agency Operations and Award Management – FY 2010 Request by Major Function

FY 2010 AOAM Request of $318.37 Million



NSF is committed to supporting excellence in science and engineering research and education. In order for NSF to excel, the Foundation must have strong infrastructure and management. To acknowledge this, the NSF Strategic Plan includes Stewardship as a strategic goal, on a par with NSF's program-focused goals of Discovery, Learning, and Research Infrastructure. The Strategic Plan defines Stewardship as: "support excellence in science and engineering research and education through a capable and responsive organization."

The NSF plan includes a number of long-term priorities for the Stewardship goal. These emphasize improving transparency, consistency, and uniformity of the merit review process; continued emphasis on award oversight and management, particularly for large facilities; and implementing a range of activities to maintain and strengthen relationships with the agency's key stakeholders in the research and education community.

HUMAN CAPITAL ($245.44 million)

The FY 2010 request for Human Capital totals $245.44 million, an increase of $20.62 million, or 9.2 percent, over the FY 2009 Current Plan of $294.0 million. These investments consist of four major components: Personnel Compensation and Benefits, Management of Human Capital, Operating Expenses, and Travel.

Human Capital Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Personnel Compensation & Benefits	$174.28	$191.50	$208.65	$17.15	9.0%
Management of Human Capital	9.57	10.15	12.24	2.09	20.6%
Operating Expenses	12.04	14.68	15.55	0.87	5.9%
Travel	6.62	8.49	9.00	0.51	6.0%
Total, Human Capital	$202.51	$224.82	$245.44	$20.62	9.2%

Totals may not add due to rounding.

Personnel Compensation and Benefits ($208.65 million)

Personnel Compensation & Benefits
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2010 Request	FY 2009 Plan Amount[3]	FY 2009 Plan Percent
Regular FTE Allocation	1,270	1,295	1,310	15	1.2%
Regular FTE Usage (actual/projected)	*1,224*	*1,260*	*1,305*	*45*	*3.6%*
Regular Salary					
Base Salary	$131.74	$135.27	$146.50	$11.23	8.3%
Salary Cost of Additional FTE	-	4.52	5.20	-	-
COLA & Locality Pay[1]	-	5.01	4.52	-	-
Subtotal, Regular FTE Salary	$131.74	$144.80	$156.22	$11.42	7.9%
Student FTEs	*32*	*40*	*40*	-	-
Student Salary	$1.31	$1.39	$1.45	$0.06	4.3%
Total, FTEs	*1,256*	*1,300*	*1,345*	*45*	*3.5%*
Subtotal, FTE Pay	$133.05	$146.19	$157.67	$11.48	7.9%
Benefits and Other Compensation[2]	41.23	45.31	50.98	5.67	12.5%
Total, PC&B	$174.28	$191.50	$208.65	$17.15	9.0%

[1]The pay increase includes the annualization of the FY 2009 pay raise, nine months of the projected FY 2010 pay raise, as well as anticipated within grades and promotion increases. FY 2009 has one less work day.

[2]This category includes employee benefits, detailees to NSF, terminal leave, awards, and other benefits.

[3]The increase in the FY 2010 base salary reflects the full annual cost of employees hired throughout FY 2009.

The FY 2010 request for Personnel Compensation and Benefits is $208.65 million, an increase of $17.15 million, which fully funds 1,305 FTE and includes comparability and locality pay and costs related to employee benefits.

The additional 45 FTE usage included in the Request reflects the on-going effort to hire a sufficient number of staff to meet the growing and increasingly complex workload being experienced throughout the Foundation. The additional staff will manage a growing proposal workload and award oversight and management.

Management of Human Capital ($12.24 million)

Within Management of Human Capital is a broad range of activities and fixed costs designed to facilitate the personnel, health-related, and payroll requirements of the Foundation. This includes contractor support for traditional personnel-related functions such as processing personnel actions, position classification, and staffing activities, as well as analytical support on workforce related issues; the NSF Academy which provides orientation and career development opportunities for NSF's workforce; a Health Unit that provides on-site medical assistance to NSF employees, including medical clearances for international staff travel, notably to the Antarctic; payments to the Department of the Interior and the Office of Personnel Management for centralized payroll and training initiatives, and marketing and outreach activities to facilitate recruitment.

The Human Capital Management increase will enable NSF to implement recommendations contained in the multi-year Business Analysis, promote NSF's Strategic Plan and conform to OPM Human Capital Management guidelines. The FY 2010 Management of Human Capital Request is $12.24 million, an increase of $2.09 million, or 20.6% over the FY 2009 Current Plan of $10.15 million. With these funds contractor assistance will be acquired to address critical human capital needs of the Foundation, including workforce and workload analysis, recruitment, succession planning, and career developmental opportunities for employees. In conjunction with the contractual support will be the design and implementation of integrated human capital systems that would facilitate these processes.

Specifically, the additional resources will be used for the following three contractor-led activities:

- Comprehensive workload analysis and system requirements, $450,000, will accommodate NSF's ability to measure workload needs and the appropriate staffing requirements to meet those needs. NSF will seek the workload analysis and systems design expertise to standardize workload metrics across NSF's organizations; determine workload data needs; systematically project current and future workforce requirements. Workforce analysis will be an on-going tool used collaborative by HRM and NSF managers to address current and future staffing needs based on workload and emerging priorities.

- Given the growing volume and complexity of the Foundation's workload and the rotational nature of our workforce succession planning and talent management issues must be proactively addressed. NSF is requesting $640,000 for contractor assistance, acquisition of systems to meet workforce and succession planning needs, and to ensure compliance with OPM Human Capital Management guidelines.

- Development and implementation of an NSF-wide Competency Model and Talent Management Learning Maps, $1.0 million, in conjunction with the aforementioned workforce succession planning and talent management system will identify competencies and proficiency levels associated with the various positions within the Foundation, populate database information, create recruitment tools, provide management access to centralized information for effective recruitment and staff management and staff access to information that will assist them in obtaining the competencies needed to better succeed in achieving organizational as well as personal career goals. Implementation of an NSF-wide Competency Model and Talent Management Learning Maps are consistent with OPM Human Capital Management guidelines.

Operating Expenses ($15.55 million)

Operating Expenses increase by $870,000, or 5.9 percent, to $15.55 million in FY 2010. These include direct costs of supplies, equipment, and other operating expenses necessary for the management of NSF's research and education activities. Operating Expenses also includes services for technical assistance in award oversight and monitoring, which addresses findings from recent financial statement audits.

Travel ($9.0 million)

Travel increases by $510,000, or 6.0 percent, to $9.0 million in FY 2010. These travel resources will enable NSF to increase oversight of existing awards (as recommended by the agency's Inspector General), intensify management and oversight activities, enable staff to participate in national and international science and engineering conferences and workshops, and provide access to strategic training opportunities. The majority of the increase will support travel for program management staff for oversight and training objectives.

TECHNOLOGY AND TOOLS ($71.18 million)

The FY 2010 request for Technology and Tools is $71.18 million, an increase of $2.0 million, or 2.9 percent, over the FY 2009 Current Plan of $69.18 million. These investments consist of three major components: Information Technology, Space Rental, and Other Infrastructure.

Technology and Tools Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Information Technology	$43.63	$30.00	$30.00	-	-
Space Rental	22.27	25.00	26.00	1.00	4.0%
Other Infrastructure	13.38	14.18	15.18	1.00	7.1%
Total, Technology and Tools	$79.28	$69.18	$71.18	$2.00	2.9%

Totals may not add due to rounding.

Information Technology for Agency Operations

The FY 2010 Information Technology request is $30.0 million, which is unchanged from the FY 2009 Current Plan. This level will enable the Foundation to deliver mission support administrative services and support a high quality, highly reliable, and secure infrastructure that is responsive to customer needs. Additional resources requested for Information Technology, $56.0 million in FY 2010, are discussed in the Program Related Technology (PRT) section of the Stewardship chapter.

Summary of Agency Operations Information Technology (IT)
(Dollars in Millions)

Agency Operations IT	FY 2008 Actual	FY 2009 Current Plan	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Applications Services and Support	$17.09	$11.39	$13.40	$2.01	17.6%
Associated IT Operations and Infrastructure	24.72	15.98	13.70	-2.28	-14.3%
Security and Privacy Services and Support	1.82	2.63	2.90	0.27	10.3%
Total, Information Technology	$43.63	$30.00	$30.00	-	-

Totals may not add due to rounding.

Administrative Applications Services and Support (+$2.01 million, to a total of $13.40 million).
In FY 2010, funding for these applications will increase from $11.39 million to $13.40 million. Investments in this category will be used to support and modernize administrative applications such as human resources and property tracking. Applications that directly support science and engineering, research and education activities, including Research.gov, FastLane, and eJacket will be funded by program funds, and are described within the Program Related Technology justification on page 4 of the Stewardship chapter.

FY 2010 funding will enable NSF to invest in additional components of a comprehensive Human Resource Information System, including Workforce/Succession Planning, Performance Management, and Benefits/Retirement Management. FY 2010 funding will also be used to maintain NSF's financial and accounting system and travel functions. The Financial Accounting System is used to manage funds and provides a full spectrum of financial transaction functionality and interfaces with NSF systems, including the eTravel and Learning Management Systems. NSF staff use the eTravel system to plan travel, approve travel plans, and prepare expense vouchers.

Associated IT Operations and Infrastructure (-$2.28 million, to a total of $13.70 million).
In FY 2010, support for associated IT operations and infrastructure will decrease from $15.98 million to $13.70 million. The decrease represents a shift in funding sources. IT Infrastructure services for applications that directly support science and engineering research and education activities, including Research.gov, FastLane, and eJacket will be funded from program accounts as described within the Program Related Technology justification.

FY 2010 AOAM funding along with program related technology funding for associated IT operations and support will provide basic maintenance and operations levels for ongoing operations and support new efforts essential for system modernization, such as directory services and tools to manage configuration, quality assurance, and software testing. The funding will also enable planned technical refresh projects, deploying additional system redundancy to increase operational stability, and initiatives to expand and automate support to accommodate an increasingly distributed 24x7 user community.

IT Security and Privacy ($270,000, to a total of $2.90 million).
In FY 2010, Agency Operations IT funding for IT Security and Privacy will be increased from $2.63 million to $2.9 million. This reflects the high priority the Foundation places on IT security and the continued protection of sensitive information as required by privacy policies. These investments allow NSF to acquire and maintain automated configuration management tools that manage patches and provide proactive protection from viruses, spyware, etc. In FY 2008 and FY 2009, all FastLane customers were assigned a unique NSF Identification Number to replace the Social Security Numbers (SSNs) previously used for logon. FY 2010 investments are needed to enhance the protection of applications and systems where personally identifiable information such as SSNs must be used for business purposes, per federal standards and policies. Funds will also be used for analysis and planning to support transition to a government-wide service provider for FISMA reporting.

While NSF's security program is strong, continued investment in robust solutions is needed to meet evolving and more serious threats. Critical investments are needed to support specific areas such as: network security, application security, security control testing and tools, automated vulnerability assessment tools, and remediation and intrusion detection services. NSF will fully fund security activities including risk assessments, security control testing, contingency planning, and implementing and evaluating a business continuity capability. Without this level of investment, NSF will not be able to deploy tools and practices to address emergent threats, or provide layered security capabilities needed to assure a sound security posture. Funding will also allow NSF to implement functionality to address new mandates for improved controls to assure protection of privacy and sensitive information.

Summary of Space Rental and Other Infrastructure by Function
(Dollars in Millions)

Space Rental & Other Infrastructure	FY 2008 Actual	FY 2009 Current Plan	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Space Rental	$22.27	$25.00	$26.00	$1.00	4.0%
Other Infrastructure	13.38	14.18	15.18	1.00	7.1%
- Administrative Contracts	*8.70*	*9.28*	*10.28*	*1.00*	*10.8%*
- Government Goods and Services	*3.36*	*3.60*	*3.60*	-	-
- Administrative Services Equipment & Supplies	*1.32*	*1.30*	*1.30*	-	-
Total, Space Rental & Other Infrastructure	$35.65	$39.18	$41.18	$2.00	5.1%

Space Rental (+$1.0 million, to a total of $26.0 million).

The FY 2010 request for Space Rental is $26.0 million, an increase of $1.0 million, or 4.0 percent, over the FY 2009 Current Plan. These resources will offset escalating GSA rental costs, increased real estate taxes, and rising utility costs, plus additional leased office space to accommodate the additional staff for FY 2010. The additional office space comprises roughly $600,000 of the increase and includes rent for new space as well as annualizing costs for space acquired in the previous year.

NSF currently occupies 660,000 square feet of space, almost exclusively in two adjoining, leased office buildings located in Arlington Virginia. The additional space that will be acquired in FY 2010 will be at or nearby one of these two facilities.

Other Infrastructure (+$1.0 million, to a total of $15.18 million).

In FY 2010, support for Other Infrastructure is $15.18 million which is an increase of $1.0 million, or 7.1% over the FY 2009 Current Plan.

Other Infrastructure funding supports the following major sets of activities:
Administrative Contracts will support costs for programs such as the physical security of our workplace; increased conference room, meeting and travel management support to meet increased demand for services; infrastructure maintenance and building services; improvements to the Foundation’s property and records management systems and services and the transit subsidy program.

Government Goods and Services will support expenditures for security guards and building improvements such as space updating and renovation and office space realignment and programs to support new energy efficiency programs.

Administrative Services Equipment and Supplies and Periodicals costs support a full range of office machine and office furniture purchases, upgrades and installations, as well as the yearly subscriptions to scientific and engineering databases and periodicals that support the NSF programs.

The additional $1.0 million requested for FY 2010 will be used to build a new intranet for NSF that will facilitate knowledge management and internal communication. New information architecture will be established for the site including developing a new look and feel, implementing personalization features, improving search capabilities, integration with existing NSF applications, building improved communication tools, and developing a policy repository.

FUTURE NSF HQ ($1.75 million)

Future NSF – Agency Headquarters Space Analysis and Planning

NSF's lease on its primary building expires in 2013, and a multi-year collaborative effort with GSA needs to commence immediately. The $1.75 million request will be used to establish a Project Office to manage the lease expiration and plan for the future for the Foundation. This multi-year project will begin with a thorough analysis of the current space configuration and the development of requirements for the agency for the next 15 to 20 years. Activities for FY 2010 will include developing a master project plan, resource planning, developing acquisition strategies, cost/benefit assessments, site reviews, office system research, and presentation of a housing prospectus for review by OMB for submission to Congress in the GSA Housing Portfolio.

Agency Operations and Award Management by Object Class

The following table shows the planned distribution of general operating expenses (GOE) by object class and salaries and benefits. A brief explanation of each general operating expenses category follows.

General Operating Expenses by Object Class and Salaries and Benefits

(Dollars in Thousands)

	FY 2008 Actual	FY 2009 Current Plan	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Personnel Compensation	$141,757	$154,900	$169,230	$14,330	9.3%
Personnel Benefits	33,057	36,600	39,420	2,820	7.7%
Travel and Transportation of Persons	6,616	8,490	9,000	510	6.0%
Transportation of Things	287	530	530	-	
Rental Payments to GSA	21,412	25,000	26,000	1,000	4.0%
Rent to Others	625	-	-	-	N/A
Communications, Utilities and Misc. Charges	4,899	1,589	1,589	-	-
Printing and Reproduction	175	300	300	-	-
Advisory and Assistance Services	52,433	19,512	23,982	4,470	22.9%
Other Services	8,522	9,915	11,510	1,595	16.1%
Purchases of Goods & Srvcs from Gov't. Accts	3,336	3,600	3,600	-	-
Operations and Maintenance of Equipment	34	23,888	23,868	-20	-0.1%
Supplies and Materials	3,264	4,210	4,000	-210	-5.0%
Equipment	3,799	5,466	5,341	-125	-2.3%
Other	1,574	-	-	-	N/A
Total, AOAM	$281,790	$294,000	$318,370	$24,370	8.3%

Totals may not add due to rounding.

Description of categories:

- **Personnel Compensation and Benefits** increases by $17.15 million over the FY 2009 Current Plan. Personnel compensation funds pay, awards/bonuses, details to NSF, overtime, and terminal leave. Benefits include the Government's contribution towards retirement systems, health and life insurance, thrift saving plans, special overseas allowances, and unemployment insurance.

- **Travel and Transportation of Persons** increases by $510,000 over the FY 2009 Current Plan. These resources fund travel required for planning, outreach, and increased oversight of existing awards as recommended by the agency's Inspector General.

- **Transportation of Things** consists of household moves associated with bringing new staff to NSF. Resources for this activity remain flat with the FY 2009 Current Plan.

- **Rental Payments to GSA** includes the rent charged by GSA for NSF's facility in Arlington, Virginia, and additional floors in an adjacent building. The increase of $1.0 million in FY 2010 is required to offset escalating GSA rental costs, increased real estate taxes, and rising utility costs, plus funding of additional leased office space that will be needed to accommodate additional staff for FY 2010.

- **Communications, Utilities, and Miscellaneous Charges** includes all costs for telephone lines and services, both local and long distance, and postage. These costs remain essentially constant with the FY 2009 Current Plan.

- **Printing and Reproduction** includes contract costs of composition and printing of NSF's publications, announcements, and forms, as well as printing of stationery and specialty items. These costs remain essentially constant with the FY 2009 Current Plan.

- **Advisory and Assistance Services** includes development, learning, and career enhancement opportunities offered through the NSF Academy, contracts for human capital operational activities, work life initiatives, outreach, and related services, assistance in award oversight and monitoring, A-123 review. These costs increase by $4.47 million over the FY 2009 Current Plan to pay increased fees to shared service providers, and to provide sufficient funding to meet personnel security requirements, and to cover inflationary increases.

- **Other Services** include warehousing and supply services, mail handling, proposal processing, equipment repair and maintenance, building-related costs, furniture repair, contract support for conference room services, security investigations, and miscellaneous administrative contracts. The FY 2010 Request increases by $1.60 million over the FY 2009 Current Plan to support increases in costs for programs such as enhanced physical and security access systems, and e-travel service contracts to support the government-wide travel initiative.

- **Purchases of Goods and Services from Government Accounts** includes reimbursable services purchased from GSA. These costs include security guard services, some electrical upgrades, and modest renovation services. Funds for this activity remain constant with the FY 2009 Current Plan.

- **Operations and Maintenance of Equipment** includes management and operation of the central computer facility 24x7-year round; operation of the customer service center and FastLane help desk; maintenance of database server hardware and related peripherals; software licensing fees; data communications infrastructure and network systems support; electronic mail support; and remote access (e.g., internet and World Wide Web). Costs decrease slightly in FY 2010.

- **Supplies and Materials** include office supplies, library supplies, paper and supplies for the NSF central computer facility, and miscellaneous supplies. Costs decrease $210,000 in FY 2010 to cover other priorities.

- **Equipment** costs include new and replacement computing equipment, desktop computers, data communications equipment, video-teleconferencing equipment, office furniture, file cabinets, and support equipment such as audio-visual equipment. These costs decrease by $125,000 in FY 2010, driven by the Foundation's decision to move towards off-site hosting as well as the reclassification of mission-related equipment to Program Related Information Technology.

- **Other** represents object classes erroneously recorded in FY 2008. Over $1.54 million of these obligations were administrative contracts.

NATIONAL SCIENCE BOARD $4,340,000
+$310,000 / 7.7%

The FY 2010 Request for the National Science Board is $4.34 million, an increase of $310,000, or 7.7 percent, over the FY 2009 Current Plan of $4.03 million. The FY 2010 Budget Request will enable the Board to fulfill its policy-making responsibilities for NSF and provide advice to the President and the Congress on significant national policy issues in science and engineering (S&E) research and education. This increased funding will allow the Board to enhance its actions related to its responsibilities under the American Recovery and Reinvestment Act of 2009, increase activities in the review of major research facility projects, and continue efforts to assure transparency of Board policy decisions and meetings.

National Science Board Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Personnel Compensation and Benefits	$2.11	$2.62	$2.83	$0.21	8.0%
Other Operating Expenses	1.72	1.41	1.51	0.10	7.1%
Total	$3.83	$4.03	$4.34	$0.31	7.7%
Full-Time Equivalent Employment	16	16	17	1	6.3%

Appropriation Language

For necessary expenses (including payment of salaries, authorized travel, hire of passenger motor vehicles, the rental of conference rooms in the District of Columbia, and the employment of experts and consultants under section 3109 of title 5, United States Code) involved in carrying out section 4 of the National Science Foundation Act of 1950, as amended (42 U.S.C. 1863) and Public Law 86-209 (42 U.S.C. 1880 et seq.), ~~$4,030,000:~~*$4,340,000: Provided*, That not to exceed $2,500 shall be available for official reception and representation expenses.

National Science Board
FY 2010 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Rescission	Expired	Total Resources	Obligations Incurred/Est.
FY 2008 Appropriation	$3.97	-	-$0.14	$3.83	$3.82
FY 2009 Current Plan (CP)	4.03	-	-	4.03	4.03
FY 2009 ARRA	-	-	-	-	-
FY 2010 Request	4.34	-	-	4.34	4.34
$ Change from FY 2009 CP					$0.31
% Change from FY 2009 CP					7.7%

Totals may not add due to rounding.

National Science Board in Context

As an independent federal agency, NSF does not fall under any cabinet department; rather NSF's activities are guided by the National Science Board within guidelines provided by the President and Congress. The Board, established by the Congress in 1950, has dual responsibilities to: a) provide independent national science policy advice to the President and the Congress; and b) establish policies for NSF. The Board is composed of 25 presidentially appointed, Senate-confirmed members, including the Director of the National Science Foundation, representing the broad U.S. science and engineering community. Board members, who serve 6-year terms on staggered appointments, are drawn from industry, academe, non-profit organizations and professional scientific societies, and represent the breadth of S&E disciplines and geographic areas. They are selected for their eminence in research, education, or public service.

The Board meets several times a year to review and approve major NSF awards and new programs, provide policy direction to NSF, and to report to the President, Congress and the public on significant science and engineering related national policy issues. The Board conducts studies on a broad range of policy topics, analyzes NSF's budget to ensure progress and consistency along the strategic direction set for NSF, and also identifies issues that are critical to NSF's future.

National Science Board Activities

Policy Guidance to the President and Congress
The Board issues policy guidance in the form of official statements, resolutions, and reports to the President and Congress. Recent reports have examined topics such as cost sharing, science and engineering education, the science and technology workforce, and major research infrastructure projects. Another Board project, regarding the research and development efforts in alternative sustainable energy, will be released in FY 2009. For FY 2010, the Board expects to release findings on factors impacting the next generation of STEM (Science, Technology, Engineering and Mathematics) Innovators, and a policy statement Companion Piece to *Science and Engineering Indicators 2010*, *Digest of Key Science and Engineering Indicators 2010*, and its statutory biennial statistical report, *Science and Engineering Indicators 2010* (*Indicators*).

Experience has shown that the Board will receive requests from the President and/or Congress asking it to examine and report quickly on a wide range of national policy topics related to S&E research and education. The Board will also continue to identify high priority topics for FY 2010.

Establishing Policies for the National Science Foundation
Enhanced Board responsibilities established by statute include the expanding role in prioritizing and approving Major Research Equipment and Facilities Construction (MREFC) projects, review of NSF policy with respect to cost sharing requirements in NSF awards, large facility pre-construction development, construction and post-construction operations and management costs, support for interdisciplinary research, and review of NSF policies limiting proposal submissions by institutions. In addition, by August 2010 the Board must submit to Congress a summary report of its findings, including any recommendations regarding changes to, the termination of, or the continuation of the NSF pilot program of grants for new investigators established under the America COMPETES Act of 2007.

The Board also expects to continue to be significantly engaged with assisting the agency in its activities related to the American Recovery and Reinvestment Act of 2009. Additional responsibilities specific to FY 2010 include NSF's implementation of components of the Board's Action Plan for STEM Education and new efforts to be implemented regarding enhancement of NSF support for potentially transformative research as a result of Board guidance.

The Board's annual responsibilities include review of the following:

- NSF management tables and response to the OIG Semi-annual Reports to Congress;
- Annual NSF Budget Submission for transmittal to OMB;
- Foundation's annual Merit Review Report; and
- Large awards or proposal funding requests.

The Board has established several standing committees to assist with its responsibilities. The Committee on Audit and Oversight oversees the operations of the Foundation's Office of Inspector General (OIG), as well as NSF compliance with procedures for financial accountability and information technology security. The Committee on Strategy and Budget (CSB) focuses on strategic planning and new investments for NSF. Review of the Foundation's budget request is also vested in CSB. The Committee on Education and Human Resources (CEH) focuses on Foundation activities in such priority areas as S&E workforce development, math and science education, and underrepresented populations and regions in S&E programs. The newly constituted Committee on Science and Engineering Indicators (SEI) manages the process for development and review of the Board's biennial statistical report, *Science and Engineering Indicators* and associated products.

The Board is responsible for direct review and approval of the largest Foundation awards, and is responsible for the review and approval of major research infrastructure projects at all stages of development, including budget planning, review of proposals and management effectiveness, and approval of awards. The members of the Committee on Programs and Plans (CPP) review proposals for major awards, the health of the Foundation's merit review system, and program performance and accountability. The Board monitors the critical infrastructure that supports research in Antarctica through the CPP Subcommittee on Polar Issues.

The Executive Committee acts on behalf of the Board between meetings on grants, contracts, and other instances where an immediate decision is required. In addition, the Committee is developing a prioritization process for the full Board to determine major Board policy activities for subsequent fiscal years. This prioritization process is expected to be finalized and approved in May 2009.

Summary of FY 2010 Request

Staffing

Most of the Board's FY 2010 Budget Request supports a small and independent core of full-time policy, administrative, and operations staff. Over 65 percent of the FY 2010 request, or $2.83 million, is for Board member and staff salaries and benefits. The Board Office staff members provide the independent resources and capabilities for coordinating and implementing S&E policy analyses and development, and the operational support that is essential for the Board to fulfill its mission. The one additional FTE requested in the FY 2010 request is for the Board's Administrative Manager who is returning from leave after five years of military service. Increased staff support will also be applied to the new Subcommittee on Facilities, the increasing number of awards coming to the Board for reviews, and support for Science and Engineering Indicators.

Science and Engineering Indicators

In FY 2010, the Board will deliver *Science and Engineering Indicators (Indicators) 2010* to the President and to Congress, in keeping with its statutory responsibility. *Indicators* is an important biennial statutory publication of the major, high quality quantitative data on the status of U.S. science and engineering. Over the past several years, the Board has heightened its efforts to expand the audience for Indicators, implementing several enhancements that encourage audiences outside the normal community of users to become familiar with the data resources in Indicators and to facilitate the use of Indicators data in policy decisions and analyses. With the last cycle of Indicators, in 2008, the Board prepared a short *Digest of Key Science and Engineering Indicators* that provided selected graphical summaries of important trends and data points relevant to U.S. science and technology, with an explanation of why the U.S. public should be interested in these data. The Board plans to enhance the graphical capabilities of the web version of the *Digest* and other statistical resources to enable the analysis and interpretation of data by students, teachers, professionals and policy makers.

The Next Generation of STEM Innovators Report

In FY 2010, the Board will deliver a report on future STEM Innovators. Gathering national experts, the Board plans to:

- Identify strategies for nurturing the talents of those individuals in adolescence and early adulthood who are likely to become the next generation of high level STEM professionals and innovators;
- Explore the possible existence of pools of potential talent in our society that currently are overlooked, under-developed, and under-utilized, but who could become a source of adults productive in STEM to fuel innovation in this country;
- Develop a research agenda on effective means for nurturing and developing the STEM talent in youth and early adulthood in order to accelerate the STEM productivity and creativity of such individuals over their careers; and
- Suggest development of policies that could help ensure a strong pipeline of STEM talent and nurture innovation in the STEM workforce.

Policy for Research Facilities

In FY 2010, the Board will staff and fully implement a Subcommittee on Facilities to provide recommendations on the development, construction, operations, maintenance, and decommissioning of research equipment and facilities supported by NSF. This is an essential component of annual and long-term budget planning undertaken by the National Science Board.

The Subcommittee on Facilities reports to the Committee on Strategy and Budget (CSB) and assists the Board in strategic budget planning for the NSF-funded research equipment and facilities portfolio. Subcommittee responsibilities include:

- Undertaking an annual review of the portfolio of all NSF-funded research facilities. This review considers projects from the MREFC account, as well as large and mid-size research facilities and infrastructure funded by the Research and Related Activities (R&RA) account. The review considers currently operating facilities, as well as those under construction and in early and late-stage planning. The review further considers impacts on the long-term budgets of NSF divisions, directorates, and the Foundation as a whole and potential partnerships among NSF directorates and offices and with other organizations.
- Providing to the Board a clear assessment of the impact that specific projects and the overall facilities portfolio will have on long-term budget planning at NSF. This includes consideration of whether existing facilities continue to be the best use of NSF's limited resources given alternative potential uses of funding for research facilities and individual investigator-led research.
- Recommending to the Board guidance to be provided to NSF management on the prioritization of all projects that have completed a Conceptual Design Review (CDR) and are being considered for further funding to develop Preliminary Designs.

Effective Communication with the Public

Effective communications and interactions with our constituencies contribute to the Board's ability to identify priority science and technology issues, and to develop policy advice and recommendations to the President and Congress. To this end, the Board will continue to increase communication and outreach with the university, industry, professional scientific societies, the broader science and engineering research and education community, Congress, federal science and technology agencies, and the public. To enhance and improve upon outreach activities, it is important to make the Board's discussions on policy and recommendations more accessible, transparent, and widely available.

One of the major functions of the Board Office is to store and maintain records of Board decisions and policy pronouncements. The records of these decisions, and policy statements and reports on national science and engineering policy issues prepared for the President and Congress, are currently housed in various formats and media. Electronic and paper documents are not easily accessible to the public, other Federal agencies, or staff of the Foundation because they are maintained in inconsistent systems of records, as individual reports and statements, or in testimony, letters and other communications with Congress and other agencies. For older records, many have been archived as paper documents and their existence relies on the memory of staff who participated in the policy discussions. This situation creates substantial barriers to the Board Office's ability to respond to frequent requests from interested members of the public, science historians, and NSF staff who wish or need to understand the underlying process for particular decisions or to obtain original documents relevant to a policy position.

In FY 2010, the Board will begin development of electronic resources to search, identify and retrieve relevant electronic documents, in a common electronic format, for use by stakeholders including members of the public, Congress, other agencies, and NSF staff. This work will start with Board resolutions establishing NSF policy and will determine the extent of necessary future resources to permit historians, the media, policy analysts, and other members of the public and Federal establishment to feel confident in the completeness of the information they are obtaining on Board discussions and decisions, facilitate NSF staff implementation of Board policies within the Foundation, and reduce the administrative cost and effort associated with information retrieval.

Other costs associated with supporting Board activities include website maintenance; transcription services; report printing and distribution; and logistical support for Board meetings, workshops and roundtables. The Board's logistical support provides limited services for events including: travel planning assistance for invited speakers and participants; mailing of announcements and invitations; local transportation planning, printing, audio-visual and other services for off-site events; and additional low-level meeting, workshop and roundtable support.

Personnel Compensation and Benefits and General Operating Expenses

(Dollars in Thousands)

	FY 2008 Actual	FY 2009 Current Plan	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Personnel Compensation and Benefits	$2,108	$2,620	$2,830	$210	8.0%
Staff Development & Training	28	45	47	2	4.4%
Advisory & Assistance Services	1,040	723	781	58	8.0%
Travel & Transportation of Persons	480	449	480	31	6.9%
Communications, Supplies and Equipment	161	190	199	9	4.7%
Representation Costs	8	3	3	-	-
Total	$3,825	$4,030	$4,340	$310	7.7%
FTE	16	16	17	1	6.3%

Totals may not add due to rounding.

OFFICE OF INSPECTOR GENERAL

$14,000,000
+$2,000,000 / 16.7%

The Appropriations Act that funds the National Science Foundation provides for a separate appropriation for NSF's Office of Inspector General (OIG). Accordingly, the FY 2010 Budget Request identifies the resources needed to support OIG, including amounts for personnel compensation and benefits, contract services, training, travel, supplies, materials, and equipment.

The FY 2010 Budget Request for OIG is $14.0 million, which represents an increase of $2.0 million over the FY 2009 current plan of $12.0 million.

Office of Inspector General Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA	FY 2010 Request	Change over FY 2009 Plan Amount	Percent
Personnel Compensation and Benefits	$9.25	$9.56	$1.00	$10.65	$1.09	11.4%
Other Operating Expenses[1]	2.57	2.44	1.00	3.35	0.91	37.3%
Total	$11.82	$12.00	$2.00	$14.00	$2.00	16.7%
Full-Time Equivalent Employment	67	64	-	67	3	4.7%

Totals may not add due to rounding.
[1] Includes the costs of the annual financial statements audit and the outsourcing of contracting services.

Appropriation Language

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, as amended, ~~$12,000,000,~~*$14,000,000.*

Office of Inspector General
FY 2010 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Carryover/ Recoveries	Rescission	Expired	Total Resources	Obligations Incurred/Est.
FY 2008 Appropriation	$11.43	$1.12	-0.46	-0.01	$12.08	$11.83
FY 2009 Current Plan (CP)	12.00	0.25	-	-	12.25	12.25
FY 2009 ARRA	2.00	-	-	-	2.00	2.00
FY 2010 Request	14.00	-	-	-	14.00	14.00
$ Change from FY 2009 CP						$1.75
% Change from FY 2009 CP						14.3%

Totals may not add due to rounding.

Explanation of Carryover

Within the **Office of Inspector General (OIG)** appropriation, a total of $253,612 was carried forward into FY 2009. Funds will be used to procure an electronic work-paper system, audit contracts, and fund personnel compensation costs.

OIG RESPONSIBILITIES

In February 1989, the National Science Board established OIG pursuant to the Inspector General Act Amendments of 1988. The statute confers on OIG the responsibility and authority to:

- Conduct and supervise audits of NSF programs and operations, including organizations that receive NSF funding.

- Conduct investigations concerning NSF programs and operations, including organizations that receive NSF funding and individuals that benefit from NSF programs and operations.

- Evaluate allegations of research misconduct, such as fabrication, falsification, or plagiarism, involving individuals who participate in NSF-funded activities.

- Provide leadership, coordination, and policy recommendations for:
  - Promoting economy, efficiency, and effectiveness in the administration of NSF programs and operations, and
  - Preventing and detecting fraud and abuse in NSF programs and operations.

- Issue semiannual reports to the National Science Board and Congress to keep them informed about problems, recommended corrective actions, and progress being made in improving the management and conduct of NSF programs.

As set forth in the OIG Strategic Plan, the primary functions of the Office are audits, reviews, and investigations. To provide the diverse skills, training, and experience necessary to oversee NSF's varied programs, the OIG staff includes scientists, attorneys, certified public accountants, investigators, evaluators, and information technology specialists. The focus of an investigation, audit, or other review may be on a single entity or individual, an organization, a project involving multiple disciplines, or a broad program or functional area.

OIG performs audits of grants, contracts, and cooperative agreements funded by the Foundation's programs. The Office also conducts audits and reviews of both internal agency programs and external organizations that receive NSF funding to ensure that financial, administrative, and programmatic activities are conducted economically, effectively, and in compliance with agency and federal requirements. OIG is also responsible for overseeing the audit of the Foundation's annual financial statements, which are required for all NSF accounts and activities by the Government Management Reform Act of 1994. The Office contracts with a public accounting firm to conduct the financial statements audit. Since FY 2006, funds to cover the complete cost of the financial audit have been requested in this appropriation. OIG also audits financial, budgetary, and data processing systems used by NSF to develop the financial statements. In addition, the Office performs multi-disciplinary reviews – involving auditors, attorneys, management analysts, investigators, and other professionals as needed – of financial, management, and program operations to identify broader problems and highlight best practices.

OIG investigates possible wrongdoing by organizations and individuals who submit proposals to receive awards from, conduct business with, or work for the Foundation. Allegations of research misconduct are also investigated. OIG assesses the validity and seriousness of all the allegations it receives and recommends proportionate action. When appropriate, the Office refers the results of these investigations to the Department of Justice or other authorities for criminal prosecution, civil litigation, or resolution via settlement agreements and institutional compliance plans. OIG refers other cases to the Foundation for administrative resolution and, when appropriate, recommends modifications to agency policies and procedures to ensure the integrity in NSF's systems. The Office works closely with institutions on the conduct of their internal investigations and performs outreach activities aimed at preventing and detecting fraud, waste, and abuse and at raising the awareness of funded researchers, institutional administrators, and agency employees about the OIG's role and NSF's rules and expectations.

Personnel Compensation and Benefits and General Operating Expenses

(Dollars in Thousands)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA	FY 2010 Request	Change over FY 2009 Estimate Amount	Percent
Personnel Compensation and Benefits	$9,252	$9,565	$1,000	$10,650	$1,085	11.3%
Travel & Transportation of Persons	235	246		290	44	17.9%
Advisory & Assistance Services[1]	2,207	2,058	1,000	2,760	702	34.1%
Communications, Supplies and Equipment, and Other Services	131	131		300	169	129.0%
Total	$11,825	$12,000	$2,000	$14,000	$2,000	16.7%

Totals may not add due to rounding.

[1] Includes the costs of the annual financial statements audit and other outsourced grant audits.

The additional funds requested for FY 2010 will cover increased personnel costs, including three additional FTEs; the rapidly rising costs of audits conducted by CPA firms under contract to OIG; essential technology upgrades to replace aging copiers and personal computers, about half of which are over four years old; and the need for software and training that will provide more effective support for our investigations and audits. In addition we have been asked, along with all other OIGs, to contribute 0.25 percent of our appropriation to fund the new Council of Inspectors General for Integrity and Efficiency. The increase requested for FY 2010 will enable us to significantly improve the efficiency and impact of OIG in performing its oversight role.

The majority of the requested increase is allocated to personnel costs, which consume 78 percent of the OIG budget. The request covers increased costs for staff travel, which is essential for conducting investigations, audits, and meetings with counterparts in this country and abroad to share information and best practices and foster improved coordination of efforts. Finally, the requested funding will allow OIG to keep pace with the increased risks faced by NSF through an increased number of contracted audits. While other agencies may primarily contend with other kinds of liabilities, NSF's greatest risk by far is its financial exposure in awarding billions of dollars in grants and contracts each year. As the agency's funding grows, so does this risk – and the concomitant need for increased OIG oversight.

One to two additional FTEs are needed to improve audit coverage of larger, and increasingly complex, interdisciplinary and collaborative NSF awards. The new FTEs would enable us to provide adequate audit coverage of awardees and NSF programs that we have identified as high risk.

The greatly increased demand in the marketplace for auditors due to the Sarbanes-Oxley legislation, along with the further temporary increase expected as a result of the American Recovery and Reinvestment Act of 2009 has impaired OIG's ability to hire and retain qualified grant auditors. To address this hiring issue, we would like to contract with the Office of Personnel Management on ways to attract and retain staff with knowledge and expertise in these highly specialized areas. The requested funds would allow us to move this effort forward. In addition, OIG expects to convert to electronic work papers in keeping with most other OIG and professional audit organizations, which will require an initial expenditure of about $160,000, plus subsequent expenditures for ongoing training and maintenance costs.

The FY 2010 request would also allow OIG to cover the significantly higher costs for outsourced audits conducted by CPA firms. As indicated above, their average cost has increased by over a third over the past few years, from approximately $100,000 per audit in FY 2004 to approximately $134,000 per audit in FY 2008. To ensure OIG independence and provide more efficient and timely servicing of contracting requirements, we will continue to use the Department of Interior's acquisition service center. Therefore, for FY 2010 the additional funding requested will also cover the estimated $140,000 cost of outsourcing contract administration services once performed by the NSF contracts office.

Increased resources would enable OIG to focus audits more effectively on the six areas we have identified as posing the greatest risks to NSF: 1) pre-award and post-award monitoring of grants, contracts, and large facility projects, especially those that have experienced large cost overruns; 2) the human capital resources needed to process the more than 40,000 proposals submitted to the agency each year; 3) the merit review process, including such issues as (a) obtaining sufficient reviewers with the appropriate expertise to review proposals that are increasingly multidisciplinary and (b) increasing traditionally underrepresented groups in the reviewer pools; 4) the infrastructure for the United States Antarctic Program, which NSF manages, to ensure the health and safety of researchers and support personnel and to enable world-class research in such an extreme environment; 5) the processes NSF uses to evaluate the accomplishments and ensure accountability of its research programs; and 6) the adequacy of NSF cooperative agreements for overseeing and managing facilities and centers. In addition, OIG will allocate increased resources to closely monitor NSF actions undertaken to implement the American Recovery and Reinvestment Act of 2009. This effort will involve evaluating NSF's steps to plan, award, oversee and account for the $3 billion of stimulus funds NSF will receive under this legislation. OIG received $2 million in dedicated funding under the Act, most of which will be expended on contracting for audits.

In FY 2007 OIG had the resources to audit four percent of the total $9.6 billion of NSF funds expended by awardees classified as high risk. The requested 2010 funding would enable audits of a larger percentage of risky awardees, provide more effective oversight of NSF programs, and promote the more efficient use of NSF grant funds. This level of funding would also allow for the major ongoing initiative to audit labor-effort costs charged to NSF awards by institutions receiving the most funding from NSF. Labor effort is the single largest cost in NSF awards, and it is frequently cited in audit reports for weak internal controls. OIG will also continue to focus attention on audits of international institutions, which are an increasingly important part of NSF's research portfolio but often are not subject to the terms and conditions of NSF's other awardees. Our efforts will be coordinated with other OIGs and international audit organizations to evaluate the need for developing standardized financial, accounting, and audit requirements for better accountability of funds provided by all sources.

In support of the American Recovery and Reinvestment Act of 2009 and the America COMPETES Act of 2007, OIG will help ensure that each additional dollar NSF invests in basic research is subject to appropriate oversight and sound management controls. With their emphasis on efficiency and effectiveness, OIG program audits support efforts to increase NSF's operational capacity at a reasonable cost to the taxpayer. Our audits continue to focus on many of the priorities identified in the legislation. For example, we are working on an audit of NSF centers, which facilitate collaboration on complex scientific projects, and of large-scale facilities and instruments, which enable discovery and development. Following the recommendations of prior OIG audits of large facilities, NSF is reengineering its approach to planning, building, and managing these projects. Our audits have also recommended improvements in the large-facility cooperative agreements to include requirements for establishing research goals and measures of accomplishments. The changes will facilitate mutual understanding between NSF and those facilities of what is expected, and consequently provide for improved accountability. As NSF attempts to leverage its investments by entering into a growing number of international partnerships, OIG has played a leadership role in establishing a dialogue among international organizations responsible for science research funding to discuss strategies for addressing mutual accountability challenges. OIG has also completed a series of incurred cost audits and internal control reviews of the accounting and billing systems of NSF's Antarctic support contractor. As the current contract expires in 2010, the OIG plans to monitor NSF's procurement and selection process to ensure 1) compliance with Federal acquisition regulations, and 2) that the successful contractor has cost accounting and billing systems to properly charge costs under the new contract.

The requested budget level will provide the resources that are needed to continue the expansion of OIG's Quality Control Reviews of the CPA firms conducting audits for grantees under the Single Audit Act (OMB Circular A-133). Because NSF relies extensively on these audits for post-award monitoring and financial statement reporting, it is critical that the quality of the audits be carefully assessed and that any deficiencies be corrected. In June 2007 the President's Council on Integrity and Efficiency and the Executive Council on Integrity and Efficiency published their *Report on National Single Audit Sampling Project*. It found that for entities expending at least $500,000 of federal awards, but less than $50 million, only 48 percent of the A-133 audits were acceptable.

One to two additional FTEs are requested to cope with a growing investigative workload. The criminal, civil, administrative, and research misconduct cases conducted by our investigative staff have become increasingly more complex, requiring more extensive discussions and negotiations with NSF management, awardee administrators, international organizations, and the Department of Justice to bring them to a satisfactory resolution. Increasingly our investigations are requiring coordination with international entities and involve individuals from or located in foreign countries. Our civil and criminal cases frequently produce both financial settlements for institutional fraud and compliance agreements for correcting the underlying systemic problems, thus providing greater protection for future federal funding. Monitoring institutions' efforts to meet the terms of their five-year compliance plans is vital to preventing fraud from recurring, but it is also very time consuming for our staff. With the increase in the number of compliance programs in recent years, we have experienced a corresponding growth in staff hours committed to monitoring them. The systemic problems that have allowed fraud to occur take time to correct, and ongoing oversight is required to ensure that the flaws in the systems are not further exploited.

With increasing frequency, OIG has been called upon to investigate instances of employee misconduct within the agency. The urgency of these investigations has required the reassignment of staff focused on the core areas of our investigative program: research misconduct and fraud. In 2008, we experienced a 6-fold increase in employee misconduct cases and associated proactive and management implication report activities. To manage this dramatic increase without an increase in staff required us to significantly reduce our efforts to investigate grant fraud. We anticipate a significant decline in investigative recoveries and prosecutions in the coming years as a direct result. An increase in staff will help minimize this decline while allowing us to handle the continued flow of employee cases. More importantly, it will provide the additional resources needed to balance the proportionate need to investigate employee misconduct, grant fraud and research misconduct.

OIG will continue to initiate proactive reviews based on previous investigative findings, as well as fraud and research misconduct indicators. In the past, these reviews have identified institutions whose high-risk management practices created significant opportunities for institutional fraud, and have resulted in improved management controls, recoveries of government funds, and new administrative/civil/criminal cases. Increased case loads have required that proactive reviews receive lower priority and be conducted by summer interns rather than full-time investigative staff. Although our reduced efforts continue to successfully uncover important investigative and policy issues, our ability to identify such issues in a timely manner to ensure the integrity of NSF's systems has been dramatically hampered. The increased FTEs will allow us to pursue a vigorous proactive program and provide reports that consolidate investigative findings and identify recurring operational problems that need the attention of NSF management.

We anticipate that cases handled in FY 2010, like past and current cases, will result in significant recoveries, settlement and compliance agreements, and critical system changes in institutions and NSF programs. Further, we expect concomitant improvements in institutional detection of fraud and greater assurance that federal funds will thereafter be put to proper use. Under our monitoring, the systemic changes will also promote higher ethical conduct in the application for and execution of federal awards. As in our compliance efforts, these cases require significantly more staff time, as well as specialized knowledge and strong forensic, computer and analytical skills.

Our investigative workload is also growing rapidly in other areas. Over the past year, we have seen a notable increase in serious data fabrication and falsification cases and in the incidence of fraud in international collaborations. The latter, in particular, require substantial resources to determine their scope and complexity and to perform more intricate investigations. Overall, in the past ten years we have experienced almost a four-fold increase in the number of matters we have reviewed, a more than 15-fold increase in actions related to cases (including financial recoveries, debarments, and DOJ actions), and a more than 20-fold increase in referrals to DOJ or other entities for investigation, prosecution, or recovery. Recent studies have shown that one-third of all scientists admit to committing questionable research practices, which both threaten the integrity of NSF's funded efforts and require additional OIG staff to investigate. The additional resources we have requested will allow us to pursue matters that threaten the integrity of NSF's systems and meet the challenges inherent in the growing number, size, and complexity of NSF awards projected under the America COMPETES Act.

The 2010 Request will also allow OIG to meet its commitment to a strong outreach effort to educate NSF staff and the national and international research communities to help them avoid the kinds of problems that lead to investigations, unfavorable audit findings, or administrative corrective actions. This initiative is designed to make NSF staff, awardee institutions, international collaborators, and other researchers more aware of grant management issues and any preventive or corrective measures that may need to be taken. Auditors, investigators, and other staff regularly participate in outreach activities, and as NSF programs increase in funding, complexity, and number, OIG has seen a commensurate increase in requests for information from universities and research institutions. As in recent years, we will strive to continue to play a leadership role in organizing and participating in international conferences and workshops, which have been well attended by NSF's counterparts in other countries, including their auditing and investigative components, to discuss common issues, share best practices, and develop policies and procedures permitting parallel investigations and the sharing of information.

We will also continue to work closely with other IG offices on issues of mutual concern. Commitment of staff effort is necessary for a variety of IG community responsibilities. The NSF IG leads the Misconduct in Research Working Group on behalf of the new Council of Inspectors General for Integrity and Efficiency and is a member of several other committees. Our senior management also actively participates in the Audit and Investigations Committees, and with international committees to coordinate matters of mutual interest.

OIG's increasingly complex audits and investigations require significantly more staff time and contractor support than in the past, as well as specialized knowledge and strong forensic, IT systems, and analytical skills. This request will provide the resources needed to ensure diligent audits and investigations of the growing number of substantive complaints we are receiving and to enable us to respond to emerging situations, such as NSF's increasing reliance on computer information systems and security controls, changing audit standards, and challenges to cybersecurity at NSF, its funded institutions, and remote locations like Antarctica.

MAJOR MULTI-USER RESEARCH FACILITIES $1,085,560,000

-$8,320,000 / -0.8%

Major Multi-User Research Facilities Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Facilities	$840.02	$876.76	$526.93	$865.47	-$11.29	-1.3%
Federally Funded R&D Centers	191.37	217.12	28.70	220.09	2.97	1.4%
Total, Major Multi-User Research Facilities	$1,031.39	$1,093.88	$555.63	$1,085.56	-$8.32	-0.8%

Totals may not add due to rounding.

NSF investments provide state-of-the-art tools for research and education, such as multi-user research facilities, distributed instrumentation networks and arrays, accelerators, telescopes, research vessels, aircraft, and earthquake simulators. In addition, investments in internet-based and distributed user facilities are increasing as a result of rapid advances in computer, information, and communication technologies. NSF's investments are coordinated with those of other organizations, agencies, and countries to ensure complementarity and integration. All operations and maintenance of multi-user facilities are funded through the Research and Related Activities (R&RA) account, and most major construction projects are funded through the Major Research Equipment and Facilities Construction (MREFC) account.

This chapter provides descriptions of each major multi-user research facility supported through the R&RA account and provides funding information by life cycle phase for each facility. The information presented for each facility follows the overall framework established by NSF for large facility projects. Information on the construction projects funded through NSF's MREFC account is provided in the MREFC chapter.

NSF is investing $555.63 million of ARRA funds in major research facilities and infrastructure. $400.0 million of these funds are provided through the MREFC account for construction and acquisition activities associated with three MREFC projects: the Alaska Region Research Vessel (ARRV); the Advanced Technology Solar Telescope (ATST); and the Ocean Observatories Initiative (OOI). An additional $3.10 million of ARRA funding is provided through the R&RA account to the ATST for late-stage design and development. The balance of ARRA funding provided through the R&RA account, totaling $152.53 million, supports major facilities and infrastructure needs across the NSF portfolio.

Major Multi-User Research Facilities Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Request
Academic Research Fleet	$75.28	$98.68	$18.00	$87.58	-$11.10	-11.2%
Cornell Electron Storage Ring	14.11	10.50	7.80	6.60	-3.90	-37.1%
Cornell High Energy Synchrotron Source	5.60	2.51	7.20	6.67	4.16	165.7%
EarthScope[1]	19.21	24.31	4.00	25.05	0.74	3.0%
Gemini Observatory	18.69	18.71	-	19.10	0.39	2.1%
Incorporated Research Institutes for Seismology	11.75	12.00	2.33	12.36	0.36	3.0%
Integrated Ocean Drilling Program[2]	37.41	43.41	25.00	43.41	-	-
Large Hadron Collider	18.00	18.00	-	18.00	-	-
Laser Interferometer Gravitational Wave Observatory	29.50	30.30	-	28.50	-1.80	-5.9%
National High Magnetic Field Laboratory	27.75	26.50	20.00	31.95	5.45	20.6%
National Nanotechnology Infrastructure Network	14.13	16.26	10.00	16.26	-	-
National Superconducting Cyclotron Laboratory	19.25	20.50	2.00	21.00	0.50	2.4%
Network for Earthquake Engineering Simulation	19.38	21.82	-	22.00	0.18	0.8%
Other Facilities[3]	8.45	6.30	5.00	6.65	0.35	5.6%
Polar Facilities and Logistics[4]	328.60	342.18	22.50	374.35	32.17	9.4%
MREFC Projects[5]	192.91	184.78	403.10	145.99	-38.79	-21.0%
Federally Funded R&D Centers[6]						
National Astronomy and Ionosphere Center	12.75	11.60	3.10	11.40	-0.20	-1.7%
National Center for Atmospheric Research	89.07	106.92	13.20	100.00	-6.92	-6.5%
National Optical Astronomy Observatory and the National Solar Observatory	36.81	37.81	7.00	41.60	3.79	10.0%
National Radio Astronomy Observatory[7]	52.73	60.79	5.40	67.09	6.30	10.4%
Grand Total	$1,031.38	$1,093.88	$555.63	$1,085.56	-$8.32	-0.8%

Totals may not add due to rounding.

[1]EarthScope funding includes support provided through the R&RA account for operations and maintenance of the facility. Support provided through the MREFC account for the construction of the project, totaling $4.21 million in FY 2008, is included in the MREFC Projects line.

[2]Funding for the Integrated Ocean Drilling Program (IODP) includes support for the continued phase out of program and contract activities for the Ocean Drilling Program, predecessor to the IODP. This line also includes support for the operations and maintenance of the Scientific Ocean Drilling Vessel. Final MREFC support for the SODV, totaling $24,000 in FY 2008, is included on the MREFC projects line.

[3]"Other Facilities" includes support for other physics and materials research facilities.

[4]Polar Facilities and Logistics funding includes support for the operations and maintenance of the South Pole Station Modernization (SPSM) project. Funds provided through the MREFC account for SPSM, totaling $7.57 million in FY 2008, are included on the MREFC Projects line.

[5]Funding levels for MREFC Projects in this table include support for concept and development associated with these projects provided through the R&RA account, specifically for NEON, OOI and ATST, initial support for operations and maintenance provided through the R&RA account, and implementation support provided through the MREFC account. Final MREFC support for EarthScope, SODV and SPSM is also included in this line.

[6]"Federally Funded R&D Centers" does not include support for the Science and Technology Policy Institute, which is an FFRDC but not a research platform.

[7]Funding for the National Radio Astronomy Observatory includes operations and maintenance support for the Atacama Large Millimeter Array (ALMA). Construction funding for ALMA is included in the MREFC Projects line above.

Academic Research Fleet

$87,580,000
-$11,100,000 / -11.2%

Academic Research Fleet
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Academic Research Fleet	$75.28	$98.68	$18.00	$87.58	-$11.10	-11.2%

The Academic Research Fleet consists of 22 vessels in the University-National Oceanographic Laboratory System (UNOLS). These vessels range in size, endurance, and capabilities, enabling NSF and other federally-funded scientists with the means to conduct ocean science research with a diverse fleet capable of operating in coastal and open ocean waters. Funding for the Academic Research Fleet includes investments in ship operations; shipboard scientific support equipment; oceanographic instrumentation and technical services; and submersible support. Funding levels reported here reflect investments by the Division of Ocean Sciences (OCE) and the Division of Innovative and Collaborative Education and Research (ICER), and the FY 2008 Actual includes $2.0 million in supplemental appropriations. In addition to operations, OCE has undertaken selected construction projects based on an inter-agency fleet renewal status plan.

Total Obligations for the Academic Research Fleet
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Operations and Maintenance	$73.68	$98.58	$15.00	$80.58	$81.00	$82.00	$84.00	$86.00	$88.00
Fleet Renewal:									
Human Occupied Vehicle	-		3.00	5.00	2.00	-			
R/V Langseth (Seismic Ship)	1.60	-							
Regional Class Research Vessel		0.10		2.00	2.00	20.00	20.00	20.00	20.00
Total, Academic Research Fleet	$75.28	$98.68	$18.00	$87.58	$85.00	$102.00	$104.00	$106.00	$108.00

Totals may not add due to rounding.

The Academic Research Fleet serves as the main platform for the collection of data and testing of hypotheses about the structure and dynamics of the oceans. Scientists contribute to advances made in areas such as climate variability, marine ecosystems, fisheries, and ocean-related natural hazards such as tsunamis through use of these facilities. Vessels in the Academic Research Fleet permit shipboard training of future oceanographers. Participating graduate and undergraduate students interact with scientists and marine technicians, enabling them to gain first-hand exposure to ocean science field research. Recent technological innovations allow research conducted at sea to be transmitted via satellite back to the classroom, broadening the educational impact of the vessels to a wider audience, including K-12 students.

The Academic Research Fleet is supported through an interagency partnership, principally with the National Oceanic and Atmospheric Administration (NOAA) and the Office of Naval Research (ONR) via a Memorandum of Understanding (MOU). The operating costs for the Fleet are divided proportionally among the vessel users based on usage; NSF supports approximately 70 percent of the total. NSF also coordinates with ship-operating and ship-user academic institutions through UNOLS.

Support for scientists using the fleet is provided by both NSF and other state and federal agencies. Within NSF, science is supported via competitive peer-reviewed proposals, most typically funded within OCE and through selected programs in the Divisions of Earth Sciences (EAR) and the Division of Atmospheric and Geospace Sciences (AGS), and also through the Office of Polar Programs (OPP) and the Directorate for Biological Sciences (BIO). Approximately 30 percent of the GEO proposals request ship time; GEO-funded shipboard science has ranged from about $35 million to $45 million per year over the last 5 years. Not reflected in this number is the science that utilizes samples or data collected on prior cruises, scientists piggy-backing on scheduled cruises to accomplish additional science, international scientists sailing with the U.S. fleet, and science funded by other agencies.

The significant temporary increase in funding for support of ship operations in FY 2009 reflects the large number of awards that NSF anticipates will require ship support, for which NSF will provide funding through ARRA. This temporary increase reflects approximately 600 additional ship days. The FY 2010 Request of $80.58 million will support approximately 2,400 ship days.

Project Report:

Management and Oversight:

- Fleet Operations:

  - NSF provides oversight to the Academic Research Fleet through cooperative agreements with each ship-operating institution and through a separate cooperative agreement with the UNOLS Office. In addition, NSF oversees the fleet through the Large Facilities Office via the Business Systems Review of selected operating institutions, site visits, ship inspections, and participation at UNOLS Council and Subcommittee meetings by program managers. Several program managers within OCE at NSF, at NOAA, and at ONR are involved in the activities and overall oversight of the Academic Research Fleet. NSF has recently reviewed two large Academic Research Fleet operating institutions through the Large Facilities office via the Business Systems Review in CY 2008.
  - Management of an individual institution’s ship-operating facilities varies with the scale of the operation, but the core responsibility typically resides with the Director of the Institution, the Marine Superintendent (for all aspects of the facility), and the Ship’s Captain (for at-sea operations). For larger multi-ship-operating institutions, a chief of marine technicians, schedulers, and finance administrators may also be involved in facility management.

- Fleet Renewal:

  - The NSF coordinator is the program director for Ship Acquisitions and Upgrades, within the Integrative Programs Section (IPS) in OCE, with additional IPS staff providing project management assistance.
  - External Structure: NSF and the Navy’s Program Executive Office Ships (PEO Ships) are ending a MOU for the acquisition of the Regional Class Research Vessels (RCRVs). The design competition produced two designs by late 2008 and the process was halted before a down-select to a single design was completed because funds to commence with ship construction in 2009 could not be identified.

- Reviews: Based on projected science requirements identified in recent reports and workshops, a fleet of vessels supporting ocean science research will be needed far into the future. In coordination with the other federal agencies with ocean research investments and UNOLS, the Interagency Working Group for Facilities (IWG-F) published a Federal Oceanographic Fleet Status Report in December 2007 describing plans for renewal of the federal and academic oceanographic research and survey fleet. In addition, several activities are underway to support the upgrade of the U.S. Academic Research Fleet. Ship operations and technical activities are internally reviewed yearly on the basis of detailed annual reports provided by the operating institutions. Ship operations proposals are exempt from external review by peers. Detailed annual reports, in the form of the ship operations proposals, are reviewed and budgets are negotiated yearly and are dependent on the number of days at sea in support of NSF funded research programs. Technical services awards are reviewed every three years and negotiated annually.

<u>Fleet Renewal:</u>

- Ongoing activity in FY 2009 and key FY 2010 milestones:

  - Development and construction of a deep submergence capability to replace the submersible human occupied vehicle (HOV) *ALVIN* continues in FY 2010. This project, begun in FY 2004, includes a Preliminary Design Review (PDR) in July 2009 and a Final Design Review (FDR) in December 2009. Integration of a new titanium 6,500 meter-capable personnel sphere with existing *ALVIN* vehicle components is planned during FY 2010. Initial Phase I operations are anticipated in 2011 with a depth capability of 4,500 meters, the limit of the current *ALVIN* and the infrastructure components to be shared across both platforms. Upgrades to permit operations at a depth of 6,500 meters could follow in 3 to 5 years. The anticipated total NSF cost for Phase I is $32.90 million, which includes $22.90 million from prior years and $10.0 million from FY 2009 through FY 2011. Funding in FY 2009 represents the $3.0 million provided through ARRA for final Phase I design of the *ALVIN* upgrade and limited development activities. An increase of $10.0 million in NSF funds over previous estimates are due to delays in schedule, increases in labor costs and levels of effort, and a rise in titanium costs. Additional increases will be shared by the awardee.
  - NSF is awaiting the results of two NRC studies on Ocean Infrastructure needed in the near and longer term before moving ahead with construction of the Regional Class Research Vessel (RCRV's). Funds in FY 2009 allow finalization of the design work for construction of vessels; those in FY 2010 will allow any needed design refresh to comply with any regulation changes and, potentially, the issue of a shipyard RFP.
  - The Research Vessel (R/V) *Marcus G. Langseth* started seismic operations in 2008, and scientific outfitting continues to ready the ship for general oceanographic research. To date, the quality and quantity of data collected has been remarkable, and the ship is recognized world-wide by the science community as the premier ship for geophysical studies.
  - Maintenance and upgrade projects are on-going on all of the 22 ships in the Academic Research Fleet. $15.0 million in ARRA funding will be used to upgrade specific ship management control systems, replace aged science mission equipment, and accomplish deferred maintenance on many of the ships in the fleet.

Cornell Electron Storage Ring and Cornell High Energy Synchrotron Source — $13,270,000 / +$260,000 / 2.0%

Cornell Electron Storage Ring-Cornell High Energy Synchrotron Source
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Cornell Electron Storage Ring	$14.11	$10.50	$7.80	$6.60	-$3.90	-37.1%
Cornell High Energy Synchrotron Source	5.60	2.51	12.40	6.67	4.16	165.7%
Combined CHESS/CESR*	$19.71	$13.01	$20.20	$13.27	$0.26	2.0%

Totals may not add due to rounding.

* Starting in FY 2009

The Cornell Electron Storage Ring (CESR) was originally constructed to support research in elementary particle physics as well as accelerator physics and superconducting radio frequency applications. CESR funding for these purposes concluded with final phase-out support from the Division of Physics in the Directorate for Mathematical and Physical Sciences in FY 2009. Concomitant with this phase-out, a larger fraction of CESR operations was dedicated to providing electrons for the Cornell High Energy Synchrotron Source (CHESS) beginning in FY 2009. As of FY 2010, this will be CESR's primary function.

CHESS is a high-intensity, high-energy X-ray source supported by NSF, with partial co-support from the National Institutes of Health (NIH). It uses synchrotron light given off by charged particles, both electrons and positrons, as they circulate at nearly the speed of light around CESR. As a user facility, CHESS provides state-of-the-art facilities for X-ray light research in physics, chemistry, biology, materials, and environmental sciences. Areas of user emphasis include soft matter and thin film studies, solution scattering, structured nanomaterials, high-pressure science, structural biology, time-resolved materials science, and x-ray studies of items of art and archaeology.

Total Obligations for CESR-CHESS
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
CESR-Ops & Maintenance	$14.11	$10.50	$6.50	$6.60	$11.03	$11.90	$12.96	$13.65	$14.44
CHESS-Ops & Maintenance	5.60	2.51	7.20	6.67	7.90	8.38	8.47	8.89	9.41
CESR-R&D	-	-	1.30	-	-	-	-	-	-
CHESS-R&D	-	-	5.20	-	-	-	-	-	-
Combined CHESS/CESR	$19.71	$13.01	$20.20	$13.27	$18.93	$20.28	$21.43	$22.54	$23.85

Totals may not add due to rounding.

Note: Estimated support beyond FY 2010 is contingent upon satisfactory performance review.

Starting in FY 2010, CESR/CHESS facilities are transitioning to DMR stewardship. $13.27 million will allow for continued operation of the facilities in support of synchrotron light users as well as in support of research and development on coherent light sources. Funding beyond FY 2010 is contingent upon the successful outcome of a performance review expected to conclude in late FY 2009-early 2010.

CESR/CHESS staff assist in transferring Superconducting Radio Frequency (SRF) technology to industry. Through a license arrangement with Cornell University, the ACCEL Corporation has manufactured two superconducting RF sources to power synchrotron light sources. They have been tested and installed in CESR to replace two older, lower gradient modules. Also, some CHESS users are from industry, including pharmaceutical corporations (Rib-x Pharmaceuticals) and the research arms of Eastman Kodak, Xerox, and General Motors. Some medical institutions also make use of CHESS (Dana Farber Cancer Institute, Boston Biomedical Research Institute, and Memorial Sloan-Kettering Institute).

CESR/CHESS supports and enhances Ph.D. level graduate education, postdoctoral research, research experiences for undergraduates, and research experiences for K-12 science teachers. Engendering excitement in science among children is a focus for strengthening K-12 engagements. An important component of that effort is the participation of graduate students in pre-college science classrooms.

Project Report:

<u>Management and Oversight:</u>

- NSF Structure: Through FY 2008, NSF oversight of CESR was provided through the Division of Physics (PHY) of the Directorate for Mathematical and Physical Sciences (MPS) and by periodic site visits by NSF staff. Technical review of the award involved panel evaluation of the CESR continuation proposal, and a site visit by NSF staff and external reviewers. The oversight process included annual financial reports and program reports to NSF and an annual review by a Program Advisory Committee of outside physicists reporting to the Laboratory Director and NSF. As CESR transitions from supporting elementary particle physics research to a dedicated source of electrons for CHESS, oversight and funding of CESR will shift from PHY to the Division of Materials Research (DMR) in 2010. (For more information, see the PHY and DMR narratives within the MPS chapter).

  CHESS is supported through the Division of Materials Research (DMR) in MPS and by NIH. These organizations provide management oversight for CHESS through regular site visits.

- External structure: Both CESR and CHESS are administratively part of the Cornell Laboratory of Accelerator-based Sciences and Education (CLASSE) reporting to Cornell's Vice-Provost for Research. CESR and CHESS are operated by Cornell University in accordance with the respective cooperative agreements with NSF that set goals and objectives of the facilities.

- CHESS is a national user facility providing access to users on the basis of competitive proposal review. The primary function of facility staff is to maintain and operate the facility and to assist users in use of the facility. A Users Committee, appointed by the users of CHESS, provides advice to the Director of CHESS on policies related to the use and development of CHESS facilities and equipment for user experiments. An annual users meeting with several workshops help to disseminate results of facility users and of CHESS and MacCHESS (the component supported by NIH) staff. As of FY 2010 the CESR storage ring is dedicated to supporting the CHESS operation.

- Reviews:
  - Recent reviews conducted (CESR):
    - Comprehensive site review with panel of external experts, FY 2006
    - Review for phase-out of facility particle physics operations, FY 2008
  - Recent reviews conducted (CHESS):
    - Proposal review including site visit review with panel of external experts, FY 2008

- Upcoming reviews:
  - Review of combined CESR/CHESS (planned) FY 2009

Renewal/Recompetition/Termination:

CESR is currently funded through a five-year cooperative agreement initiated in 2003. Use of CESR as a facility for particle physics concluded with final phase-out over FY 2008 and FY 2009. As of FY 2010, CESR is dedicated entirely to support the CHESS operation. CHESS is currently funded through a cooperative agreement also initiated in 2003. NSF expects to consider the continued operation of CESR/CHESS in support of X-ray photon science past FY 2010 pending satisfactory performance review.

EarthScope

$25,050,000
+$740,000 / 3.0%

EarthScope
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
EarthScope	$19.21	$24.31	$4.00	$25.05	$0.74	3.0%

The EarthScope facility is a distributed, multi-purpose geophysical instrument array that is making major advances in our knowledge and understanding of the structure and dynamics of the North American continent. EarthScope instrumentation is expected to be located in nearly every county within the U.S. over the 10 year life span of the program. Construction of EarthScope was completed September 30, 2008, on-time and on-budget. FY 2009 is the first year of operation of the full EarthScope.

Total Obligations for EarthScope
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	$9.36								
Management and Operations	11.63	19.21	24.31	25.05	26.00	26.65	27.25	28.05	28.86
ARRA Estimate			4.00						
Subtotal, R&RA Obligations	$20.99	$19.21	$28.31	$25.05	$26.00	$26.65	$27.25	$28.05	$28.86
MREFC Obligations:									
Implementation	195.97	4.21	-	-					
Subtotal, MREFC Obligations	$195.97	$4.21	-	-	-	-	-	-	-
Total, EarthScope	**$216.95**	**$23.42**	**$28.31**	**$25.05**	**$26.00**	**$26.65**	**$27.25**	**$28.05**	**$28.86**

Totals may not add due to rounding.

EarthScope seeks to enhance our understanding of the structure and evolution of the North American continent, including earthquakes and seismic hazards, magmatic systems and volcanic hazards, lithospheric dynamics, regional tectonics, continental structure and evolution, fluids in the crust, and associated educational aspects. Science and non-science students will be engaged in geosciences discovery through the use of technology in real time or retrospectively with the aim of integrating research and education.

The U.S. Geological Survey (USGS), the National Aeronautics and Space Administration (NASA), the Department of Energy (DOE), and the International Continental Scientific Drilling Programme are partners with NSF in EarthScope. Project partners also include state and local governments, geological and engineering firms, and Canadian and Mexican agencies. Over 3,000 earth scientists and students are expected to use the facility annually. Geotechnical and engineering firms directly use data and models, which are enabled by EarthScope. Instrumentation firms are collaborating on development for state-of-the-art seismic systems, down-hole instrumentation, and high-precision GPS antenna designs.

Along with direct operations and maintenance support for EarthScope, NSF will support research performed utilizing the facility through ongoing research and education programs. The annual support for such activities is estimated to be about $6.20 million in FY 2010.

Project Report:

Management and Oversight:

- NSF Structure: The EarthScope Program Director, located in the Division of Earth Sciences (EAR) in the Directorate for Geosciences (GEO), provides NSF oversight. The Deep Earth Processes Section Head in EAR and a Project Advisory Team, including the staff from GEO, the Office of the General Counsel (OGC) and staff from the Office of Budget, Finance and Award Management (BFA), including the Deputy Director for Large Facility Projects, provide other internal oversight.

- External Structure: The external management structure includes a community-based EarthScope National Office, currently located at Oregon State University, an independent Steering Committee consisting of scientists from the EarthScope community including two subcommittees, one devoted to Education and Outreach and one devoted to Cyberinfrastructure; and external management oversight committees for each of the EarthScope facility components.

- Reviews: Each year, NSF convenes a panel of external experts to review project management, cost, schedule, and technical status of the EarthScope facilities and provide advice for the EarthScope managers and NSF.

Current Project Status:

EarthScope completed its construction phase on-time and on-budget on September 30, 2008 and is now fully operational. The USArray component of EarthScope is a continental-scale seismic and magnetotelluric observatory designed to provide a foundation for integrated studies of continental lithosphere and deep Earth structure over a wide range of scales. USArray consists of four major components: (1) a Reference Network of permanent seismic stations, (2) a Transportable Array of ~400 seismic stations, (3) a Flexible Array pool of seismic instruments for use in specific experiments, and (4) a Magnetotelluric Array with permanent and transportable instruments. The Plate Boundary Observatory (PBO) component of EarthScope is a geodetic observatory designed to study the three-dimensional strain field resulting from deformation across the active boundary zone between the Pacific and North American plates in the western United States. PBO includes 1200 geodetic and 79 strain meter/seismic stations. The San Andreas Fault Observatory at Depth (SAFOD) is a 3-kilometer deep hole drilled directly into the San Andreas Fault midway between San Francisco and Los Angeles, near Parkfield, CA. Located in an area that has ruptured six times since 1857, the hole is providing the first opportunity to observe directly the conditions under which earthquakes occur, to collect rocks and fluids from the fault zone for laboratory study, and to continuously monitor the physical condition within an active earthquake nucleation zone. Up-time of EarthScope seismic and geodetic instruments is consistently greater than 90 percent.

Although it became fully operational only last year, EarthScope has already led to a number of important scientific advances. EarthScope is aiding in the development of predictive models for earthquakes by unraveling the dynamic processes along faults, from stress build-up to catastrophic rock failure. While the unique SAFOD core from the San Andreas Fault is just beginning to be analyzed, early mineralogical analysis has already answered key questions about why sections of the fault exhibit slip in the form of creep. The combined use of PBO geodetic and strain data, and USArray seismic data, has documented a wide range of seismic and aseismic signals associated with different modes of fault slip along the Cascadia subduction zone and provided unique new insight into spatial and temporal relationships between earthquakes (large and small), tremor, and slow slip. These exciting new results may have important implications for assessing seismic risk along a plate boundary that is capable of a magnitude 9+ earthquake similar to the great Sumatra earthquake and tsunami of December 2005. PBO's regional scale geodetic network has also provided surprising new information on the Pacific-North American plate boundary, showing for example that extension in the Basin and Range province is not uniform as was once widely believed, but instead focused near its western and eastern edges. New advances are also being made in joint modeling of EarthScope seismic and strain data with other data types such as geochemistry and structural geology. Finally, EarthScope data has been used to develop a revolutionary new tomographic technique for imaging crust and upper mantle structure in western North America that utilizes seismic signals previously considered to be noise.

The EarthScope project has been represented at several dozen professional meetings and conferences through an exhibit booth, presentations, and well-attended scientific sessions. Scientific results utilizing data collected by the EarthScope facility have already been presented at national meetings and in professional publications. The third biennial EarthScope National Meeting will be held in Idaho in the Spring of 2009.

Operations costs

Annual operational costs for EarthScope are anticipated to remain approximately steady at about $25.0 million, with annual adjustments for inflation. EarthScope is receiving $4.0 million in ARRA funds in FY 2009 to cover a budget shortfall caused by smaller than anticipated growth of the EarthScope operations budget in 2008. The ARRA funds will allow the full EarthScope facility to operate throughout 2009, avoiding a potential reduction in operations staff and loss of scientific data.

Gemini Observatory

$19,100,000
+$390,000 / 2.1%

Gemini Observatory
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Percent
Gemini Observatory	$18.69	$18.71	-	$19.10	$0.39	2.1%

The Gemini Observatory consists of two 8-meter telescopes, one in the northern hemisphere, in Hawaii, and one in the southern hemisphere, in Chile. The Hawaiian telescope, Gemini North, is optimized for infrared observations and is located on Mauna Kea at an altitude of 4,200 meters. The telescope in Chile, Gemini South, is located on Cerro Pachon, also an outstanding photometric site, at an altitude of 2,700 meters. This siting of the two telescopes assures complete coverage of the sky and complements the observations from space-based observatories. It provides access to the center of our own Galaxy as well as the Magellanic Clouds, our nearest galactic neighbors. Both telescopes are designed to produce superb image quality and both use sophisticated adaptive optics technology to compensate for the blurring effects of the Earth's atmosphere.

Total Obligations for the Gemini Observatory
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Operations and Maintenance	$18.69	$18.71	$19.10	$19.58	$20.07	$20.57	$21.08	$21.61

Astronomers need to resolve important questions about the age and rate of expansion of the universe, its overall topology, the epoch of galaxy formation, the evolution of galaxies, including our own once they are formed, and the formation of stars and planetary systems. The current generation of optical/infrared telescopes with significantly larger aperture (8-meter diameter) than previous instruments provides better sensitivity and spectral and spatial resolution. Technological advances in a number of key areas of telescope construction and design optimize the telescopes' imaging capabilities and infrared performance, and compensate for the blurring effects of the Earth's atmosphere.

The Gemini telescopes help educate and train U.S. astronomy and engineering students. An estimated 10 percent of the roughly 500 U.S. users per year are students. Gemini is also providing a focus for public outreach and high school student training in all the partner countries, including "sister city" arrangements between Hilo, Hawaii and La Serena, Chile involving students and teachers at high school and elementary school levels. Gemini staff also provides guidance and support to the Imiloa Science Center, a public astronomy and cultural center in Hilo.

Gemini is an international partnership with the United Kingdom, Canada, Australia, Chile, Argentina, and Brazil. Construction of the telescopes and their instrumentation has involved a large number of industrial entities in a number of partner and non-partner countries. These have involved firms specializing in large and/or complex optical systems, aerospace industries, electronics, and engineering, etc. Continued involvement of such industries is part of the instrumentation and facilities renewal activities included in the operating budget of the Gemini Observatory.

Peer-review telescope allocation committees provide merit-based telescope time but no financial support. NSF does not provide awards targeted specifically for use of Gemini. Many U.S. users are supported through separate NSF or NASA grants to pursue scientific programs that require use of Gemini.

The Gemini North telescope photographed while propagating its guide star laser. The laser excites neutral sodium atoms at a height of about 90 km in the Earth's atmosphere, which produces an artificial guide star which is used by the adaptive optics system to correct for the blurring of the atmosphere. *Credit: Gemini Observatory.*

Laser guide star systems, which greatly improve the telescopes' ability to correct for atmospheric blurring, are being developed for both telescopes with the laser on Gemini North in routine operation and integration of the system on Gemini South underway. An advanced 'multi-conjugate' adaptive optics system, which will yield crisp images over a larger field of view, is in development on Gemini South and will start scientific operation in FY 2009. Several new instruments are in various states of development, including: (1) an improved infrared spectrometer, to be delivered in FY 2009; (2) the construction of the Gemini Planet Imager, a camera designed to directly detect planets around nearby stars; and (3) design studies for a very wide-field optical spectrometer that will collect data from thousands of objects simultaneously.

Budget projections for FY 2011 and beyond are based on a 2.5 percent annual ramp approved by the Gemini Board and NSF.

Facility Report

Management and Oversight:

- NSF Structure: NSF has one seat on the Gemini Board and provides the Executive Secretary to the Board. Programmatic management is the responsibility of an assigned NSF program manager for Gemini in the Division of Astronomical Sciences in the Directorate for Mathematical and Physical Science. The program manager approves funding actions, reports, and contracts, and conducts reviews on behalf of the Gemini partnership.

- External Structure: The Observatory is governed by the Gemini Board, established by the International Gemini Agreement signed by the participating agencies. NSF serves as the Executive Agency for the seven-nation partnership, carrying out the project on their behalf. An independent Visiting Committee, established by the Gemini Board, advises on the operation of the Observatory and meets bi-annually. Gemini is managed by Associated Universities for Research in Astronomy (AURA), Inc. on behalf of the partnership through a cooperative agreement with NSF. AURA conducts its own management reviews through standing oversight committees.

- Reviews: In addition to a review held mid-way through the cooperative agreement, NSF conducts periodic reviews of AURA management and observatory programs as requested by the Gemini

Board. The mid-term management review was held in Hilo on September 23-26, 2008. In addition, NSF conducted a Business System Review of the observatory in March 2009.

Renewal/Recompetition/Termination:

The current International Gemini Agreement will expire in 2012. The Gemini Board has begun discussing the process and schedule for renegotiation of the agreement. A decision point has been established by the Board for November 2009, at which time the partners must express their intention (or not) to remain in the partnership following 2012. It is anticipated that there will be changes in the partnership including possible rebalancing of the partners' shares. Negotiations for the international agreement and the Gemini management scheme may require a number of years to complete, thus requiring extensions of the current agreements.

The current NSF cooperative agreement is for FY 2006-2010. On the basis of the mid-term management review of AURA's performance as the Gemini managing organization in November 2008, the Gemini Board recommended not to compete the management of the observatory when the current cooperative agreement expires. The new cooperative agreement, expected to start in 2011, may be subject to amendment as details of the renewal International Gemini Agreement are finalized in the 2012-2013 timeframe. Discussions with AURA are underway to provide stable ongoing operations and management through the negotiations with the Gemini partners on their future involvement in the partnership.

Incorporated Research Institutions for Seismology

$12,360,000
+$360,000 / 3.0%

Incorporated Research Institutes for Seismology
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Incorporated Research Institutes for Seismology	$11.75	$12.00	$2.33	$12.36	$0.36	3.0%

IRIS operates a distributed national facility for the development, deployment, and operational support of modern digital seismic instrumentation to serve national goals in basic research in the Earth sciences, in earthquake research, global real-time earthquake monitoring, and in nuclear test ban verification. It is managed via a consortium of 109 U.S. universities and non-profit institutions with research and teaching programs in seismology. IRIS led the construction of the USArray component of the EarthScope project and it is now operating USArray as part of the EarthScope Facility.

Total Obligations for IRIS
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Operations and Maintenance	$11.75	$12.00	$12.36	$12.71	$13.09	$13.48	$13.89	$14.31
ARRA Estimate		2.33						
Total, IRIS	$11.75	$14.33	$12.36	$12.71	$13.09	$13.48	$13.89	$14.31

Totals may not add due to rounding.

The Earth's interior remains a major scientific frontier holding the key to understanding the origin of the planet. Recent developments in seismic sensor design, and the acquisition, transmission, and storage of data have resulted in dramatic improvements in the resolving power of seismic imaging of the interior. To serve the research needs of the broad national and international seismology community, IRIS is organized in four major core program elements:

1. The Global Seismographic Network (GSN), which currently consists of a global deployment of over 150 permanently installed broadband digital seismic stations, most of which have real-time data access;
2. The Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL), which manages a pool of portable seismometers that are made available to the seismology research community for scheduled regional and local scale studies;
3. The IRIS Data Management System (DMS), which provides the national and international seismic research community with timely access to data from the GSN and PASSCAL (70 terabyte archive);
4. The IRIS Education and Outreach (E&O) Program, which enables audiences beyond seismologists to access and use seismological data and research for educational purposes, including teacher workshops, student internships, museum exhibits, educational materials, and programs for under-resourced schools.

In addition, IRIS operates the USArray component of EarthScope. The USArray is a continental-scale seismic and magnetotelluric observatory designed to provide a foundation for integrated studies of continental lithosphere and deep Earth structure over a wide range of scales. The $2.33 million provided to IRIS through the American Recovery and Reinvestment Act of 2009 (ARRA) will be used to augment the Reference Network of USArray in the Pacific Northwest in order to facilitate the study of a wide spectrum of earthquake fault behavior and crustal deformation along this active plate boundary, including the newly discovered phenomena of episodic tremor and slip.

Besides its role in providing the observational data essential for basic research in geophysics and earthquake dynamics, IRIS also plays a significant role providing real-time seismic data to the U.S. Geological Survey and the National Oceanic and Atmospheric Administration for global earthquake and tsunami monitoring, in seismic monitoring of the Comprehensive Test Ban Treaty, and in bringing seismology to students and the public through the activities of its education and outreach program.

This is an image of the entrance to the Global Seismic Network's seismic vault on Tristan da Cunha in the South Atlantic. This station is part of a collaboration with the Comprehensive Test Ban Treaty Organization International Monitoring System and Geoscope. *Credit: Ted Kromer.*

IRIS is heavily involved in partnership activities, many international in nature. Installation and operation of the GSN has put IRIS in contact with scientists as well as government and non-government organizations from around the world. Many international IRIS GSN stations are designated as the official stations for nuclear test ban monitoring in their host countries. The IRIS facilities also are multi-use resources for other government agencies that have responsibilities for development of a nuclear test-ban monitoring capability and for monitoring global seismicity. For these purposes, agencies in partnership with NSF have provided substantial support to IRIS for accelerated development of the GSN (Department of Defense), shared operation and maintenance of the GSN (U.S. Geological Survey), and accelerated development of the PASSCAL instrument pool (Department of Energy).

The use of IRIS PASSCAL instruments for investigations of the shallow crust provides opportunities for collaboration with the petroleum exploration industry. Many students involved in these experiments receive training in techniques that prepare them for careers in the exploration industry. In a broader sense, IRIS continues to collaborate closely with industry in development of seismic instrumentation and software.

The Geophysics, Tectonics, and Continental Dynamics Programs in the Division of Earth Sciences (EAR); the Marine Geology and Geophysics Program in the Division of Ocean Sciences (OCE); and the Geology and Geophysics and Glaciology Programs in the Antarctic Research Section of the Office of Polar Programs (OPP) provide most of the funds for NSF-sponsored research making use of the IRIS facilities, totaling approximately $15 million per year. Funds permit deployment of PASSCAL instruments and use of GSN data stored at the DMS to solve major earth science problems.

Facility Report:

Management and Oversight:

- NSF Structure: EAR, through its Instrumentation & Facilities Program (IF), provides IRIS with general oversight to help assure effective performance and administration. The program also facilitates coordination of IRIS programs and projects with other NSF-supported facilities and projects and with other federal agencies and evaluates and reviews the scientific and administrative performance of IRIS.

- External Structure: IRIS is incorporated as a non-profit consortium representing practically all U.S. university and non-profit organizations with research and teaching programs in seismology. Each member institution appoints a representative. However, all IRIS program and budget decisions are made by a nine-member Board of Directors. These decisions are made after consultation with the IRIS advisory committees (the four standing committees for each of the four IRIS programs and additional ad hoc working groups appointed for special tasks). The Board of Directors appoints a president of IRIS to a two-year term. The president is responsible for IRIS operations, all of which are managed through the IRIS Corporate Office.

<u>Reviews & Renewal</u>:

A new five-year cooperative agreement with the IRIS Consortium for the continued management of the IRIS core facilities (2006-2011) was approved by the NSB in May 2006 and finalized in September 2006. All major ongoing geoscience facilities routinely undergo mid-award reviews of their management in addition to peer review of proposals for new or continued support. A management review of IRIS took place in April 2009. Although a number of specific recommendations were made by the review committee, overall the committee found that IRIS is an extremely well-managed and effective organization that has, through its commitment to the collection and open dissemination of the highest quality seismological data, transformed the discipline of seismology.

The Integrated Ocean Drilling Program and the Scientific Ocean Drilling Vessel — $43,410,000 +$0.0 / 0.0%

The Integrated Ocean Drilling Program
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Integrated Ocean Drilling Program	$37.41	$43.41	$25.00	$43.41	-	-

The Integrated Ocean Drilling Program (IODP), which began in FY 2004, is an expanded successor program to the Ocean Drilling Program (ODP) and represents an international partnership of more than 20 national funding organizations, scientists, and research institutions organized to explore the evolution and structure of Earth as recorded in the ocean basins. The IODP is co-led by NSF and the Ministry of Education, Culture, Sport, Science and Technology (MEXT) of Japan. IODP platforms provide sediment and rock samples (cores), in-situ monitoring, sampling, and measurement from borehole observatories, shipboard and shorebased descriptive and analytical facilities, downhole geophysical and geochemical measurements (logging), and opportunities to conduct experiments to determine in-situ conditions beneath the seafloor.

SODV Underway for Initial Science Expedition, March 10, 2009. *Credit: NSF*

Total Obligations for IODP
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
SODV Operations and Maintenance	$37.41	$43.41	$43.41	$43.41	$44.41	$44.41	$45.00	$46.00
ARRA Estimate		25.00						
Total, IODP	$37.41	$68.41	$43.41	$43.41	$44.41	$44.41	$45.00	$46.00

Totals may not add due to rounding.

NOTE: The IODP program officially ends in 2013 but may be renewed. NSF activities regarding IODP renewal, including overall program review, are expected to commence in FY 2011. IODP scientific community planning efforts for a post- FY 2013 science program commenced in FY 2009. Funding for FY 2014 and FY 2015 is estimated assuming renewal of the program.

Annual operations and maintenance support for IODP includes the costs of operating the platform itself, providing technical scientific support, maintaining databases and preparing scientific publications emerging from IODP expeditions, and management of the international program. In addition, NSF will support research enabled by the facility through ongoing research and education programs. The annual costs for such associated science support, not included in the table above, are estimated to be about $11.0 million. Operations and maintenance costs are based on NSF experience in management of the ODP and the contract with the SODV operator. Funding in FY 2009, including $25.0 million provided through the American Recovery and Reinvestment Act of 2009 (ARRA), will enable a 30 percent increase in the operating schedule of the Scientific Ocean Drilling Vessel (SODV). This increase allows for full time operation of the vessel.

The IODP Scientific program includes emphasis on the following research themes:

- Deep Biosphere and the Sub-seafloor Ocean.
- Processes and Effects of Environmental Change.
- Solid Earth Cycles and Geodynamics, including study of tsunami-producing seismogenic zones and other geohazards.

Undergraduate and graduate students participate in drilling expeditions, working with leading scientists to help become future leaders themselves. Other students and the public are engaged in geoscience discovery through distance learning initiatives (including remote broadcasts from the drillship), classroom teaching modules on IODP research initiatives, outreach displays for museums and educational/teaching institutions, and lecture programs. In FY 2007, an estimated 180,000 K-12, 10,000 undergraduate and 10,500 graduate students engaged in or were supported by IODP education and outreach efforts, as were 35,000 teachers.

MEXT and NSF are equal partners in IODP and contribute equally to program operation costs. The European Consortium for Ocean Research Drilling (ECORD) – representing 16 European countries and Canada – the People's Republic of China and Korea have officially joined IODP and provide financial contributions. India and Australia have also announced their intention to join the partnership. IODP partners, including NSF, support IODP integrative activities including science planning, review, data management, drilling science-related engineering development, core and sample archiving, publishing, and international outreach.

Over 2,000 scientists from 40 nations have participated on ODP and IODP expeditions since 1985, including about 900 U.S. scientists from over 150 universities, government agencies, and industrial research laboratories. Samples and data have been distributed to more than 800 additional U.S. scientists.

NSF is contracting the services of the light drillship from a leading offshore drilling contractor. A commercial contractor provides downhole-logging services. In addition, scientists from industrial research laboratories propose and participate in IODP cruises, are members of the program's scientific and technical advisory committees, and supply data for planning expeditions and interpretation of drilling results.

Facility Report:

<u>Management and Oversight:</u>

- NSF Structure: The Division of Ocean Sciences in the Directorate for Geosciences (GEO) manages the SODV and the IODP under the NSF Ocean Drilling Program. NSF's Ocean Drilling Program is located within the Marine Geosciences Section, with several program officers dedicated to its oversight. One of the program officers serves as the contracting officer's technical representative for the Central Management Office (CMO) contract and the System Integration Contractor (SIC) contract.

- External Structure: NSF and MEXT have signed a Memorandum of Cooperation, which identifies procedures for joint management of a contract to an IODP CMO. A non-profit corporation of U.S., Japanese, and other international institutions (IODP Management International, Inc.) has been contracted by NSF for the CMO activity. The CMO coordinates and supports scientific planning, drilling platform activity, data and sample distribution, and publication and outreach activities through its management of commingled international science funds, collected and provided by NSF. Drillship providers are responsible for platform operational management and costs. NSF provides the light drillship through contract with the U.S. SIC, an alliance formed by the Consortium for Ocean Leadership, Inc. (COL) together with subcontractors Texas A&M University and Lamont-Doherty Earth Observatory, Columbia University. MEXT manages its drillship through the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), while the British Geological Survey manages ECORD drilling contributions.

Scientific advice and guidance for IODP is provided through the science advisory structure (SAS). The SAS consists of a Science Advisory Structure Executive Committee (SASEC) and a series of committees, panels, and groups headed by the Science Planning Committee (SPC). The CMO, under the direction of the SPC Chair, is responsible for coordinating the SAS committees, panels, and groups, and for integrating the advice from the SAS into drilling and operational guidance for IODP. Representation in the SAS is proportional to IODP member's financial contribution.

- Reviews: Both the CMO and SIC contracts call for management reviews every three years by independent, external panels. Both the SIC and CMO contracts will undergo external review in FY 2010. Reviews for each expedition are carried out on a regular basis to evaluate operational and scientific performance, with review of scientific progress in broader thematic areas conducted by independent panel every several years.

<u>Renewal/Recompetition/Termination:</u>

IODP international agreements and contracts cover activities through FY 2013. NSF activities regarding IODP renewal, including overall program review, are expected to commence in FY 2011. IODP scientific community planning efforts for a post- FY 2013 science program commenced in FY 2009.

<u>Scientific Ocean Drilling Vessel (SODV)</u>

The SODV project was funded through the Major Research Equipment and Facilities Construction (MREFC) account and supported the contracting, conversion, outfitting and acceptance trials of a deep-sea drilling vessel for long-term use in the IODP. The total NSF cost of the project was $115 million appropriated through the MREFC account over three years, with FY 2007 representing the final year of appropriations. The ship operator, Overseas Drilling Limited (ODL), is covering certain construction costs in exchange for a higher day rate charge during the operations phase. Construction activities have been completed and the ship is scheduled to commence international scientific operations on May 10, 2009. The outfitted drillship is capable of operating in nearly all ocean environments (subject to limitations regarding minimum water depth and surface ice coverage), and accommodates a scientific and technical staff of up to 60 persons.

Project Report:

<u>Management and Oversight:</u>

- NSF Structure: The project was overseen by a program director in the OCE in GEO with advice and oversight support from a NSF Project Advisory Team, including representatives from GEO, the Office of Polar Programs, the Office of Budget, Finance and Award Management (BFA), and the

Office of General Counsel. The BFA Deputy Director for Large Facility Projects participated as a member of the PAT, providing advice and assistance.

- External Structure: A SODV Independent Oversight Committee provided technical, financial and scheduling recommendations and advice for the SODV project to top-level management. A Program Advisory Committee (PAC), comprised of members of the science and drilling communities, provided ongoing assessment of the design plans for the on-board science and drilling capabilities, to assure that the converted vessel reflects the needs of the scientific communities.

- Reviews:
  - A two-phase independent readiness assessment of the SODV science systems was completed in February and March 2009 by a group of ocean drilling veteran scientists: the first phase included a land-based assessment of a new integrated database for IODP measurements, and the second phase included an underway assessment of the functionality of analytical instruments and their integration with the database software.
  - A final acceptance review process is being performed by the System Integration Contractor and NSF and is due in late 2009.

<u>Current Project Status:</u>

Shipyard conversion of the vessel was completed in early January 2009. Initial load-out and shakedown activities were conducted and the SODV is scheduled to commence IODP scientific operations on May 10, 2009.

<u>Cost and Schedule:</u>

Refitting of the ship is completed. Due to the enormous worldwide demand for shipyard services during the SODV refit period, actual shipyard work lagged planned progress, resulting in significant delay in return of the vessel to science operations. Various project costs are still under review but current indications are that the NSF portion of the SODV refit has been completed within the MREFC project funding profile established in early FY 2005.

<u>Risks:</u>

The remaining project risks include successful and timely resolution of final “punch list” items requiring vendor repairs and science system software issues identified during the independent readiness assessment.

<u>Future Operations Costs:</u>

Future operations costs are described in the obligations table above.

Large Hadron Collider

$18,000,000
$0.0 / 0.0%

Large Hadron Collider
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Large Hadron Collider	$18.00	$18.00	-	$18.00	-	-

The Large Hadron Collider (LHC), an international project under construction at the CERN laboratory in Geneva, Switzerland, will be the premier facility in the world for research in elementary particle physics. The facility will consist of a superconducting particle accelerator providing two, counter-rotating beams of protons, each beam having an energy up to 7 TeV (1TeV=10^{12} electron volts). The U.S. is involved in the maintenance and operation of two particle detectors, a Toroidal LHC Apparatus (ATLAS) and the Compact Muon Solenoid (CMS). These have been built to characterize the different reaction products produced in the very high-energy proton-proton collisions that will occur in intersection regions where the two beams are brought together. A total of 34 international funding agencies participate in the ATLAS detector project and 31 in the CMS detector project. NSF and the Department of Energy (DOE) are providing U.S. support. CERN is responsible for meeting the goals of the international LHC project. The ATLAS and CMS detectors are expected to take data approximately 200 days per year. The remaining time is to be used for maintenance and testing.

The U.S. LHC collaboration has been a leader in the development of Grid-based computing. The Grid will enable the enhanced participation of U.S. universities, and thus the training of students, in both state of the art science and computational techniques, in a project that is centered overseas. The Grid is expected to have broad application throughout the scientific and engineering communities.

Total Obligations for the LHC
(Dollars in Millions)

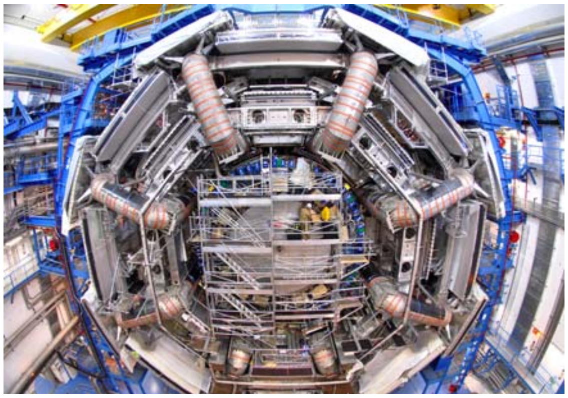
	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Operations and Maintenance	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00

The current cooperative agreement ends in FY 2011. Outyear funding estimates are for planning purposes only and do not reflect policy decisions.

The LHC will enable a search for the Higgs particle, the existence and properties of which will provide a deeper understanding of the origin of mass of known elementary particles. The LHC will also enable a search for particles predicted by a powerful theoretical framework known as supersymmetry, which may provide clues as to how the four known forces evolved from different aspects of the same ‘unified’ force in the early universe, and can investigate the possibility that there are extra dimensions in the structure of the universe. Through the participation of young investigators, graduate students, undergraduates, and minority institutions in this international project, LHC serves the goal of helping to produce a diverse, globally-oriented workforce of scientists and engineers. Further, innovative education and outreach activities, such as the QuarkNet project, allow high school teachers and students to participate in this project (see http://quarknet.fnal.gov).

Major procurements of components of both warm and superconducting magnets, as well as high-speed electronics, are performed through U.S. industries. Major developments in Grid computing are also valuable outcomes. In the construction phase, approximately $45.0 million was devoted to materials procurements from industry. In FY 2010 the estimate for material procurements is approximately $3.80 million, which is included within the $18.0 million operating costs.

The U.S. LHC Collaboration is in the final stages of installation of detector components in the experimental areas and has been actively engaged in the integration of these components with the rest of the detectors and the commissioning of the detectors using cosmic rays. This effort is proceeding on schedule and budget. However, the accelerator start-up schedule has been delayed due to failure in September 2008 of a high current line that caused arching and destructive failure of a liquid helium cryogenic system. First beams are now expected in late FY 2009, after which detector commissioning will proceed using the particle beams and will continue into FY 2010. Data-taking is expected to begin in FY 2010 when the beam performance stabilizes.



The ATLAS detector in February 2007. *Credit: CERN.*

Facility Report:

Management and Oversight:

- NSF Structure: A program director in the Division of Physics (PHY) is responsible for day-to-day project oversight. The NSF program director participates in an internal Project Advisory Team, including staff from the NSF Offices of Budget Finance and Award Management, General Counsel, Legislative and Public Affairs, Office of International Science and Engineering, and Office of the Assistant Director for MPS.

- External Structure: U.S. LHC program management is performed through a Joint Oversight Group (JOG), created by the NSF and DOE. The JOG has the responsibility to see that the U.S. LHC Program is effectively managed and executed to meet commitments made under the LHC International Agreement and its Protocols.

- Reviews: There is one major management/technical review each year with a panel of external, international experts as well as one review by NSF/DOE program directors to monitor progress on issues raised at panel reviews. Two JOG review meetings per year monitor overall program management.

Renewal/Recompetition/Termination:

The LHC project is expected to continue at least through to the end of the next decade. Since the present award goes through FY 2011, it will require a renewal. The U.S. LHC collaboration is part of an international collaboration where the U.S. contribution to the detector construction and operations is intimately connected to that of its international collaborators. Under these circumstances it would be difficult, if not unrealistic, to consider recompeting the U.S. role in the international collaboration when the present award ends.

Laser Interferometer Gravitational-Wave Observatory

$28,500,000
-$1,800,000 / -5.9%

Laser Interferometer Gravitational-Wave Observatory
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Laser Interferometer Gravitational-Wave Observatory	$29.50	$30.30	-	$28.50	-$1.80	-5.9%

Einstein's theory of general relativity predicts that cataclysmic processes involving extremely dense objects in the universe will produce gravitational radiation. Detection of these gravitational waves is of great importance for both fundamental physics and astrophysics. The Laser Interferometer Gravitational Wave Observatory (LIGO), the most sensitive gravitational-wave detector ever built, comprises two main facilities, one in Livingston Parish, LA and one in Hanford, WA. At each facility, a large vacuum chamber with two 4-km arms joined at right angles houses one or more optical interferometers; Hanford has a second 2-km interferometer in the same housing. The interferometers are used to measure minute changes in the distances between test masses at the ends of the arms caused by a passing gravitational wave. The predicted distortion of space caused by a gravitational wave from a likely type of source is on the order of one part in 10^{21}, meaning that the expected change in the apparent 4-km length is only on the order of 4×10^{-18} or about 1/1000th the diameter of a proton. The 4-km length for LIGO, the largest for any optical interferometer, was chosen to make the expected signal as large as possible within terrestrial constraints. Looking for coincident signals in all the interferometers simultaneously increases the likelihood for gravitational wave detection.

LIGO's current and projected operations and maintenance requests for FYs 2009-2013 are less than the FY 2014 and later requests since some employees and resources will be diverted to the Advanced LIGO (AdvLIGO) project funded through the Major Research Equipment and Facilities Construction (MREFC) account, which began in FY 2008. LIGO operations will, however, continue to analyze data taken during the current and earlier runs and will also plan for, conduct, and analyze future scientific runs scheduled from FY 2009 until a temporary shutdown of the detectors in FY 2011.

Total Obligations for LIGO
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Operations and Maintenance	$29.50	$30.30	$28.50	$30.30	$30.40	$30.50	$36.00	$39.00

LIGO has been a significant source of highly trained Ph.D. graduates for the country's workforce. The number of graduate students has grown from the beginning of LIGO's science runs in FY 2002 and will continue to do so. In addition, LIGO has a diverse set of educational activities at its different sites, activities that involve a large number of undergraduates (including those from minority-serving institutions), hands-on activities for K-12 classes and teachers at all levels, and informal education and outreach activities for the public. A Visitors' Center at the Livingston, LA site, dedicated in November, 2006, is filled with Exploratorium exhibits and is the focal point for augmenting teacher education at Southern University and other student-teacher activities state-wide through the Louisiana Systemic Initiative Program, originally funded by NSF.

The intersection of the 4-kilometer arms of the Livingston, LA LIGO interferometer. *Credit: Courtesy of the LIGO Laboratory.*

Substantial connections with industry have been required for the state-of-the-art construction and measurements involved in the LIGO projects. Some have led to new products. Involvement includes novel techniques for fabrication of LIGO's vacuum system, seismic isolation techniques, ultrastable laser development (new product), development of new ultra-fine optics polishing techniques, optical inspection equipment (new product). LIGO has recently cooperated with the Defense Intelligence Agency on research on LIGO interferometers as impulse seismic event detectors.

In 1997 LIGO founded the LIGO Scientific Collaboration (LSC), an open collaboration that organizes the major international groups doing research supportive of LIGO. The LSC now has more than 60 collaborating institutions with over 650 participating scientists. A Memorandum of Understanding between the LIGO Laboratory and each institution determines the role and membership responsibilities of each participating institution. The LSC plays a major role in many aspects of the LIGO effort including: R&D for detector improvements, R&D for AdvLIGO, data analysis and validation of scientific results, and setting priorities for instrumental improvements at the LIGO facilities. Annual NSF support for science and engineering research directly related to LIGO activities through ongoing research and education programs is about $5.50 million.

LIGO concluded its mission-defining scientific run (S5), in which a year's accumulation of data was taken at its design sensitivity with all three interferometers operating in coincidence, in October, 2007. These data were taken at a detector sensitivity in excess of the defined goal sensitivity outlined in the design specifications. Science runs planned to begin in 2009 will test technologies that will become part of AdvLIGO; the detector sensitivity will be at least twice that during the previous S5 run.

LIGO's operations during the AdvLIGO construction era will concentrate on:

- Planning for and operation of "enhanced" LIGO and the corresponding science run at a sensitivity about twice that of initial LIGO in FYs 2009–2011
- Research and development to reduce risk for the AdvLIGO project, to enhance performance post-construction and to enable future enhancements
- Data analysis and other science activities by staff of the LIGO Laboratory
- Education and Outreach activities
- Ramp-up of AdvLIGO commissioning activities

For more information on AdvLIGO, see the MREFC chapter.

Facility Report:

Management and Oversight:

- NSF Structure: NSF oversight is coordinated internally by the LIGO Program Director in the Division of Physics (PHY), who also participates in the PHY AdvLIGO Project Advisory Team, comprising staff from the Office of General Counsel, the Office of Legislative and Public Affairs, the

Office of Budget, Finance and Award Management, including the Deputy Director for Large Facility Projects, and the Office of International Science and Engineering.

- External Structure: LIGO is sponsored by NSF and managed by Caltech under a cooperative agreement. The management plan specifies significant involvement by the user community, represented by the LIGO Scientific Collaboration (LSC), and collaboration with the other major gravitational-wave detector activities in Asia, Europe, and Australia. External peer-review committees organized by the NSF help provide oversight through an annual review.

- Reviews:
  - Advanced LIGO Baseline Review, May-June 2006
  - LIGO Annual Review, November 2006
  - Advanced LIGO Baseline Update Review, June 2007
  - LIGO Annual Review and LIGO FY 2009-2013 Operations Proposal Review, November 2007
  - LIGO Annual Review, November 2008
  - Advanced LIGO Annual Review, April 2009

Renewal/Recompetition/Termination:

LIGO began operating under a new five-year cooperative agreement at the beginning of FY 2009. As a condition of approval of this award (and a possible future award), the National Science Board stipulated that the operation of LIGO be recompeted no later than 2018. The projected lifetime of the LIGO facility is 20 years.

Major Research Equipment and Facilities Construction Account Projects

The MREFC account supports the acquisition, construction and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Projects supported by this account are intended to extend the boundaries of technology and open new avenues for discovery for the science and engineering community. Initial planning and design, and follow on operations and maintenance costs of the facilities are provided through the Research and Related Activities (R&RA) and Education and Human Resources (EHR) accounts.

For information on projects funded through this account, please see the MREFC chapter in this document.

National High Magnetic Field Laboratory **$31,950,000**
+$5,450,000 / 20.6%

National High Magnetic Field Laboratory
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
National High Magnetic Field Laboratory	$27.75	$26.50	$5.00	$31.95	$5.45	20.6%

The National High Magnetic Field Laboratory (NHMFL) is operated by Florida State University (FSU), the University of Florida (UF), and Los Alamos National Laboratory (LANL). The Laboratory develops and operates high magnetic field facilities that scientists and engineers use for research in physics, biology, bioengineering, chemistry, geochemistry, biochemistry, materials science, medicine, and engineering. It is the world's premier high magnetic field laboratory with a comprehensive assortment of high-performing magnet systems. Many of the unique magnet systems were designed, developed, and built by the magnet engineering and design team at the NHMFL in collaboration with industry. The facilities are available to all qualified scientists and engineers through a peer-review proposal process. The additional funding requested in FY 2010 will support magnet development, new instrumentation, planned facility upgrades, and support of in-house high impact research and development.

Total Obligations for NHMFL
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Operations and Maintenance	$27.75	$26.50	$31.95	$34.00	$34.00	$37.50	$38.50	$39.50
ARRA Estimate	-	5.00	-	-	-	-	-	-
Total, NHMFL	$27.75	$31.50	$31.95	$34.00	$34.00	$37.50	$38.50	$39.50

Totals may not add due to rounding.

An increase of $5.45 million in FY 2010 will allow the facility to strengthen user support and in-house research, education, and training. Funding will also help meet operations needs, such as electricity and cryogenics cost increases, critical parts for replacement of aging equipment, completion of the planned split-magnet development, and support of technical staff and education and training efforts.

The principal scientific goals of NHMFL are to provide the highest magnetic fields, state-of-the-art instrumentation, and support services for scientific research conducted by users from a range of science and engineering disciplines. In addition, the lab is an internationally recognized leader in magnet design, development, and construction. The Magnet Science and Technology (MS&T) Division of NHMFL has broad responsibility to develop high field magnets and conducting and superconducting materials for future generation magnet wires in response to national needs. MS&T works with industry and other international magnet laboratories on a variety of technology projects. These include analysis, design, component development and testing, coil fabrication, cryogenics, system integration and testing.

Current magnet development at NHMFL is focusing on design and construction of high field magnets for the Nation's premier neutron and light sources. The lab has collaborated with more than 60 private sector companies, including American Magnetics, Exxon Mobil, and Oxford Instruments, and national laboratories and federal centers, including those supported by the Department of Energy (DOE) such as the Spallation Neutron Source and the Advanced Photon Source. International collaboration includes magnet development with the Hahn-Meitner Institute in Berlin and the Korea Basic Science Institute.

With its distinguished faculty and world-class facilities, NHMFL provides a unique interdisciplinary learning environment. Its annual K-12 outreach engages over 7,000 students from Florida and Georgia in hands-on activities and tours of the lab. In addition NHMFL conducts a College Outreach-Workforce Initiative Program to increase diversity in lab programs. This has included outreach to approximately 200 undergraduates at Historically Black Colleges and Universities. NHMFL hosts an annual one-day Open House (over 5,000 attendees in 2009) as well as tours (e.g., about 10,000 students per year).

Facility Report

<u>Management and Oversight:</u>

- NSF Structure: NHMFL is supported by the Division of Materials Research (DMR) and Division of Chemistry (CHE) in the Directorate for Mathematical and Physical Sciences (MPS). Primary responsibility for NSF oversight is with the National Facilities Program Director in DMR, with guidance from an ad hoc working group with members from CHE and the Directorates for Engineering and for Biological Sciences. Site visit reviews are conducted annually. Representatives from other federal agencies such as DOE and the National Institutes of Health (NIH) are invited to observe.

- External Structure: NHMFL is operated by a FSU, UF, and LANL consortium under a cooperative agreement. FSU, as the signatory of the agreement, has the responsibility for appropriate administrative and financial oversight and for ensuring that operations of the laboratory are of high quality and consistent with the objectives of the cooperative agreement. The principal investigator serves as the NHMFL director. Fur senior faculty members are co-principal investigators. The NHMFL director receives guidance and recommendations from an External Advisory Committee, the NHMFL Executive Committee, NHMFL staff, participating institutions, and the Users' Committee.

- Reviews: NSF conducts annual reviews using external reviewers, which assess user programs, in-house research, long-term plans to contribute significant research developments both nationally and internationally, and operations, maintenance, and new facility development. Annual reviews also assess the status of education training and outreach, operations and management efficiency, and diversity plans. Recent reviews include:
  - Renewal Review, January 9-11, 2007
  - Annual Review by external panel, December 2008
  - Total Business Systems review planned, Spring 2009
  - Annual Reviews by external panel planned, late 2009, and 2010

<u>Renewal/Recompetition/Termination:</u>

A comprehensive renewal review was conducted in FY 2007. On August 8, 2007 the National Science Board approved NSF's recommendation for a 5-year renewal award not to exceed $162.0 million for FY 2008-2012. This award allows NHMFL to increase its user program, continue development of new magnet systems, and support the strongest aspects of its in-house research efforts. The award ensures that the laboratory will remain the international leader in magnet research operations and development. In FY 2011 NSF will examine options to recompete or renew the award in FY 2012.

National Nanotechnology Infrastructure Network **$17,000,000**
+$0.0 / 0.0%

The National Nanotechnology Infrastructure Network
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
The National Nanotechnology Infrastructure Network	$13.83	$17.00	$10.00	$17.00	-	-

The National Nanotechnology Infrastructure Network (NNIN) has been renewed for a final five-year period from FY2009-2013. In the renewal period, NNIN now comprises 14 university sites that form an integrated national network of user facilities supporting research and education in nanoscale science, engineering, and technology. The NNIN provides users across the Nation with access, both on-site and remotely, to leading-edge tools, instrumentation, and capabilities for fabrication, synthesis, characterization, design, simulation, and integration. The broad scope of NNIN coverage includes areas of physics, chemistry, materials, mechanical systems, geosciences, biology, life sciences, electronics, optics, molecular synthesis, and molecular scale devices, among others.

Total Obligations for NNIN
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Operations and Maintenance	$13.83	$17.00	$17.00	$17.00	$17.00	$17.00	$17.00	$17.00
ARRA Estimate	-	10.00						
Total, NNIN	$13.83	$27.00	$17.00	$17.00	$17.00	$17.00	$17.00	$17.00

Totals may not add due to rounding.

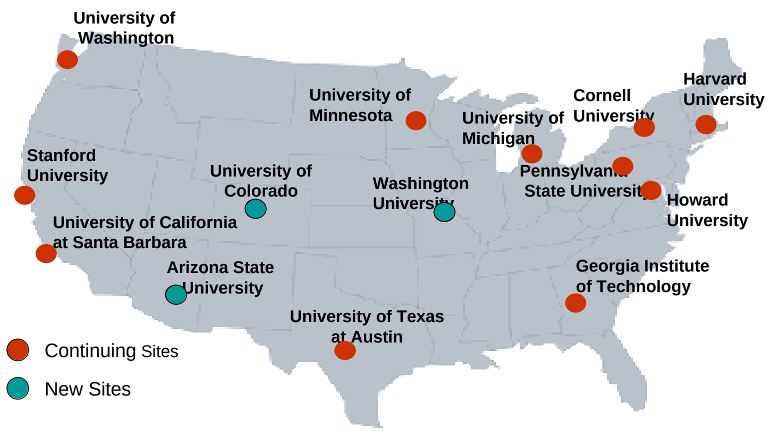
NNIN's broad-based national user facilities enable the Nation's researchers from academia, small and large industry, and government to pursue transformative research, to seek new discoveries and applications in a broad range of domains of nanoscale science and engineering, and to stimulate technological innovation. The network also develops the infrastructure and intellectual and institutional capacity needed to examine and address societal and ethical implications of nanotechnology, including issues of environment, health, and safety.

NNIN undertakes on a national scale a broad spectrum of innovative activities in education, human resource development, knowledge transfer, and outreach to the science, engineering, and technological communities. Special emphasis is placed on education and training of a diverse science and engineering workforce that involves non-traditional users and under-represented groups, including women and minorities.

NNIN seeks to leverage its capabilities through connections and collaborations with national and industrial laboratories and with foreign institutions. Through such partnerships, joint meetings, and workshops, the network shares expertise and perspectives, provides specialized training opportunities, coordinates access to unique instrumentation, and transfers newly developed technologies.

NNIN leverages research strengths of the university to bring them to the external community. The institutions comprising the NNIN have strong underlying internal research programs that provide the knowledge base for developing new processes, methodologies, and instrumentation, as well as much of the capital infrastructure. NSF and other agencies independently award research grants to principal investigators who use the NNIN facilities to carry out some aspects of their research projects.

During the renewal award period, three new institutions have joined the network, and each brings new capabilities: the University of Colorado, which will focus on research in energy-related problems and in precision sciences, which includes measurements, standards, and systems; Arizona State University, which will focus on organic/inorganic interfaces in electronics, biodesign, implantable devices, flexible electronics, sensors., and outreach to underrepresented communities in the Southwest; and Washington University in St. Louis, a leading medical and public health institution, whose research focus will be on nanomaterials and nanosciences for environment, health, and safety.



NNIN continues to maintain a strong network-wide Research Experience for Undergraduates (REU) program, with a focus on the diversity of its participants. The renewal award provides substantial support for the REU program. NNIN held its first International Winter School for Graduate Students (iWSG) at IIT Kanpur, India in late 2008. It was attended by 12 U.S. graduate students who were competitively selected from across the country and several NNIN faculty members. The program provided an international learning experience in a nascent research area of organic electronics and optoelectronics with strong society and ethics components aimed at exposing U.S. graduate students to nanotechnology issues and research challenges in the context of developing country environments.

In its fifth year of operation, user data collected during the initial ten-month period showed that NNIN served 4,739 unique users, of whom 3,906 were academic users, 758 industrial users, 32 from US State and Federal laboratories, and 34 from foreign institutions. More than 1,600 new users were trained during the ten-month period. Over a period of a year, NNIN has enabled in excess of 1,000 PhD awards, activities of 250 small and large companies, and leveraged over $400 million dollars in research investments through use of its facilities.

Facility Report:

<u>Management and oversight:</u>

- NSF structure: NSF provides oversight of the NNIN under a cooperative agreement. The program officer for the NNIN activity resides in the Division of Electrical, Communications and Cyber Systems (ECCS) in the Directorate for Engineering (ENG). The program officer coordinates NNIN oversight with the NNIN working group comprised of representatives from all NSF research and education directorates. NNIN is reviewed annually through site reviews held at one of the network sites. These reviews involve an external team of experts selected by NSF staff. In addition to the annual site reviews, semi-annual briefings of NSF staff are held at the NSF attended by the NNIN network director, site directors, and area coordinators.

- External structure: NNIN is managed as a cohesive and flexible network partnership through a Network Executive Committee derived from the individual Site Directors, and the Education/Outreach and Society/Ethics Coordinators. The Network Director, is from the lead institution, Cornell University, and provides intellectual leadership for the network, is responsible, in cooperation with the Network Executive Committee, for developing strategies, operational plans, and coordination of the activities of the network, and serves as the principal contact on behalf of the network with the NSF. An external Network Advisory Board meets at least annually and provides independent advice and guidance to the Network Director and Executive Committee concerning the network's programs, activities, vision, funding allocations, and new directions. The Advisory Board shares its major recommendations with the NSF. The Site Directors are responsible for local management functions of the individual user facilities, for interfacing with other facilities and with the management team for the overall network, and for connections with the outside communities.

- Reviews:
  - The first comprehensive annual review of the NNIN was held following an initial 9 months of operation at the Georgia Institute of Technology site in December 2004. The second annual review was held at the University of Texas-Austin site in February 2006. The third annual review was held at the University of Michigan site in May 2007. The fourth annual review was held at Stanford University in May 2008. This review also served to evaluate the NNIN renewal proposal for the five-year period FY 2009-2113.
  - Upcoming reviews: A fifth annual review will be held in Spring 2010.

NNIN will be provided $10,000,000 in ARRA funds to acquire advanced nanofabrication and characterization instrumentation and tools at several of its network sites that will enable users to accomplish state-of-the-art research projects. Availability of these funds will address the challenges the network has faced in maintaining its capital equipment base through acquisition of new instrumentation and replacement of old or high-demand equipment.

<u>Renewal/Recompetition/Termination:</u>

Consistent with the program solicitation under which NNIN was competed, the NNIN award could be renewed once, without recompetition, for an additional five years. In early 2008, NNIN submitted a renewal proposal, which was reviewed both by *ad hoc* mail review and by on-site panel review in May 2008. The site review panel report strongly recommended that NSF renew NNIN for an additional five years. The National Science Board approved NSF's recommendation and authorized renewal of the NNIN award for a final five-year period from FY 2009-2013. In the third year of this final award period, NSF plans to convene a panel of recognized national experts to evaluate the needs of, and appropriate future investments in, the national infrastructure for nanotechnology.

National Superconducting Cyclotron Laboratory **$21,000,000**
+$500,000 / 2.4%

National Superconducting Cyclotron Laboratory
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
National Superconducting Cyclotron Laboratory	$19.25	$20.50	$2.00	$21.00	$0.50	2.4%

The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University (MSU) is a national user facility. With two superconducting cyclotrons, K500 and K1200, it is the leading rare isotope research facility in the U.S. and is among the world leaders in heavy ion nuclear physics and nuclear physics with radioactive beams. Funding for NSCL also supports the MSU research program.

Total Obligations for the NSCL
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Operations & Maintenance	$19.25	$20.50	$21.00	$21.50	$21.50	$21.50	$21.50	$21.50
ARRA Estimate	-	2.00	-	-	-	-	-	-
Total, NSCL	$19.25	$22.50	$21.00	$21.50	$21.50	$21.50	$21.50	$21.50

Totals may not add due to rounding.

The current cooperative agreement expires in FY 2011. Outyear funding estimates are for planning purposes only and do not reflect policy decisions.

NSCL scientists employ a range of tools for conducting advanced research in fundamental nuclear science, nuclear astrophysics, and accelerator physics. Applications of the research conducted at the NSCL benefit society in numerous areas, including new tools for radiation treatments of cancer patients and the assessment of health risks to astronauts. The K500 was the first cyclotron to use superconducting magnets, and the K1200 is the highest-energy continuous beam accelerator in the world. Through the recently completed Coupled Cyclotron Facility (CCF), heavy ions are accelerated by the K500 and then injected into the K1200, enabling the production of rare unstable isotopes at much higher intensities.

Scientists at NSCL work at the forefront of rare isotope research. They make and study atomic nuclei that cannot be found on Earth and perform experimental research using beams of unstable isotopes to extend our knowledge of new types of nuclei, many of which are important to an understanding of stellar processes. Research activities include a broad program in nuclear astrophysics studies, the studies of nuclei far from stability using radioactive ion beams, and studies of the nuclear equation of state. In addition, research is carried out in accelerator physics.

NSCL supports and enhances doctorate graduate education and post-doctoral research experiences. About 10 percent of all doctorates granted in nuclear physics in the U.S. are based on research at NSCL. Also, the site provides research experiences for undergraduate students as well as K-12 teacher training.

NSCL occasionally enters into license agreements for cyclotron technology or nuclear electronics. An agreement with Accel Corporation exists for compact cyclotrons based on superconducting technology.

An experimental program using the coupled cyclotron facility is also underway. This effort is determined by beam use proposals. A Program Advisory Committee (external membership) selects the best proposals at a typical success rate of about 50 percent. The science output of NSCL is driven by these experiments – many per year, with most running one to three days. The FY 2010 funding level is part of an overall 5-year plan in response to recommendations from an external operations review committee in 2006. That committee recommended ramping up support (above the 2006 level and beyond a nominal rate of inflation) such that NSCL runs at close to optimal operation, which is defined as the maximum amount of added beam time per extra dollar spent.

Facility Report:

Management and Oversight:

- NSF Structure: MSU operates NSCL under a cooperative agreement with NSF. The laboratory director is the key officer, who has the authority to appoint associate directors and designate responsibilities, notifying NSF of changes. NSF oversight is provided through annual site visits by the cognizant program officer of the Physics Division and other staff, accompanied by external experts.

- External Structure: NSCL is managed by the laboratory director and four associate directors for research, education, operations, and new initiatives. NSCL's research program is guided by a Program Advisory Committee of external experts as well as an in-house experts, and includes the chairperson of the full NSCL User Group. The procedure for users includes writing and submitting proposals to the NSCL Director and oral presentations. There are two opportunities for proposal submission each year. About 5,000 beam hours are provided for experiments each year, with a backlog of at least a year.

A NSCL research associate adjusts cabling on a detector. *Credit: NSCL.*

- Reviews:
  - Latest Review: An annual review in FY 2008 covered results and achievements related to intellectual merit and broader impacts.
  - Next Review: Annual reviews are planned for FY 2009 and each year thereafter. Review topics include science and operations, with emphasis (and choice of external experts) to be determined.

Renewal/Recompetition/Termination:

NSCL is funded through a cooperative agreement that was renewed in FY 2007 and will expire in FY 2011. NSF anticipates that MSU will submit a renewal proposal in FY 2011. NSF will decide at that time whether to recompete the award, or whether to proceed with merit review of the proposal. Funding for FY 2012 and beyond will be determined by the outcome of that process.

Network for Earthquake Engineering Simulation

$22,000,000
+$18,000 / 0.8%

Network for Earthquake Engineering Simulation
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Network for Earthquake Engineering Simulation	$19.38	$21.82	-	$22.00	$0.18	0.8%

NEES is a national, networked simulation resource of advanced, geographically distributed, shared use earthquake engineering research experimental facilities with telepresence capabilities. NEES provides a national infrastructure to advance earthquake engineering research and education through collaborative and integrated experimentation, computation, theory, databases, and model-based simulation to improve the seismic design and performance of U.S. civil infrastructure systems. Experimental facilities include shake tables, geotechnical centrifuges, a tsunami wave basin, large-scale laboratory experimentation systems, and mobile and permanently installed field equipment. NEES facilities are located at academic institutions (or at off-campus field sites) throughout the U.S., networked together through a high performance Internet2 cyberinfrastructure system. NEES completed construction on September 30, 2004, and opened for user research and education projects on October 1, 2004. NEES is currently operated by the non-profit corporation NEES Consortium, Inc. (NEESinc), headquartered in Davis, California. Through a five-year cooperative agreement with NSF (FY 2005–FY 2009), NEESinc operates the NEES experimental facilities and the NEES cyberinfrastructure center; coordinates education, outreach, and training; and develops national and international partnerships. During FY 2008–FY 2009, NSF is recompeting NEES operations for a second five-year period.

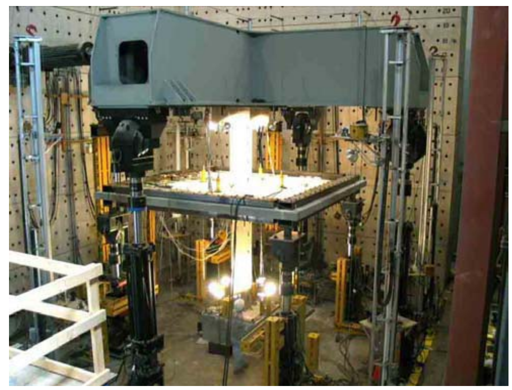
Total Obligations for NEES
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Operations and Maintenance	$19.38	$21.82	$22.00	$22.00	$22.00	$22.00	$22.50	$22.50

NEES' broad-based national research facilities and cyberinfrastructure enables new discovery and knowledge through capabilities to test more comprehensive, complete, and accurate models of how civil infrastructure systems respond to earthquake loading and tsunamis. This enables the design of new methodologies, modeling techniques, and technologies for earthquake and tsunami hazard mitigation. NEES engages students in earthquake engineering discovery through on-site use of experimental facilities, telepresence technology, archival experimental and analytical data, and computational resources with the aim of integrating research and education. NEESinc has developed an education, outreach, and training strategic plan to develop a broad spectrum of education and human resource development activities with special emphasis on non-traditional users and underrepresented groups through its Research Experiences for Undergraduates (REU) program. NEESinc also organizes the NEES Annual Meeting for NEES users/researchers and facility operators.

Through the National Earthquake Hazards Reduction Program (NEHRP), the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), and the NSF support research related to earthquake hazard mitigation. Connections to industry include private engineering consultants and engineering firms engaging in NEES research or using data and models developed through NEES. NEES is leveraging and complementing its capabilities through connections and collaborations with large testing facilities at foreign earthquake-related centers, laboratories, and institutions. NSF and NEESinc have developed partnerships to utilize the NEES infrastructure with the 3-D Full-Scale Earthquake Testing Shake Table Facility (E-Defense), built by the Japanese National Research Institute for Earth Science and Disaster Prevention (NIED) and operational in 2005. To facilitate NEES/E-Defense collaboration, in August 2005, NEESinc and NIED signed a Memorandum of Understanding (MOU), and in September 2005, NSF and the Japanese Ministry of Education, Culture, Sports, Science, and Technology signed a Memorandum Concerning Cooperation in the Area of Disaster Prevention Research. A planning meeting was held at NSF in January 2009 to explore research topics for a second five years of NEES/E-Defense collaboration.

Along with direct operations and maintenance support for NEES, NSF separately provides support for research to be conducted at the NEES experimental facilities through ongoing research and education programs. The NEES cyberinfrastructure also provides a platform for the earthquake engineering and tsunami communities, as well as other communities, to develop new tools for shared cyberinfrastructure. The annual support for such activities, funded through annual NEES research program solicitations, is estimated to be up to $12.0 million in FY 2009 and $12.50 million in FY 2010. These awards support basic research in multi-hazard engineering involving experimental and theoretical simulations at the NEES facilities, addressing important challenges in earthquake and tsunami engineering research.



Slab-column subassembly being tested as part of a NSF-supported NEES research award at the NEES Multi-Axial Subassemblage Testing (MAST) Laboratory at the University of Minnesota. *Courtesy of the MAST Laboratory at the University of Minnesota.*

Facility Report:

Management and oversight:

- NSF structure: NSF provides oversight to NEES operations through a cooperative agreement with NEESinc during FY 2005-FY 2009. NEES operations are reviewed through annual site visits and through periodic site visits to the individual NEES equipment sites. The NSF Program Manager for NEES is located in the Division of Civil, Mechanical and Manufacturing Innovation (CMMI). The Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management (BFA) provides advice and assistance.

- External structure: NEESinc, located in Davis, CA, operates the NEES experimental facilities and the NEES cyberinfrastructure center; coordinates education, outreach, and training; and develops national and international partnerships. As a non-profit corporation, NEESinc operates under its own governance structure and is overseen by a Board of Directors elected from its membership in accordance with its by-laws. Day-to-day operations of NEESinc are overseen by its headquarters staff led by a Chief Executive Officer. Each of the experimental facilities has an on-site director responsible for local day-to-day equipment management, operations, and interface with NEESinc, other NEES facilities, users, and the NEES cyberinfrastructure center for network coordination. The NEES cyberinfrastructure center maintains telepresence, data, collaborative, simulation, and other related services for the entire NEES network.

- Reviews:
  - Management reviews: NSF BFA Business Systems Review - May 2006
  - Mid-award operations reviews: NSF Annual Merit Reviews - June 2005, April 2006, July 2007
  - Experimental facility reviews: NSF Periodic Merit Reviews - FY 2006 - FY 2008

Renewal/Recompetition/Termination:

NEESinc currently operates under a five-year cooperative agreement during FY 2005 – FY 2009, with annual funding based upon satisfactory progress and availability of funding. In FY 2008, NSF made the decision to recompete NEES operations for a second five-year period from FY 2010 – FY 2014. During FY 2010, the incumbent awardee (NEESinc) will be supported by NSF to provide continuity of operations, help transition software, documents, and other inventory to the new awardee and to complete award close-out. In FY 2010, NSF will fund an assessment of the NEES experimental facilities and cyberinfrastructure and multi-hazard experimental facilities available worldwide. This assessment is expected to be completed by early FY 2012 and will form the basis for determination by NSF of whether to renew the cooperative agreement for an additional period, recompete NEES operations, or terminate NEES operations at the end of FY 2014.

Polar Facilities And Logistics and the South Pole Station Modernization Project **$374,350,000 +$32,170,000 / 9.4%**

Polar Facilities and Logistics
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Polar Facilities	$217.73	$233.35	$15.50	$260.08	$26.73	11.5%
Polar Logistics	111.21	108.83	7.00	114.27	5.44	5.0%
Total, Polar Facilities and Logistics	$328.94	$342.18	$22.50	$374.35	$32.17	9.4%

Totals may not add due to rounding.

Polar Facilities:

The Office of Polar Programs (OPP) within NSF provides the infrastructure needed to support U.S. research conducted in Antarctica, including that funded by U.S. mission agencies, for year-round work at three U.S. stations, two research ships, and a variety of remote field camps. All life support is provided by NSF/OPP, including transportation, facilities, communications, utilities (water and power), and health and safety infrastructure. NSF management of the U.S. Antarctic Program (USAP) also provides environmental stewardship and maintains the U.S. presence in Antarctica in accordance with U.S. policy.

Total Obligations for Polar Facilities
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Antarctic Infrastructure & Logistics	$166.84	$179.35	$15.50	$206.08	$209.58	$213.78	$218.26	$222.85	$227.53
South Pole Station Modernization Project	*15.38*	*15.76*	-	*15.93*	*16.20*	*16.53*	*16.88*	*17.23*	*17.59*
U.S. Coast Guard Icebreaker Support	50.89	54.00	-	54.00	54.00	54.00	54.00	54.00	54.00
Total, Polar Facilities	$217.73	$233.35	$15.50	$260.08	$263.58	$267.78	$272.26	$276.85	$281.53

Totals may not add due to rounding.

NOTE: Funding for the South Pole Station Modernization (SPSM) Project in this table is for the operation of the South Pole Station and is included in the amounts shown for Antarctic Infrastructure and Logistics.

OPP contracts with a prime contractor for science support, operations, and maintenance of the Antarctic stations and related infrastructure in New Zealand and Chile, and leasing of research vessels. The contractor is selected through a competitive bidding process. Rotary- and fixed-wing aircraft used in support of research are provided through competitively awarded contracts. Other agencies and contractors provide technical support in areas of expertise such as engineering, construction, and communications.

Facility Report:

Management and Oversight:

- NSF Structure: OPP has overall management responsibility for Operations and Science Support. From FY 2006 through 2008, NSF also funded the operation and maintenance of the U.S. Coast Guard's (USCG) three polar icebreakers, the *Polar Star*, the *Healy*, and the *Polar Sea*. Beginning in FY 2009, it was decided that NSF would fund operation and maintenance for only the *Polar Sea* and the *Healy* because NSF does not envision current or future use of the *Polar Star* in support of its mission. The agencies cooperate under a Memorandum of Agreement that includes guidance for planning and scheduling. It sets forth the terms and conditions for reimbursement to the USCG by NSF. NSF and the USCG work together to formulate operations and maintenance plans and associated funding requirements. NSF is responsible for ascertaining the needs of other federal agencies and for securing USCG program plans for accommodating them on a reimbursable funding basis.

- External Structure: The current Antarctic support contract was recompeted and awarded to Raytheon Polar Services Company (RPSC) in FY 2000. There are many separate subcontractors for supplies and technical services.

- Reviews: OPP evaluates the performance of RPSC every year via a Performance Evaluation Committee and an Award Fee Board that includes representatives from OPP and the Office of Budget, Finance, and Award Management (BFA). In addition, OPP's performance is reviewed externally by Committees of Visitors and the OPP Advisory Committee (OPP AC).

Helicopters provide support to field parties in the McMurdo Dry Valleys in southern Victoria Land and at remote field camps. *Credit: Kristan Hutchison, RPSC.*

Current Status:

- All facilities (stations, research vessels, and field camps) are currently operating normally. The relatively poor condition of the USCG polar icebreaker *Polar Sea*, due to its age and the uncertainty regarding its future availability, prompted OPP and the OPP AC to identify and study options for reducing demands on the ship-based logistics system. OPP is implementing several projects as contingencies against a possible failure of that system.

Evolution:

U.S. policy directs NSF to maintain an active and influential presence in Antarctica, including year-round occupation of South Pole Station and two coastal stations. However, the research emphases at the three stations changes as the scientific forefronts addressed there evolve with time, as does the infrastructure needed to support it.

Recompetition:

NSF is currently engaged in an effort to recompete the Antarctic support contract. The most recent Antarctic support contract was recompeted and awarded to Raytheon Polar Services Company (RPSC) in

FY 2000. After a five-month phase-in period, RPSC assumed responsibility for operations in March 2000. The contract's ten-year performance period is segregated into a five-year initial period and a five-year option period. NSF exercised its option to extend the performance period through March 31, 2010. An award for the new support contract is expected to be made in FY 2010.

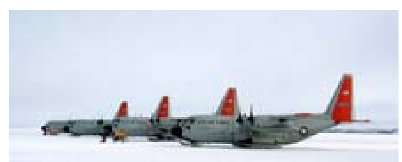
Polar Logistics:

Polar Logistics consists of two activities: the U.S. Antarctic Logistical Support program within the Division of Antarctic Infrastructure and Logistics, and the Research Support and Logistics program within the Arctic Sciences Division.

Total Obligations for Polar Logistics
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
U.S. Antarctic Logistical Support	$67.63	$67.52	-	$67.52	$67.52	$67.52	$67.52	$67.52	$67.52
Research Support and Logistics	43.59	41.31	7.00	46.75	47.54	48.50	49.51	50.55	51.62
Total, Polar Logistics	$111.21	$108.83	$7.00	$114.27	$115.06	$116.02	$117.03	$118.07	$119.14

Totals may not add due to rounding.



The U.S. Antarctic Logistical Support program funds support provided by the U.S. Department of Defense (DoD). The DoD operates as a primary logistical support provider on a cost-reimbursable basis. Major funding elements of DoD support include: military personnel, LC-130 flight operations, maintenance, and facilities support of the 109th Airlift Wing (AW) of the New York Air National Guard in Scotia, New York and Antarctica; transportation and training of military personnel supporting the U.S. Antarctic Program; support for air traffic control, weather forecasting, and ground electronic equipment maintenance; the charter of Air Mobility Command airlift and Military Sealift Command ships for the re-supply of McMurdo Station; bulk fuel purchased from the Defense Logistics Agency; and reimbursement for use of DoD satellites for communications.

The Research Support and Logistics program in the Arctic Sciences Division is driven by and responds to science supported by the division. Funding is provided directly to grantees or to key organizations that provide or manage Arctic research support and logistics. The current contract with CH2M HILL (previously, VECO USA) to provide research support and logistics services for NSF-sponsored activities in the Arctic was recompeted and awarded in January 2005. The contract has an initial term of four years and the possibility of three one-year extensions exercised on the basis of performance. Additional major support components include: access to U.S. Coast Guard and other icebreakers, University-National Oceanographic Laboratory (UNOLS) vessels and coastal boats; access to fixed and rotary-wing airlift support; upgrades at Toolik Field Station, University of Alaska, Fairbanks' field station for ecological research on Alaska's North Slope; safety training for field researchers and funding for field safety experts; global satellite telephones for emergency response and improved logistics coordination; and development of a network of strategically placed U.S. Long-Term Ecological Research observatories linked to similar efforts in Europe and Canada.

Facility Report:

Management and Oversight:

- NSF Structure: OPP has overall management responsibility for U.S. Antarctic Logistical Support and Arctic Research Support & Logistics. DoD operates as a primary logistical support provider on a cost-reimbursable basis. The agencies cooperate under a Memorandum of Agreement that includes guidance for planning and scheduling and sets forth the terms and conditions for reimbursement to DoD by NSF.

- External Structure: There are many separate subcontractors for supplies and technical services.

- Reviews: OPP's performance is externally reviewed by Committees of Visitors and the OPP AC.

Current Status:

- All facilities (stations, research vessels, and field camps) are currently operating as normal.

Renewal/Recompetition/Termination:

U.S. policy directs NSF to maintain an active and influential presence in Antarctica, including year-round occupation of South Pole Station and two coastal stations. However, as discussed above, the research emphases at the three stations and at Arctic research sites changes as the scientific forefronts addressed there evolve with time, as does the logistics support for these activities. Support contracts are recompeted as noted earlier.

South Pole Station Modernization (SPSM)

The SPSM project was funded through the MREFC Account and supported the procurement, construction, and commissioning. SPSM provides a new station to replace the previous U.S. station at the South Pole, built 30 years ago and inadequate in terms of capacity, efficiency, and safety. The new station is an elevated complex with two connected buildings, supporting 150 people in the summer and 50 people in the winter. The completed South Pole Station will provide a platform for the conduct of science at the South Pole and fulfills NSF's mandate to maintain a continuous U.S. presence at the South Pole in accordance with U.S. policy. FY 2008 represented the final year of appropriations for SPSM; no funds are requested in FY 2010. Construction continues through FY 2010.

The prime contractor for the U.S. Antarctic Program is responsible for constructing the South Pole Station. In addition, there are approximately 385 separate subcontractors for supplies and technical services.

NSF will also support education associated with the research projects at the South Pole. Along with direct operations and maintenance support for South Pole Station, NSF will support science and engineering research through ongoing programs. The annual support for such activities is currently estimated to be approximately $9.50 million.

Total Obligations for SPSM
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Current Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations									
Concept & Development	$16.40								
Management & Operations		15.38	15.76	15.93	16.20	16.53	16.88	17.23	17.59
Subtotal, R&RA Obligations	$16.40	$15.38	$15.76	$15.93	$16.20	$16.53	$16.88	$17.23	$17.59
MREFC Obligations									
Implementation	139.66	7.57	2.06	-					
Subtotal, MREFC Obligations	$139.66	$7.57	$2.06	-	-	-	-	-	-
Total, SPSM Obligations	**$156.06**	**$22.95**	**$17.82**	**$15.93**	**$16.20**	**$16.53**	**$16.88**	**$17.23**	**$17.59**

Totals may not add due to rounding.

NOTE: Funding for the operation of South Pole Station is provided through Antarctic Infrastructure and Logistics.

Project Report:

Management and Oversight:

- NSF Structure: OPP has the overall oversight responsibility for SPSM, including development of the basic requirements, design, procurement, and construction. The project status, including cost expenditures and cost projections, is monitored closely by the OPP Facilities Engineer and other OPP staff, and on a periodic basis by the project's Project Advisory Team, a group of experts drawn from all relevant NSF Directorates and Offices.

- External Structure: NSF has contracted for procurement and construction management for all phases of the project, including design reviews of all drawings and specifications; conformance of the designs and procurements with established standardization criteria; assistance in establishing functional interfaces; transition from the existing to the new facilities; and systems integration. Naval Facilities Engineering Command, Pacific Division (PACDIV) selects, monitors, and manages architectural and engineering firms for design, post-construction services, and construction inspection for the project.

- Reviews: Design, development, planning, and closely related activities in support of this project included preparation of more than 40 engineering studies and reports. The documents ranged widely in subject matter including subjects such as snowdrift minimization modeling, detailed analysis of power and heating requirements, preparation of a draft Environmental Impact Statement, energy conservation measures, efficiency and maintainability of diesel generators, fuel storage support system evaluation, design code criteria matrix, concept for signal/communication systems, gray-water system evaluation, minimization of ventilation requirements, control of diesel engine exhaust emissions, and jacking plan and concept.

  The OPP Facilities Engineer, other OPP and NSF staff, and subject matter experts attend quarterly reviews at the contractor's facility for the purpose of reviewing all aspects of the project including cost, schedule, and plans. In September 2006, an external panel of experts reviewed the scope, cost, schedule, and effectiveness of management processes to complete the final 10 percent of the project.

As a result, the project's baseline was increased to \$149.29 million. A review of the cost and schedule for the final year of the project is planned for early FY 2010.

Current Project Status:

- Tasking Completed in FY 2009:
  - Conditional Occupancy of the Logistics Facility and the Aircraft Fueling Module, the last major technical milestones

Cost and Schedule:

SPSM scope is nearly 95 percent complete, with the elevated station and all science facilities in full use. Project cost performance index (CPI) and schedule performance index (SPI) are presently ranked green, indicating variances are within 10 percent, and current forecasts show the project completing on schedule. The project is just over budget and behind schedule, with a cost performance index of 98.18 percent and a schedule performance index of 98.63 percent as of February 2009 financial data. Available contingency is approximately 2 percent of remaining costs

- Tasking Scheduled/Completed for FY 2009:
  - Conditional Occupancy of Logistics/Warehousing Facility
  - Completion of Siding Pod A
  - Begin Dome Demolition
  - Aircraft Fueling Module

- Tasking Scheduled for FY 2010:
  - Complete Dome Demolition
  - Retrograde Demolition Materials
  - Install Logistics Facility Racks
  - Complete Siding of the Elevated Station
  - Complete Punch List Items

Risks:

Project performance could be affected if a full construction crew cannot be maintained for the remaining scope. Additional high impact risk elements to project completion include equipment failure, damaged materials, unforeseen downtime from power failures, inclement weather, and widespread illness – all of which have occurred to varying degrees. Risk management is ongoing and has produced multiple sets of back-up strategies to employ in the face of identified concerns.

Future Operations Costs:

Operational costs of the modernized station are expected to be higher than operational costs of the previous station due to increased station size and increases in science support and information systems. A steady state of operational support is anticipated at \$15.0 million, excluding inflation. The expected lifetime of the modernized station is 25 years, through FY 2031.

FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS

National Astronomy and Ionosphere Center

$11,400,000
-$200,000 / -1.7%

National Astronomy and Ionosphere Center
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
National Astronomy and Ionosphere Center	$12.75	$11.60	$3.10	$11.40	-$0.20	-1.7%

The National Astronomy and Ionosphere Center (NAIC) is a national research center focusing on radio and radar astronomy and atmospheric sciences. The center's principal observing facility is the world's largest single-dish radio/radar telescope, a 305-meter diameter reflector in western Puerto Rico. Located near the town of Arecibo on 120 acres of U.S. Government-owned land, the facility is known as Arecibo Observatory. NAIC is Federally Funded Research and Development Center (FFRDC), operated and managed by Cornell University under a cooperative agreement with NSF. NAIC provides telescope users with a wide range of research and observing instrumentation and serves over 250 users annually.

NAIC has a staff of about 120 positions, including those who support the Angel Ramos Visitor Center and Learning Center. A permanent staff of 17 scientists and 36 engineers/technicians are available to help visiting investigators with their observation programs. The remainder includes 25 administrative and clerical positions, 37 maintenance staff, and several postdoctoral scholars and graduate students.

Total Obligations for NAIC
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Operations and Maintenance	$12.75	$11.60	$11.40	$7.00	$7.42	$7.87	$8.34	$8.84
Astronomical Sciences (MPS)	*10.72*	*9.60*	*8.40*	*4.00*	*4.24*	*4.49*	*4.76*	*5.05*
Atmospheric & Geospace Sciences (GEO)	*2.02*	*2.00*	*3.00*	*3.00*	*3.18*	*3.37*	*3.57*	*3.79*
ARRA Estimate (MPS)	-	3.10	-	-	-	-	-	-
Total, NAIC	$12.75	$14.70	$11.40	$7.00	$7.42	$7.87	$8.34	$8.84

Totals may not add due to rounding.

NOTE: The Division of Astronomical Sciences (AST) Senior Review recommended that sufficient external financial or personnel contributions be found to operate NAIC with competitive scientific productivity after 2011 with an AST contribution not to exceed half of the expected costs, estimated at $8.0 million in FY 2006. FY 2011-2015 amounts are extrapolations based on current levels only. The program solicitation for management and operation of NAIC will identify five-year budget guidance at a significantly reduced level relative to current operations. AST support for FY 2011–2015 will be based upon the Senior Review recommendation, guidance from a third-party cost review of AST facilities, and a third-party estimate of NAIC's non-scientific costs.

NAIC is jointly supported by the Division of Astronomical Sciences (AST) in the Directorate for Mathematical and Physical Sciences (MPS) and the Division of Atmospheric and Geospace Sciences (AGS) in the Directorate for Geosciences (GEO). AGS funds currently support incremental science programs in Space and Atmospheric Sciences. The AST Senior Review recommended an emphasis on observations in support of large astronomical surveys and a reduction in AST funding to $8.0 million (FY 2006 dollars) for NAIC by 2010. In response, the managing organization, Cornell University, has modified the operating mode for astronomy observations and limited the observing time for astronomy projects. These changes also resulted in a reduction in force of 30 FTEs in FY 2007. In addition, availability of the S-band planetary radar system was reduced in FY 2008. The FY 2010 Budget Request reflects the planned ramp down to meet Senior Review recommendations.

Partnerships and Other Funding Sources: NAIC leverages NSF support with funding from other federal and non-federal sources. In FY 2008, NAIC received $942,000 from other federal agencies such as the Defense University Research Instrumentation program at the Air Force Office of Scientific Research (AFOSR/DURIP) and the Office of Naval Research (ONR), and approximately $100,000 from the Joint Institute for Very Long Baseline Interferometry (VLBI) in Europe and other non-federal and private sources. Cornell has also contracted for $2.35 million with the Puerto Rico Department of Education to provide student enhancement and teacher professional development programs at Arecibo through the site's Angel Ramos Foundation Visitor and Learning Center.

An image of the Arecibo Radio Telescope in Puerto Rico. The gregorian dome, which houses the main suite of research instruments, and its suspension structure are visible over the main reflector below. *Credit: Arecibo Observatory/NSF.*

A peer-review telescope allocation committee provides merit-based telescope time but no financial support. NSF does not provide awards targeted specifically for use of Arecibo. Many users are supported through NSF or NASA grants to pursue scientific programs that require use of NAIC.

Education and Public Outreach: NAIC's primary education goal is to support and enhance the experiences of student researchers. Arecibo hosts a Research Experiences for Undergraduates (REU) site, and Ph.D. students receive training through use of the facility. In collaboration with the National Radio Astronomy Observatory, NAIC holds a summer school on single-dish radio astronomy techniques. NAIC also sponsors a major outreach program in Puerto Rico via the modern Visitor Center and Learning Center, as well as summer workshops for K-12 teachers. The Visitor Center attracts roughly 100,000 visitors each year, and with new funds from the Puerto Rico Department of Education, NAIC will host up to 50,000 school children each year for science enrichment programs. Continued operation and enhancement of these programs are anticipated to generate additional revenue that may contribute to Observatory operations.

Operations and Maintenance, $11.40 million ($200,000 below the FY 2009 Current Plan level of $11.60 million): NAIC administers observing time to the astronomy and aeronomy communities via competitive observing proposals and conducts educational and public outreach programs at all levels. Observing hours among science programs are based on the quality of observing proposals; the current average oversubscription rate of the telescope is approximately three to four. This metric accounts for the number of current astronomical surveys requesting time for a given area of sky, plus the time request in the Program Year for small radio astronomy projects, solar system observations, and atmospheric sciences programs.

- Division of Astronomical Sciences, $8.40 million ($1.20 million below the FY 2009 Current Plan level of $9.60 million): AST funds basic operations costs and science programs in passive radio astronomy and solar system radar astronomy. Radio astronomers and planetary scientists use the

Arecibo facility to study diverse areas such as interstellar gas, galactic structure formation and evolution, pulsars and fundamental physics, the dynamic variations in Earth's ionosphere, and topics in solar system astronomy, such as the physical properties of asteroids, planetary surfaces and moons and the post-discovery characterization and orbital refinement of near-Earth asteroids. Funding for the Astronomy program decreases by $1.20 million from FY 2009 to FY 2010 following the recommendations of the AST senior review.

- Starting in 2006 approximately 80 percent of the astronomy observing time was dedicated to three large survey programs that use the Arecibo L-band Feed Array (ALFA) receiver that was commissioned in 2005–2006. About 75 percent of astronomy users conduct their observing programs remotely via networked control software, while radar observations typically employ on-site users.

- Division of Atmospheric and Geospace Sciences, $3.0 million (+$1.0 million over FY 2009 Current Plan level of $2.0 million): AGS primarily funds a research staff in the Space and Atmospheric Sciences program and has historically contributed only incrementally for basic operations costs. As AST has ramped down support for NAIC in response to the Senior Review, AGS has provided modest increases that may be directed towards basic operations. Funding for the Space and Atmospheric Sciences program increases by $1.0 million from FY 2009 to FY 2010.

Facility Report:

<u>Management and Oversight:</u>

- NSF Structure: Ongoing oversight is by an assigned NSF program director in AST and in consultation with community representatives. The program director makes use of detailed annual program plans, long range plans, quarterly technical and financial reports, and annual reports submitted to NSF by Cornell as well as attending Cornell governance committee meetings. To address issues as they arise, AST program managers work closely with other offices at NSF, particularly the Division of Acquisition and Cooperative Support, the Office of General Counsel, and the Large Facilities Project Office. The NSF Program Officer conducts site periodic visits.

- External Structure: Management is via a cooperative agreement with Cornell University. Cornell provides management and oversight through its own advisory and visiting committees. The NAIC Director is resident at Cornell and reports to the Vice Provost for Research in Physical Sciences and Engineering. The Arecibo Observatory Site Director reports to the NAIC Director.

- Reviews: Management reviews by external review panels are held midway into each 5-year cooperative agreement. The last management review was held in March 2007; a follow up assessment of Cornell's response to the Astronomy Senior Review recommendations was completed in March 2008. NAIC underwent a NSF Business Systems Review in FY 2005. In addition, in response to recommendations from the Senior Review, AST conducted a review of administrative and operational costs at all its facilities.

<u>Renewal/Recompetition/Termination:</u>

The current cooperative agreement with Cornell for the management of Arecibo is in effect through March 31, 2010. Consistent with NSB policy, NSF will solicit proposals for a new, five-year cooperative agreement for the management and operation of NAIC through a competitive process. The program solicitation is under development with publication anticipated in 2009.

The Astronomy Senior Review report recommended that sufficient external financial or personnel contributions be found to operate NAIC with competitive scientific productivity after 2011 with an AST contribution not to exceed half of the expected function costs. In response, AGS plans to increase support post-2010 to $3.0 million, including a $1.50 million contribution to basic operations.

The program solicitation for the management and operation of NAIC will identify five-year budget guidance at a significantly reduced level relative to current operations. AST support for FY 2011–2015 will be based upon the Senior Review recommendations, guidance from a third-party cost review of AST facilities, and a third-party estimate of NAIC's nonscientific function costs. Potential managing organizations will be encouraged to consider novel models of operations and governance, revisions to programmatic scope, and/or sources of additional funding that would sustain NAIC as a competitive scientific and educational facility that is responsive to its stakeholders in the scientific community and the Commonwealth of Puerto Rico.

National Center For Atmospheric Research

$100,000,000
-$6,920,000 / -6.5%

National Center for Atmospheric Research
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
National Center for Atmospheric Research	$89.07	$106.92	$13.20	$100.00	-$6.92	-6.5%

The National Center for Atmospheric Research (NCAR) is a Federally Funded Research and Development Center (FFRDC) serving a broad research community, including atmospheric scientists and researchers in complementary areas of the environmental and geosciences. NCAR is managed under a cooperative agreement with NSF by the University Corporation for Atmospheric Research (UCAR), a university-governed and university-serving organization comprising 73 Ph.D. granting academic institutions.

The Mesa Laboratory, designed by architect I. M. Pei, in Boulder, CO. *Credit: NCAR*

As of January 2009, there are a total of 756 FTEs in NCAR of which 357 are funded under the NSF primary award to UCAR.

Number of FTEs Supported at NCAR

FTEs	Primary Award[1]	All Funding
Career Scientists	98	130
Scientific Support[2]	233	507
Other Staff[3]	26	119
Total	357	756

[1]The primary award supports substantial facility infrastructure that does not include staff costs.

[2]Scientific Support includes Associate Scientists, Project Scientists, Post Docs, Software Engineers, Engineers, System Support and Technicians.

[3]Other Staff includes Administrative positions, Managers, Paid Visitors, Pilots and Mechanics.

NCAR provides facilities to university, NCAR, and other atmospheric researchers including world-class supercomputing services, research aircraft, airborne and portable ground-based radar systems, atmospheric sounding, and other surface sensing systems for atmospheric research. In addition, NCAR operates several facilities dedicated to the study of the Sun, solar phenomena, space weather, and the responses of the upper atmosphere to the Sun's output. As an NSF sponsored facility, NCAR is committed to the dissemination of newly discovered knowledge in all the above areas.

Total Obligations for NCAR
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Aircraft Support[1]	$7.58	$9.30	$10.70	$9.30	$9.77	$10.25	$10.77	$11.30	$11.87
Computational Infrastructure[2]	18.61	25.00	2.50	22.00	23.10	24.26	25.47	26.74	28.08
Other Facility Support	23.02	27.62	-	25.70	26.99	28.33	29.75	31.24	32.80
Research & Education Support	39.86	45.00	-	43.00	45.15	47.41	49.78	52.27	54.88
Total, NCAR	$89.07	$106.92	$13.20	$100.00	$105.00	$110.25	$115.76	$121.55	$127.63

Totals may not add due to rounding.
[1]Includes about $150,000 for scientific research in areas such as biogeosciences and aerosols.
[2]Does not contain research funds

Partnerships and Other Funding Sources: NCAR leverages NSF support with funding provided by other federal agencies and non-federal sources. In FY 2008, NCAR received approximately $40.0 million in support from other federal agencies such as the National Oceanographic and Atmospheric Administration (NOAA) and the Office of Naval Research (ONR), and $23.0 million from non-federal sources.

Major Investments in FY 2010: In FY 2010, investments at NCAR will focus on issues of societal importance in the areas of atmospheric chemistry, climate, including climate models, cloud physics and storms weather models, weather hazards to aviation, and interactions between the sun and earth. In all of these areas, NCAR scientists will work with their university colleagues to look closely at the role of humans in both creating climate change and responding to severe weather occurrences. Example investments are an increased emphasis on preparing input for the next Intergovernmental Panel on Climate Change (IPCC) assessment and research into significantly enhancing our ability to understand and predict changes in hurricane intensity. In addition, UCAR will continue to invest NSF funds to refurbish NSF-owned infrastructure such as replacing the underground power cable to the laboratory, which is forty years old, and beyond its designed life expectancy.

Aircraft Support: NCAR operates a C-130 and a Gulfstream V (also know as the High Altitude Instrumented Airborne Platform for Experimental Research, or HIAPER), both of which are highly modified to enable the support of complex research measurements. The two aircraft will support several community-originated projects deemed by peer review to be of exceptional scientific merit. In 2010, aircraft support totals $9.30 million.

Scheduled projects in FY 2009:

- The continuation of a project investigating shorter-range dynamics and forecast problems over eastern Asia and the western North Pacific to better understand medium range dynamics and forecast problems of regions downstream (e.g., North America). This is a multi-aircraft experiment conducted primarily in late FY 2008 and continuing into FY 2009 and located in Hawaii, Guam, and Japan.
- The VOCALS Research Experiment, which seeks to understand the physical and chemical processes central to the climate of the Southeast Pacific, including the interactions of clouds, aerosols, marine boundary layer and upper ocean dynamics. This experiment is primarily located in Chile and includes aircraft from several countries and US agencies. Logistical support for the experiment totaled $1.91 million, which includes $1.54 million for C-130 support and operation costs.

- The HIAPER Pole to Pole Observations (HIPPO) experiment, which measures cross sections of atmospherics concentrations of carbon cycle and greenhouse gases from the north to the south polar areas four different times over a two year period. This experiment provides a comprehensive global survey of atmospheric trace gases covering the full troposphere in all seasons and multiple years. Location: It is primarily located in Colorado, Alaska, Hawaii, American Samoa, New Zealand, Tahiti, Easter Island, and Costa Rica, and totals $2.96 million to support all HIAPER-related costs.
- The Profiling of Winter Storms (PLOWS) Main Study total $2.22 million, which includes $1.55 million for the C-130. PLOWS is an experiment to learn more about the profile of storms in the central U.S.
- A study of Airborne Detector for Energetic Lightning Emissions (ADELE). Specific costs associated with deployment of the G-V are approximately $359,000.
- An examination of the Sprite Spectra. Specific costs for deployment of the G-V are approximately $393,000.

Projects scheduled or under consideration for FY 2010:

- The PRE-Depression Investigation of Cloud-systems in the Tropics (PREDICT) is a scheduled field experiment designed to improve our understanding of the dynamics of tropical cyclone formation and to dramatically improve the spatial and temporal sampling of tropical disturbances prior to, and during, genesis. The project will be located in St. Croix and totals about $3.0 million, including $1.76 million to support costs associated with HIAPER. Aircraft from other agencies will also be utilized.
- The HIAPER Equipment Flight Test for FY 2009 (HEFT-09) is a scheduled experiment to test the performance of new research instruments on the G-V aircraft, totaling $250,000.
- The Global Climate Change and Antarctic Peninsula (GLIMPSE) project is a proposed experiment to examine in detail the atmospheric response to external forcing in the Weddell Sea sector of Antarctica. The Antarctic peninsula is a barrier to stable air flow from both the east and west and is an effective climatic divide between the Weddell Seas on the east and the Bellingshausen Sea to the west. The proposed cost of the project is $2.37 million, which includes $1.94 million for G-V support costs; however, the project has not yet been approved.

Computational Infrastructure: NCAR's computational facility is recognized as world-class. The latest addition to the facility, BlueFire, installed in November 2008, was ranked as the 43rd most powerful computer in the world by the top 500 Supercomputer Centers project.

Computational Infrastructure by Subcategory, FY 2010

(Dollars in Millions)

Operations Staff and Staff Related Costs	$13.54
IT and Facility Infrastructure, Utilities, Data Analysis, Mass Storage Equipment	4.46
Supercomputing Capital Equipment	4.00
Total	$22.00

BlueFire supports the Community Climate Simulation Model (CCSM) which uses mathematical formulas to recreate the chemical and physical processes that drive Earth's climate, and was used by the Intergovernmental Panel on Climate Change (IPCC) to forecast future climate under a number of scenarios.

In FY 2010, planning efforts will continue for a new computational facility. These activities received $2.5 million in ARRA funding in FY 2009. This activity is currently in the development phase and the total preliminary project cost is currently estimated between $60 million and $62 million. For this effort, NCAR is working with the University of Wyoming and other partners in the state. The Wyoming partners are providing the land, $20 million for the construction of the facility, and will also contribute $1 million annually for maintenance. The building and computational resources would be available to the community in 2012 according to a preliminary proposal. This 3-year effort would provide the physical infrastructure needed to expand NCAR's computational capability. Planning activities currently underway include a project development plan, an architectural and engineering study, an environmental assessment study, and a thorough external review of the proposed enhancement to NCAR facilities.

Other Facility Support: In addition to the C-130 and G-V, NCAR also provides support for a number of other atmospheric observing platforms through its Earth Observing Laboratory (EOL), including mobile Doppler radars, upper atmosphere observing capabilities, and other experimental systems. These facilities are used by both NCAR and community researchers to undertake cutting edge research projects. Funding for other facilities at NCAR totals $25.70 million in FY 2010.

Other Facility Support by Subcategory, FY 2010
(Dollars in Millions)

Observing Platforms and Technology	
EOL Infrastructure (including Equipment)	$2.77
Field Proj. and Data Management	0.94
Design and Fabrication Services	1.19
CDS Systems Infrastructure	1.88
Dropsonde/Driftsonde	1.16
SPOL	2.03
Technology Developments	1.02
ISFS	1.22
ELDORA	0.68
ISS/GAUS	1.14
Subtotal, Observing Platforms and Technology	$14.03
Community Models	
Community Climate System Model	$7.28
Weather Research and Forecasting model	1.60
Whole Atmosphere Community Climate Model	0.60
Subtotal, Community Models	$9.48
Other Infrastructure	
Upper atmospheric observing facilities	$1.39
Chemistry instrumentation (ACD)	0.80
Subtotal, Other Infrastructure	$2.19
Grand Total, Other Facility Support	**$25.70**

Totals may not add due to rounding.

Research and Education Support: Funding for research and education support at NCAR totals $43.0 million in FY 2010. As an internationally-recognized center of excellence, NCAR operates scientific research programs that include the following areas:

- studies of large-scale atmospheric and ocean dynamics that contribute to an understanding of the past and present climate processes and global climate change;
- global and regional atmospheric chemistry, including atmospheric connections to geochemical and biogeochemical cycles;
- the variable nature of the Sun and the physics of the corona and their interaction with the Earth's magnetic field;
- the physics of clouds, thunderstorms, precipitation formation, and their interactions and effects on larger-scale weather; and
- the examination of human society's impact on and response to global environmental change.

Management at NCAR uses the NSF merit review criteria to allocate resources within NCAR. These allocations are subject to review and approval by the Division of Atmospheric and Geospace Sciences.

Research collaborations among NCAR staff and university colleagues are integral to its success as an institution, and serve as a focus and meeting point for the broader atmospheric and related sciences community. Further, NCAR works to develop new collaborations and partnerships with the private sector through directed research and technology transfer. These activities span improved capabilities for detecting, warning, and forecasting mesoscale weather phenomena of economic and social importance to the private and public sectors to longer term economic consideration of climate change issues. This research is preformed in the Research Application Laboratory and currently receives $1.40 million in support.

Educational activities at NCAR are recognized as outstanding in their field, in particular the SOARS (Significant Opportunities in Atmospheric Research and Science) program is an undergraduate-to-graduate bridge program designed to broaden participation in the atmospheric and related sciences, which integrates research, education, and mentoring into an effective program.

In addition, NCAR further supports the scientific community by providing fellowships, internships, workshops, and colloquia for students and visiting scientists, and disseminates knowledge of the geosciences to the general public, K-12 schools, teachers and students, undergraduate and graduate institutions, postdoctoral and career scientists and researchers, as well as to policy and decision makers. Professional training courses, innovative and award-winning science education websites, as well as the directed activities of NCAR's Office of Education and Outreach are further examples of how NSF's goal of integrating research and education is attained through NCAR activities. Total support for Educational and Outreach is $2.80 million which includes the Advanced Study Program.

Facility Report:

<u>Management and Oversight:</u>

- NSF Structure: NSF's Division of Atmospheric Sciences (in GEO) along with the Division of Acquisitions and Cooperative Support (DACS), provide oversight of NCAR and the cooperative agreement with the University Corporation for Atmospheric Research (UCAR) for NCAR's management. The present Cooperative Agreement between UCAR and NSF encourages interactions between NCAR scientists and ATM staff and ensures close coordination between ATM and UCAR management. There are specific activities under the agreement that delineate requirements necessary for ATM's oversight of the NCAR program and UCAR management activities that affect NCAR. These include a requirement that UCAR submit an annual program plan for ATM approval that provides details on how resources will be used in that fiscal year. In addition, NCAR summarizes its past year's accomplishments in an annual scientific report. Annual strategic planning sessions between ATM, UCAR and NCAR are held to ensure that scientific and facility priorities remain consistent with those of NSF. Previous COV reports offered positive and constructive comments on NSF's oversight of UCAR/NCAR. Nearly all the recommendations of the previous COV have been addressed. A COV of the oversight section for UCAR/NCAR will take place in 2009.

- External Structure: UCAR works in partnership with NSF, and the university community to ensure the effective implementation of the strategic mission of NCAR to the benefit of the research community. In addition, other research sponsors such as NASA, NOAA, DOE, DOD, EPA, and the FAA support research collaboration wherever it enhances NCAR's basic NSF-supported research goals or facilities missions

- Reviews:
  - Management review: March, 2006.
  - Complete science and management review leading to the 2008 award to UCAR
  - Approximately mid-way through the current award comprehensive reviews of science, facilities, and management will be conducted.

Renewal/Recompetition/Termination Issues:

In May 2008, UCAR competed successfully for the management and operation of NCAR. The term of the award is for a period of 60 months allowing for an additional 60 months after appropriate and successful review.

National Optical Astronomy Observatory and National Solar Observatory **$41,600,000**
+$2,020,000 / 5.1%

National Optical Astronomy Observatory and National Solar Observatory
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
National Optical Astronomy Observatory[1]	$28.60	$29.58	$5.60	$32.50	$2.92	9.9%
National Solar Observatory[2]	9.95	10.00	4.50	9.10	-0.90	-9.0%
Total	$38.55	$39.58	$10.10	$41.60	$2.02	5.1%

Totals may not add due to rounding.
[1] Includes the Telescope System Instrumentation Program (TSIP)
[2] Includes $3.10 million in ARRA funding for ATST late stage design and development.

The National Optical Astronomy Observatory (NOAO) was established in 1982 by uniting operations of the Kitt Peak National Observatory (KPNO) in Arizona and the Cerro Tololo Inter-American Observatory (CTIO) in Chile. NOAO is a Federally Funded Research and Development Center (FFRDC) for research in ground-based, nighttime, optical, and infrared astronomy. NOAO also is the gateway for the U.S. astronomical community to the International Gemini Observatory and to several non-federal observatories through the Telescope System Instrumentation Program (TSIP). NOAO manages national community involvement in the development of potential future infrastructure projects such as the Giant Segmented Mirror Telescope and the Large Synoptic Survey Telescope, both of which are high priority recommendations of the 2000 Decadal Survey conducted by the National Research Council's Astronomy and Astrophysics Survey Committee.

The National Solar Observatory (NSO) operates facilities in New Mexico (Sacramento Peak Observatory, SPO) and Arizona (at KPNO) as well as a coordinated worldwide network of six telescopes (GONG) specifically designed to study solar oscillations. NSO leads the community in design and development of the Advanced Technology Solar Telescope (ATST). (More information on this project can be found in the Major Research Equipment and Facilities Construction chapter). NSO makes available to qualified scientists the world's largest collection of optical and infrared solar telescopes and auxiliary instrumentation for observation of the solar photosphere, chromosphere, and corona. NSO provides routine, synoptic solar data used by many researchers and other agencies through its online archive.

The Cerro Tololo Inter-American Observatory 4-meter telescope dome. *Credit: M. Urzua Zuniga/Gemini Observatory.*

NOAO and NSO telescopes are open to all astronomers regardless of institutional affiliation on the basis of peer-reviewed observing proposals. They serve over 1,000 scientists annually. In FY 2009 NOAO employed about 47 support scientists, 10 postdoctoral fellows, 59 engineers and technical staff, and 130 other personnel, a decrease of 24 FTEs below FY 2008. In FY 2009 NSO employed approximately 17 support scientists, 29 technical staff and 43 other personnel within the operating budget. In FY 2010, NOAO will replace approximately half the FTEs lost in FY 2009 and NSO will reduce staff by approximately three FTEs.

Total Obligations for NOAO and NSO
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
NOAO-Operations	$17.62	$18.14	$5.60	$19.00	$19.73	$20.40	$21.00	$21.65	$22.25
NOAO-Development	5.59	7.02	-	8.00	8.10	8.22	8.50	8.75	9.03
NOAO-Research & Ed.	1.39	0.42	-	0.50	0.50	0.55	0.55	0.55	0.60
TSIP	4.00	4.00	-	5.00	5.00	5.00	5.00	5.00	5.00
NSO-Operations	7.53	7.11	1.40	7.25	7.47	7.70	7.90	8.10	8.35
NSO-Development	2.10	2.56	-	1.50	1.55	1.60	1.65	1.75	1.75
NSO-Research & Ed.	0.32	0.33	-	0.35	0.35	0.35	0.39	0.39	0.45
ATST Design/Develop.	-	-	3.10	-	-	-	-	-	-
Total, NOAO and NSO	$38.55	$39.58	$10.10	$41.60	$42.70	$43.82	$44.99	$46.19	$47.43

Totals may not add due to rounding.

Funding displayed for FY 2011 through FY 2015 are planning estimates only.

TSIP is the Telescope System Instrumentation Program.

Partnerships and Other Funding Sources: Thirty-four U.S. member institutions and seven international affiliate members comprise the Association of Universities for Research in Astronomy, Inc. (AURA), the management organization for NOAO and NSO. Other partners include the U.S. Air Force Office of Scientific Research, U.S. Air Force Weather Agency, NASA, and industrial vendors. A large number of U.S. universities support their own astronomical facilities at KPNO and CTIO with reimbursed services provided by NOAO. Many universities and institutes collaborate with NSO on solar instrumentation development and on the design and development of ATST. Development of new telescopes, instrumentation, and sensor techniques is done in partnership with industry through subawards to aerospace, optical fabrication, and information technology companies. NOAO and NSO leverage NSF support with funding from other federal agencies and non-federal sources. In FY 2008, NOAO and NSO received about $2.49 million from other federal agencies and $1.94 million from non-federal and industrial sources. For all NOAO and NSO telescopes, peer-review telescope allocation committees provide merit-based telescope time but no financial support.

Education and Public Outreach: Both NOAO and NSO support U.S. education goals by promoting public understanding and support of science and by providing education and training at all levels. Typically, twenty-five percent of doctorates awarded annually in astronomy involve use of NOAO/NSO facilities. The observatories introduce undergraduate students to scientific research by providing stimulating environments where they are exposed to basic astronomical research and related technologies through NSF's Research Experiences for Undergraduate Students (REU) program. NOAO and NSO have diverse education programs, visitor centers, and web-based information portals, including www.noao.edu and www.nso.edu.

NOAO-Operations, $19.0 million (+$860,000 over FY 2009 level of $18.14 million): NOAO-Operations covers the operation of facilities at KPNO, CTIO, and the headquarters in Tucson. An increase of $860,000 will support the observatories' limited funding in early FY 2009. The majority of these funds will allow the hiring of technical support personnel for user support.

NOAO-Development, $8.0 million (+$980,000 over FY 2009 level of $7.02 million): Development support covers NOAO's share of the design and development of the Large Synoptic Survey Telescope (LSST) and the development of new instrumentation for telescopes at KPNO and CTIO. The Senior Review recommended that the instrumentation at KPNO and CTIO urgently be modernized. In FY 2010 NOAO will begin a multi-year effort to introduce new capabilities to the U.S. community through investment in new instrumentation at KPNO and CTIO using in part the $980,000 increase. Ongoing design and development for the LSST will continue.

NOAO-Research & Education, $500,000 (+$80,000 over FY 2009 level of $420,000): NOAO links the research conducted at its facilities to the education of the public through its Education and Public Outreach office in Tucson. An increase of $80,000 is requested to provide science community outreach, news and public information, and educational activities for K-12.

Telescope System Instrumentation Program, $5.0 million (+$1.0 million over FY 2009 level of $4.0 million): This program supports the development and fabrication of instrumentation at non-federal observatories in return for competitively reviewed observing time for the national community. A recommendation of the 2000 Decadal Survey in astronomy, TSIP has proved extremely effective in gaining access for the national community of researchers to non-federal observatories. NOAO manages the program on behalf of NSF. An increase of $1.0 million will add access to the national community for up to 20 nights of telescope time on 8-10 meter class telescopes.

NSO-Operations, $7.25 million (+$140,000 over FY 2009 level of $7.11 million): NSO-Operations includes facility operations at KPNO, SPO, and the world-wide Global Oscillations Network Group.

NSO-Development, $1.50 million (-$1.06 million below FY 2009 level of $2.56 million): This funding for NSO covers design and development of ATST and development of new instrumentation for telescopes at KPNO and SPO. The reduction of $1.06 million in FY 2010 acknowledges the end of the design and development phase of the ATST and the commencement of construction with funding from the Major Research Equipment and Facilities Construction account

NSO-Research & Education, $350,000 (+$20,000 over FY 2009 level of $330,000): NSO supports education of the public in solar physics through its Education and Public Outreach office at Sacramento Peak Observatory. This office provides science community outreach, a visitors' center, and news and public information with a modest increase of $20,000 in FY 2010.

Facility Report:

Management and Oversight:

- NSF Structure: An NSF program director in the Division of Astronomical Sciences (AST) provides ongoing oversight, including consultation with an annual NSF Program Review Panel. The program director makes use of detailed annual program plans, annual long range plans, quarterly technical and financial reports, and annual reports submitted by NOAO and by NSO as well as attending AURA governance committee meetings. These governance committees are formed from the national astronomical community and provide additional windows into community priorities and concerns. AST program managers work closely with other offices at NSF, particularly the Division of Acquisition and Cooperative Support, the Office of General Counsel, and the Large Facilities Project Office.

- External Structure: AURA is the managing organization for both NOAO and NSO. Separate NOAO and NSO directors report to the president of AURA who is the principal investigator on the two FY 2010 NSF cooperative agreements. AURA receives management advice from an Observatory Council for each observatory composed of members of its scientific and management communities. NOAO and NSO each employ separate Visiting and Users Committees for the purposes of self-evaluation and prioritization. The Visiting Committees, composed of nationally prominent individuals in science, management, and broadening participation, review for AURA all aspects of the management and operations of the observatories. The User Committees, composed of scientists with considerable experience with the observatories, review for the Directors all aspects of the observatories that affect the experiences of the users of that observatory.

- Reviews: In addition to reviews held mid-way through all cooperative agreements, NSF conducts both periodic and ad hoc reviews of AURA management as needed by external committees. In response to recommendations from the 2006 Senior Review, AST carried out a review of administrative and operational costs at all its facilities using a outside contractor. That review concluded that NOAO and NSO are operated in a very cost effective manner and also recommended several cost-savings changes that AST now has under review.

<u>Renewal/Recompetition/Termination:</u>

A management review of AURA's performance was carried out in August 2006. In response to the favorable review, the National Science Board extended the current cooperative agreement with AURA for eighteen months, through September 30, 2009. A proposal for renewal of the cooperative agreement was received from AURA in December 2007 and underwent review in 2008. The National Science Board authorized two new cooperative agreements with AURA, one for management and operation of NOAO and one for management and operation of NSO, for the period October 1, 2009, though March 31, 2014.

National Radio Astronomy Observatory **$67,090,000**
+6,300,000 / 10.4%

National Radio Astronomy Observatory
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
National Radio Astronomy Observatory	$52.73	$60.79	$5.40	$67.09	$6.30	10.4%

The National Radio Astronomy Observatory (NRAO) provides state-of-the-art radio telescope facilities for scientific users. NRAO conceives, designs, builds, operates, and maintains radio telescopes used by scientists from around the world to study virtually all types of astronomical objects known, from planets and comets in our own Solar System to quasars and galaxies billions of light-years away.

As a Federally Funded Research and Development Center (FFRDC), NRAO operates major radio telescopes in Green Bank, West Virginia, near Socorro, New Mexico, and at ten telescope array sites spanning the U.S. from the Virgin Islands to Hawaii. NRAO's headquarters is in Charlottesville, Virginia. NRAO is also the North American implementing organization for the international Atacama Large Millimeter Array (ALMA) project. These federally funded, ground-based observing facilities for radio astronomy are available to any qualified astronomer, regardless of affiliation or nationality, on the basis of scientific peer-reviewed proposals and annually serve over 1,500 users worldwide. The Observatory allocates telescope time on the basis of merit but provides no financial support. NSF does not provide individual investigator awards targeted specifically for use of NRAO facilities. Many users are supported through NSF or NASA grants to pursue scientific programs that require use of the facility.

NRAO staff include 405 FTEs in the operations and maintenance component of the Observatory: 61 in Observatory Management, 300 in Observatory Operations, 31 in Science & Academic Affairs and Education and Public Outreach (EPO), and 13 in the Central Development Laboratory.

Total Obligations for NRAO
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Operations & Maintenance	$39.08	$43.60	$43.14	$43.24	$42.89	$44.33	$46.95	$49.25
Observatory Management	*5.71*	*7.30*	*7.10*	*7.10*	*7.10*	*7.25*	*7.30*	*7.40*
Observatory Operations	*27.85*	*30.35*	*30.30*	*30.39*	*30.04*	*30.93*	*33.15*	*35.00*
Science, Academic Affairs, EPO	*3.96*	*4.26*	*4.19*	*4.25*	*4.25*	*4.40*	*4.50*	*4.60*
Central Development Lab	*1.56*	*1.69*	*1.55*	*1.50*	*1.50*	*1.75*	*2.00*	*2.25*
ARRA Estimate	-	*5.40*	-	-	-	-	-	-
Implementation of EVLA	6.01	6.19	6.38	1.13	-	-	-	-
ALMA Operations	7.64	11.00	17.57	23.50	30.65	33.92	36.41	39.17
Total, NRAO	$52.73	$66.19	$67.09	$67.87	$73.54	$78.25	$83.36	$88.42

Totals may not add due to rounding.

Funding displayed under Operations and Maintenance subareas in FY 2010 to FY 2015 are planning estimates only.

Partnerships and Other Funding Sources: NRAO supplements Division of Astronomical Sciences (AST) support with funding provided by other NSF sources, other federal agencies, and non-federal sources. In FY 2008, NRAO received approximately $1.0 million from non-AST sources at NSF and $250,000 from other federal agencies such as NASA, and about $300,000 from U.S. universities, foreign scientific and technical institutes, and other non-federal and industrial sources. The development of new telescopes, instrumentation, and sensor techniques is completed in partnership with relevant industries through competitive subawards to various large and small aerospace companies, radio antenna manufacturing firms, and specialized electronics and computer hardware and software companies.

In FY 2010, increased investments at NRAO will provide for the continued ramp up of ALMA operations. A consequence of the increase for ALMA will be a $460,000 decrease in the base operations and maintenance account of the Observatory.

Education and Public Outreach: NRAO's primary education goal is to support the development of a scientifically and technically literate society through a comprehensive outreach program in which information about radio astronomy is made available to the public (see www.nrao.edu/index.php/learn). Observational facilities are used by graduate students carrying out dissertation research and on work experience programs and by undergraduate students participating in the Research Experiences for Undergraduates (REU) program. Typically over 150 students use NRAO facilities annually. NRAO sites also support visitor/education centers and conduct an active educational and public outreach program.

NRAO has centralized its outreach activities into an Office of Education and Public Outreach. The new Green Bank Science Center is in full operation, and the VLA Visitor Center was redesigned. Approximately 68,000 public visitors pass through the Green Bank Science Center and the VLA Visitor Center each year.

The Very Large Array (VLA) telescope, located about 80 km west of Socorro, NM, is composed of 27 individual antennas arranged in a "Y" pattern. In their closest configuration (about 1 km wide), the VLA is able to image large portions of the sky. In its largest configuration (about 36 km wide) the VLA is able to home in on the fine details of astronomical objects. *Credit: NRAO/AUI and Kelly Gatlin, Patricia Smiley.*

Observatory Management, $7.10 million ($200,000 below the FY 2009 Current Plan level of $7.30 million): Funding is shifted to partially accommodate the ramp up in ALMA operations. Observatory Management includes the Director's office, administrative services, the end-to-end data management initiative, and the New Initiatives Office.

Observatory Operations, $30.30 million ($50,000 below the FY 2009 Current Plan level of $30.35 million): Funding is shifted to partially accommodate the ramp up in ALMA operations. The Observatory Operations programmatic area includes the support for operating facilities at Green Bank, West Virginia and in New Mexico, and the computer and information services that support the facilities.

Science & Academic Affairs and EPO, $4.19 million ($70,000 below the FY 2009 Current Plan level of $4.26 million): Funding is shifted to partially accommodate the ramp up in ALMA operations. This area includes staff research, science training and education, science centers, the library, science community outreach, and news and public information.

Central Development Laboratory (CDL), $1.55 million ($140,000 below the FY 2009 Current Plan level of $1.69 million): Funding is shifted to partially accommodate the ramp up in ALMA operations. The CDL is developing next generation electronics and detectors for radio astronomy, making fundamental contributions to materials science, the physics of quantum detectors, electromagnetics, photonics, and radio propagation.

Implementation of EVLA, $6.38 million ($190,000 over the FY 2009 Current Plan level of $6.19 million): FY 2010 funding allows for a long planned increase. The Very Large Array (VLA) is undergoing an upgrade of electronics and communications systems, referred to as the Expanded Very Large Array (EVLA), to significantly enhance capabilities. Total project cost is $87 million. Construction of the EVLA began in FY 2001 and is proceeding on budget and on schedule for a 2012 completion. The EVLA will provide a factor of ten improvement in capability in several areas over the VLA. More than half of the VLA antennas have been converted to EVLA standards and all remaining antennas will be retrofitted by the end of 2010. Canada is responsible for the correlator for processing EVLA data, and the first sections of the correlator arrived in the third quarter of 2008. Shared risk scientific observing will begin in 2009/2010, with full science operations by 2013. The transformation of the VLA into the EVLA has proceeded with little interruption to the regular VLA observing schedule.

ALMA Operations, $17.57 million (+$6.57 million over the FY 2009 Current Plan level of $11.0 million): NRAO is also engaged in construction of the international ALMA, which in FY 2010 will be entering the 9th year of its eleven year construction phase, funded through the Major Research Equipment and Facilities Construction (MREFC) account. Early operations funding for ALMA began in FY 2005 and ramps up sharply in FY 2008 to FY 2015. A funding profile through FY 2011 was authorized by the National Science Board in December 2007. The operations estimates for FY 2012 and beyond are based on current cost projections. Additional information on the ALMA project is available in the MREFC chapter.

In 2006 NRAO created the North American ALMA Science Center (NAASC) to support the broad user community in fully realizing the scientific capabilities of ALMA. The NAASC is ramping up its activity level in conjunction with the ramp up in ALMA operations. The NAASC serves two key functions: supporting basic ALMA operations as the North American ALMA Regional Center (ARC) by providing day-to-day support for ALMA operations carried out in Chile; and providing ease of access and strong support for the broad astronomical community in using ALMA. The NAASC is organizing schools, workshops, and courses in the techniques of millimeter and submillimeter astronomy.

Facility Report:

Management and Oversight:

- NSF Structure: Ongoing oversight and assessment is carried out in AST and in consultation with community representatives making use of detailed annual program plans, long range plans, quarterly technical and financial reports, and annual reports submitted to NSF by NRAO as well as by attendance at governance committee meetings of the managing organization, Associated Universities, Inc., (AUI). AST works closely with other NSF offices NSF, such as the Division of Acquisition and Cooperative Support, Office of General Counsel, and Large Facilities Project Office to address issues as they arise.

- External Structure: Management is through a cooperative agreement with AUI. AUI manages the observatory through its own community-based oversight and users' committees. The NRAO director reports to the president of AUI.

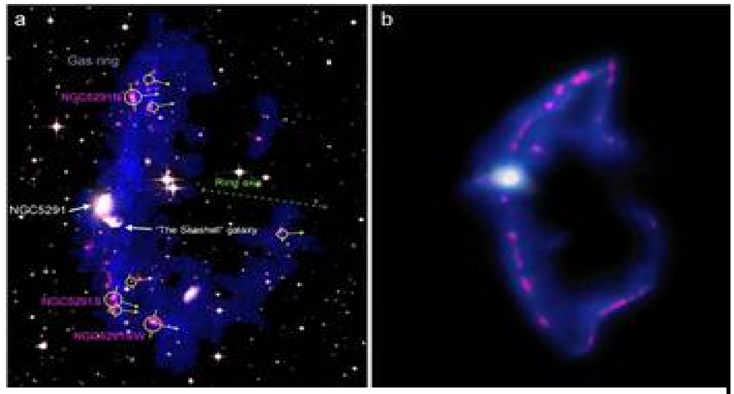
- Reviews: In addition to reviews held mid-way through all cooperative agreements, NSF conducts periodic reviews of AUI/NRAO management by external committees on an ad hoc basis. In addition, in response to recommendations from the Senior Review, AST carried out a review of administrative and operational costs at all its facilities in 2008. That review concluded that NRAO is operated in a cost effective manner and recommended several possible cost savings that AST has under review.

Renewal/Recompetition/Termination:

The present cooperative agreement expires at the end of FY 2009. AUI has submitted a renewal proposal for the operation and management of NRAO for the period FY 2010-2015, which is currently being reviewed.

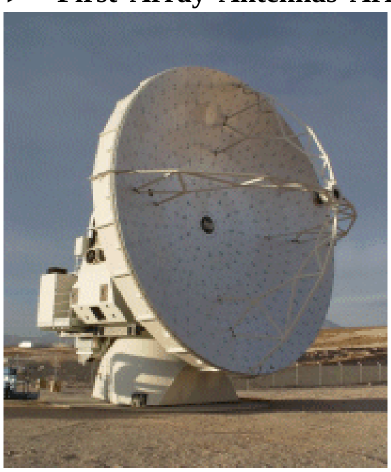
Recent Research Highlights

► **Big Dwarf Galaxies May Contain Missing Mass:** When galaxies collide, smaller "dwarf" galaxies form from the debris. An international team of astronomers studying these dwarf galaxies found them to be much more massive than expected. The researchers believe the additional material is "missing mass" that theorists said should not be present in this kind of dwarf galaxy. The scientists used NSF's Very Large Array radio telescope to study a galaxy called NGC 5291, which is 200 million light years from Earth. This galaxy collided with another 360 million years ago, and the collision shot streams of gas and stars outward. Later, the dwarf galaxies formed from the ejected debris. This research is a significant development in our understanding of the way galaxies form and the resulting evolution of galactic collisions.



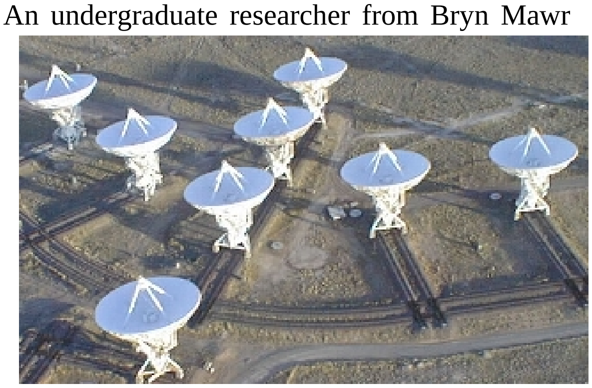
Multiwavelength image of NGC 5291 and dwarf galaxies around it. *Credit: Pierre-Alain Duc, CEA-CNRS/NRAO/AUI/NSF/NASA.*

► **First Array Antennas Arrive in Chile:** Several antennas from North America and Japan have arrived at the mid-altitude, 2,800 meter site in Northern Chile for assembly and verification. The site serves as a base for the Atacama Large Millimeter Array (ALMA) of antennas. After testing, the staff will integrate them with receiver packages and test their ability to function as an interferometric pair before transporting each completed antenna to the high-altitude (5,000 meters) operational site. The array is a partnership between North America and Europe to each construct 25 antennas, 12-meters in diameter. Japan will provide an added four antennas, 12 meters in diameter, and 12 antennas, 7 meters in diameter. Processing the signal from each antenna with that measured by every other antenna allows a radio image of the sky to be constructed with a resolution equivalent to a single dish the size of the entire array.



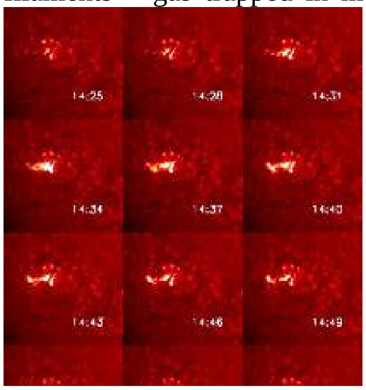
The first of several Atacama Large Millimeter Array antennas at the mid-level site in Chile undergoing initial testing. *Credit: Image courtesy NRAO/AUI.*

► **A Peek Inside a Blue Compact Dwarf Galaxy:** An undergraduate researcher from Bryn Mawr College used data obtained from NSF's Very Large Array radio telescope in Socorro, New Mexico, to learn important information about "VIIZw403," a blue compact dwarf galaxy with an unresolved (no visible structure) X-ray source. Although this galaxy had been observed by astronomers, the researcher uncovered the previously unresolved structure in the atomic hydrogen around the X-ray point source and other regions of the galaxy. This work may ultimately shed light on how blue compact dwarf galaxies undergo bursts of star formation without an obvious instigator. The researcher carried out her work as a summer student in a program led by the Florida Institute of Technology.



NSF-funded Very Large Array Radio Observatory, located in Socorro, New Mexico. *Credit: NRAO.*

► **Unraveling erupting filaments on the Sun:** A middle-school teacher tracked and analyzed erupting filaments – gas trapped in magnetic field loops – on the surface of the Sun through an NSF-funded summer school at the National Solar Observatory's facilities in New Mexico.

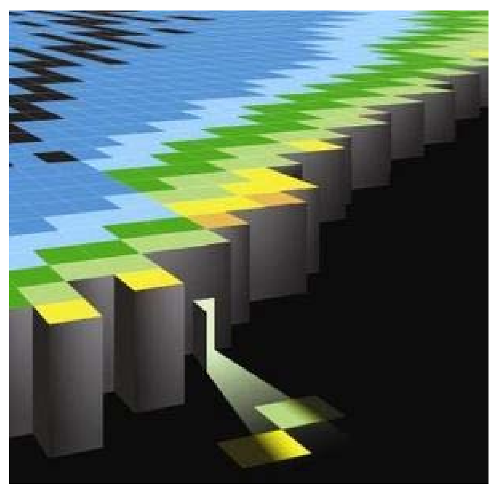


Archival data used in the analysis of erupting filaments on the Sun. These images, taken on June 20, 2004, with a hydrogen alpha emission imaging system, show the development of the filament over time. *Credit: Kathy Allshouse and & OSPAN/AFRL.*

Her analysis of the intensity and Doppler signatures of the erupting filaments showed there is expansion and unspiraling of filament structures as they erupt. The teacher is taking her research experience back into the classroom where she will be add new material to the astronomy section of the Earth Science curriculum at her middle school. She plans to include topics such as the Doppler effect, optics, telescopes, and the electromagnetic spectrum.

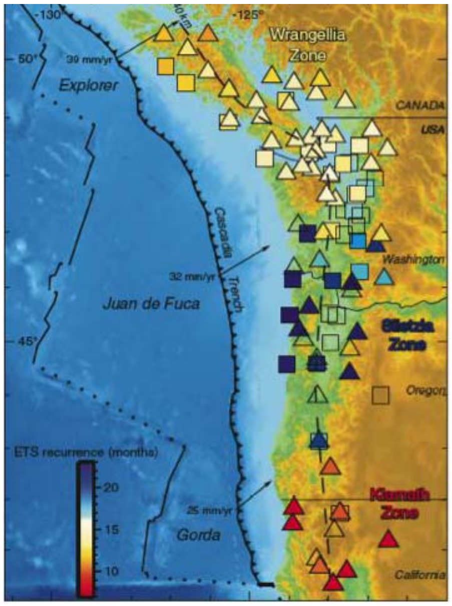
The National Solar Observatory's 2007 Research Experiences for Undergraduates and Researcher Experiences for Teachers & Summer Research Assistantship Program participants. Kathy Allshouse, the middle-school teacher featured in this highlight, is on the far left. *Credit: NSO/AURA/NSF.*

► **New Isotopes Push the Neutron "Dripline" for Magnesium and Aluminum:** How many neutrons can an atomic nucleus hold? Possibly a lot more than current scientific models predict. That's the conclusion a team of physicists from Michigan State University reached after creating one new ultra-heavy isotope of magnesium and two new ultra-heavy types of aluminum. According to one of the leading theoretical models, one of the aluminum isotopes – aluminum-42 – should not exist. That it does exist suggests the outer limit for neutron stuffing, called "the dripline" by nuclear physicists, includes more novel, neutron-rich isotopes than previously thought. Right now, scientists only know the dripline limit for the eight lightest elements, hydrogen to oxygen. The researchers used a dual-filtering process that detected and measured isotopes so rare they represent only one in every billion million particles that passed by the detectors. This experiment marks one of the first uses of two-stage separation in the world.



Michigan State University researchers created never-before-seen isotopes of magnesium and aluminum – represented by the two colored squares floating in blackness. Research results suggest that variants of everyday elements might exist which are heavier than current scientific models predict. The extra weight refers to the additional neutrons stuffed into the nucleus by a dual filtering process. *Credit: Alex Paisons, Michigan State University.*

► **Earth's Shifting Plates Provide Clues to Earthquakes and Volcanoes:** Subduction occurs when two of Earth's tectonic plates move towards each other and one plate is thrust beneath the other. Subduction also generates scraping between the plates and chemical changes within the submerging plate that can lead to earthquakes and volcanoes. A researcher from Miami University and his co-researcher from the University of California at Berkeley took an in-depth look at the Cascadia subduction zone that stretches from Vancouver Island to Northern California. Using seismic and GPS data, the researchers determined intervals between the "episodic tremor and slip" episodes – the slow release of accumulated strain along the interface of the two plates – negatively correlates with the topography of the overriding plate. Conversely, there was not a discernible relationship with characteristics of the downgoing oceanic plate. This intriguing result suggests the geology of the overriding plate may play a more important role in tremor and slip episodes and earthquake behavior than previously thought.



"Map illustrating patterns in episodic tremor and slip (ETS) along the entire Cascadia subduction zone. Colored base map shows topography and bathymetry. Dashed line onshore marks 40 km depth contour of the subduction interface. Arrows and associated annotations show directions and speeds of subduction relative to North America. Locations of continuous global positioning system stations (squares) and broadband seismometers (triangles) that exhibit ETS are shown, with colors indicating the recurrence interval when multiple ETS events were observed. Recurrence intervals establish three zones that are labeled based on the continental terrane block with which they are associated." from Geology, Oct 2007, v. 35, no, 10, p. 907. *Credit: Geology, October 2007; v.35; no. 10; p. 907-910.*

NSF-WIDE INVESTMENTS

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NATIONAL SCIENCE FOUNDATION CENTERS

NSF supports a variety of centers programs that contribute to the Foundation's mission and vision. Centers exploit opportunities in science, engineering, and technology in which the complexity of the research problem or the resources needed to solve the problem require the advantages of scope, scale, duration, equipment, facilities, and students. Centers are a principal means by which NSF fosters interdisciplinary research.

NSF Centers Funding
(Dollars in Millions)

	Program initiation	Number of Centers in FY 2008	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Centers for Analysis & Synthesis	1995	4	$13.80	$17.41	$23.00	$5.59	32.1%
Centers for Chemical Innovation	1998	9	7.87	15.50	24.00	8.50	54.8%
Engineering Research Centers	1985	15	53.42	53.55	63.20	9.65	18.0%
Materials Res. Science & Engineering Ctrs	1994	31	57.15	68.51	66.01	-2.50	-3.6%
Nanoscale Science & Engineering Centers	2001	19	45.95	45.16	45.16	-	-
Science and Technology Centers	1987	17	64.73	61.61	57.79	-3.82	-6.2%
Science of Learning Centers	2003	6	14.89	12.50	25.80	13.30	106.4%
Total, Centers			$257.80	$274.24	$304.96	$30.72	11.2%

Totals may not add due to rounding.

CENTERS DESCRIPTIONS

Centers for Analysis and Synthesis (BIO)

The Centers for Analysis and Synthesis are designed to continue development of new tools and standards for management of biological information and meta-information, support data analysis capabilities with broad utility across the biological sciences, host workshops that bring together scientists from a variety of disciplines, and begin to host and curate databases. The centers have a critical role in organizing and synthesizing biological knowledge that is useful to researchers, policy makers, government agencies, educators, and society.

The National Center for Ecological Analysis and Synthesis (NCEAS) at the University of California at Santa Barbara promotes integrative studies of complex ecological questions and serves as a locus for the synthesis of large data sets. Funding for NCEAS remains at $3.70 million for FY 2010. The National Evolutionary Synthesis Center (NESCent) is a collaborative effort by Duke University, North Carolina State University, and the University of North Carolina at Chapel Hill to foster a greater conceptual synthesis in biological evolution by bringing together researchers and educators, extant data, and information technology resources. In FY 2010, funding doubles from $2.50 million to about $5.0 million per year as NESCent ramps up activities for the next five years.

The National Institute for Mathematical and Biological Synthesis (NIMBioS, formerly CIMBS), located at the University of Tennessee-Knoxville, fosters cross-disciplinary approaches in mathematics and biology to address fundamental and applied biological questions, including national needs research in modeling of infectious diseases of plants and animals. The center will design education programs aimed at the mathematics-biology interface, thereby building the capacity of mathematically competent, biologically knowledgeable and computationally adept researchers needed to address the vast array of challenging questions in this century of biology. Although predominantly supported by BIO, MPS and the Department of Homeland Security also contribute. NIMBioS funding increases from $2.05 million in FY 2009 to $3.50 million in FY 2010.

A Plant Science Cyberinfrastructure Collaborative (iPlant, formerly PSCIC) led by the University of Arizona uses new computer and information science, and cyberinfrastructure solutions to address an evolving array of grand challenges in the plant sciences. This center is a community-driven effort, involving plant biologists, computer and information scientists and engineers as well as experts from other disciplines, all working in integrated teams. Awarded in FY 2008, iPlant ramps up from $9.16 million in FY 2009 to $10.80 million in FY 2010 .

Centers for Chemical Innovation (MPS)
The Centers for Chemical Innovation (CCI) are designed to support research on strategic, transformative "big questions" in basic chemical research. The program is stimulating the chemical sciences community to perform work that is high-risk and of potential high scientific and societal impact. CCIs promote the integration of research and education through the extensive involvement of students and postdoctoral fellows in all phases of the work. CCIs are expected to be agile, responding to scientific opportunities as they arise, and to creatively engage the public. Grand challenges include emulating and even surpassing the efficiency of the natural process of photosynthesis to capture the sun's energy; activating strong bonds as a means to store and use chemical energy and to lower energy costs in chemical processing; and designing self-assembling, complex structures, such as molecular computers, with emergent and useful functions not yet known or foreseen.

The program is designed as a staged competition, supporting several Phase I centers at $500,000 per year for three years, which then compete for Phase II awards at $4.0 million to $5.0 million per year for five to ten years. The Phase II Center awarded in FY 2007 is developing chemistry needed to transform raw materials, such as plants, into high value organic compounds, such as fuels and chemicals for industry. The Phase II Center awarded in FY 2008 is researching the chemical fundamentals of solar energy capture and conversion to a chemical fuel.

In FY 2009, NSF plans to support a total of three Phase II centers and about ten Phase I centers. In FY 2010, the requested $24.0 million will launch two new Phase II centers (for a total of five) and four new Phase I Centers (for a total of eleven as some Phase I centers either move to Phase II or sunset).

Engineering Research Centers (ENG)
NSF's Engineering Research Centers (ERCs) are proven cauldrons of innovation, bridging the energy and intellectual curiosity of university research focused on discovery with real-world engineered systems and technology opportunities through partnerships with industry. These centers also are successful in educating a technology-enabled workforce with hands-on, real-world experience. These characteristics create an environment that catalyzes the development of marketable technologies to generate wealth and address engineering grand challenges, many of which intersect the National Academy of Engineering's Grand Challenges. This is particularly evident in ERCs that address the need for intelligent electric power grid systems to integrate the distribution of electricity from a range of variable sources including wind and solar, innovations in healthcare derived from tissue engineering and microelectronics research, sensing systems that improve the prediction of tornados, and intelligent robotic systems to assist the aging and disabled in daily tasks.

ERCs are also devoted to the integration of research and education by creating collaborative environments, and producing curricula and course materials for bioengineering, manufacturing, renewable resource use, optelectronics, and other fields. Also, all ERCs have active programs that involve pre-college teachers and students to bring engineering concepts to the classroom to stimulate interest in engineering among pre-college students; several have sites at local museums to educate the general public about engineering and technology.

In FY 2008, a new third-generation of ERCs was funded that builds on lessons learned from the impacts of the 40 successful ERCs since 1985. Five new Gen-3 ERCs have added goals of speeding innovation through involvement with small firms in transnational research and partnerships with state, local, and venture capital organizations devoted to innovations and entrepreneurship. Five new ERCs in FY 2008 brought the total number to 15. The FY 2009 solicitation (NSF 09-545) will add three new ERCs in 2010 to replace two graduating centers from the Class of 2000 and increase the total number of centers to 16. Two additional centers will also be added in early 2011 to bring the total portfolio to 18.

Materials Research Science and Engineering Centers (MPS)
Materials Research Science and Engineering Centers (MRSECs) address fundamental research problems of intellectual and strategic importance that will advance U.S. competitiveness and the development of future technologies. MRSECs also support shared experimental facilities, place strong emphasis on the integration of research and education at all levels, and provide seed money to stimulate emerging areas of materials research. They support cutting-edge areas such as electronic and photonic materials, polymers, biomimetic and biomolecular materials, magnetic and ferroelectric materials, nanoscale materials, structural materials, and organic systems and colloids. MRSECs have strong links to industry and other sectors, enabling the development of marketable technologies that depend on new classes of materials and the discovery, control, and innovative exploitation of materials phenomena. Areas of potential technological impact include computers and communications, transportation, energy conversion and storage, structural engineering, health, and medicine. MRSECs also foster partnerships among academic institutions in the U.S. as well as internationally. A significant component of new MRSEC awards are expected to tie to cross-Foundation activities, particularly Science and Engineering Beyond Moore's Law (SEBML).

Open competitions for NSF support are held triennially. The FY 2008 competition yielded five new centers for a total of 31. Four other centers are currently phasing out with final funding in FY 2009 and FY 2010. FY 2010 funding for MRSECs will be comparable to FY 2009, at about $66.0 million, with 27 MRSECs expected to be supported. A new competition is planned for FY 2011.

Nanoscale Science and Engineering Centers (multi-directorate)
Nanotechnology, which addresses the smallest of scales, is projected to be one of the largest drivers of technological innovation for the next decade and beyond. This potential was recognized in the National Nanotechnology Initiative, particularly in the burgeoning area of nanomanufacturing. Research at the nanoscale through NSF-funded Nanoscale Science and Engineering Centers (NSECs) aims to advance the development of the ultra-small technology that will transform electronics, materials, medicine, environmental science, and many other fields. Each center has an extended vision for research. Together they provide coherence and a long-term outlook to U.S. nanotechnology research and education; they also address the social and ethical implications of such research. NSEC funding will also support education and outreach programs from K-12 to the graduate level, which is designed to develop a highly skilled workforce, advance pre-college training, and further public understanding of nanoscale science and engineering. These centers have strong partnerships with industry, national laboratories, and international

centers of excellence, which puts in place the necessary elements to bring discoveries in the laboratory to real-world, marketable innovations and technologies.

NSF funded 19 NSECs in FY 2008, including the Nanotechnology in Society Network, and expects to continue funding these 19 in FY 2010 at the same funding level of $45.16 million. Of these, four NSECs on nanomanufacturing established the core of the National Nanomanufacturing Network in FY 2007, and two Centers for the Environmental Implications of Nanotechnology were established in FY 2008 with an annual budget totaling $7.30 million.

Science and Technology Centers: Integrative Partnerships (multi-directorate)
The Science and Technology Centers: Integrative Partnerships (STC) program advances discovery and innovation in science and engineering through the integration of cutting-edge research, excellence in education, targeted knowledge transfer, and development of a diverse workforce. The STC portfolio reflects the disciplines of science and engineering supported by the NSF. Examples of continuing investment include cyber-security, advanced sensors and embedded networked sensing, revolutionary materials for information technology, advanced nano/microfabrication capabilities, new materials and technologies for monitoring water resources and water quality, modeling and simulation of complex earth environments for improving their sustainability, and weather/climate prediction.

STCs engage the Nation's intellectual talent and robustly draw from its full diversity through partnerships among academia, industry, national laboratories, and government. These partnerships enhance and ensure the timely transfer of knowledge and technology from the laboratory to appropriate industries, the application of patents derived from the work of the STCs, the launching of spin-off companies, and creation of job opportunities. STCs have impressive records of publications and research training of students, postdoctoral fellows, established researchers, and educators as well as strong partnerships with K-12 and informal education communities and industry.

In FY 2009, after ten years of funding, support for five centers from the Class of 2000 will end. A new competition was initiated in FY 2009 to identify and fund up to five new STCs in FY 2010. A total of 17 new and continuing STCs are expected to be funded in FY 2010.

Science of Learning Centers (multi-directorate)
The Science of Learning Center (SLC) goals are to advance fundamental knowledge about learning, transform the way people learn and teach, secure the U.S. leadership role in innovation and technology, and prepare the Nation's workforce for the 21st century. The six SLCs will continue to harness and integrate knowledge across multiple disciplines to create a common groundwork of conceptualization, experimentation, and explanation that underlies new lines of thinking and inquiry leading to a deeper understanding of learning. The SLC portfolio represents synergistic, exciting research efforts that address different dimensions of learning, including:

- combined modeling and experimental studies to link brain function and behavior and permit innovations in technology
- development of learning technologies to study robust learning in classrooms in support of educational data mining, machine learning, and developing principles to inform the use and design of new technologies that enhance learning
- the processes involved in learning visual languages and how this knowledge can improve language processing and reading in deaf, hearing-impaired, and hearing learners
- the influence of time and timing on learning across multiple scales and multiple levels of analysis, to inform understanding of learning from the cellular level to social interactivity in classrooms

- the role of social interaction in learning, including the interplay between learning in informal and formal environments
- spatial intelligence and learning, the malleability of the underlying processes and how they can be enhanced to improve learning in STEM domains

In FY 2010, almost $26.0 million will provide continuing funding for the second cohort of SLCs, enable award renewal for the first cohort of SLCs, and provide support for programmatic activities, including administrative costs, workshops, external evaluation, and infrastructure to support the network of centers.

Estimates of Centers Participation in 2008
(Dollars in Millions)

	Number of Participating Institutions	Number of Partners	Total FY 2008 NSF Support	Total Est. Leveraged Support	Number of Participants
Centers for Analysis & Synthesis	9	48	$14	$8	1,535
Centers for Chemical Innovation	27	16	$8	$1	242
Engineering Research Centers	432	455	$53	$100	4,302
Materials Research Science & Engineering Centers	357	351	$57	$54	3,950
Nanoscale Science & Engineering Centers	160	295	$46	$18	2,000
Science & Technology Centers	121	443	$65	$30	3,061
Science of Learning Centers	32	59	$15	$16	487

No. of Participating Institutions: all academic institutions participating in activities at the centers.
No. of Partners: the total number of non-academic participants, including industry, states, and other federal agencies at the centers.
Total Leveraged Support: funding for centers from sources other than NSF.
No. of Participants: the total number of people who use center facilities, not just persons directly support by NSF.

Centers Supported by NSF in FY 2008

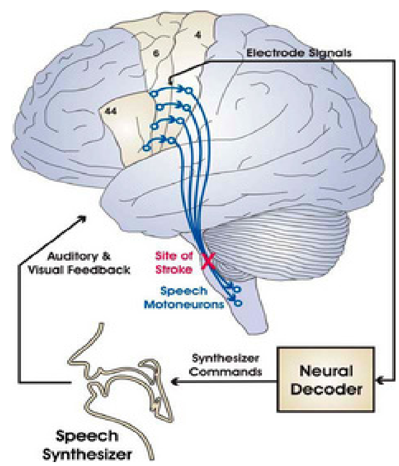
Center	Institution	State
Centers for Analysis and Synthesis		
National Center for Ecological Analysis and Synthesis	U of California-Santa Barbara	CA
National Evolutionary Synthesis Center	Duke, NC State U, U of N. Carolina	NC
National Institute for Mathematical & Biological. Synthesis	U of Tennessee- Knoxville	TN
Plant Science Cyberinfrastructure Collaborative	U of Arizona	AZ
Centers for Chemical Innovation		
Center for Enabling New Technologies through Catalysis (phase II)	U of Washington	WA
Powering the Planet (phase II)	California Institute of Tech	CA
Center for the Chemistry of the Universe (phase I)	U of Virginia	VA
Center for Green Materials Chemistry (phase I)	Oregon State U	OR
Center for Molecular Cybernetics (phase I)	Columbia	NY
Center for Molecular Interfacing (phase I)	Cornell	NY
Chemistry at the Space-Time Limit (CaSTL) (phase I)	U of California-Irvine	CA
Fueling the Future (phase I)	U of Massachusetts-Amherst	MA
The Origins Chemical Inventory & Early Metabolism Proj. (phase I)	Georgia Institute of Tech	GA
Engineering Research Centers		
Biomimetic Microelectronic Systems	U of Southern California	CA
Biorenewable Chemicals	Iowa State U	IA
Collaborative Adaptive Sensing of the Atmosphere	U of Mass-Amherst	MA
Compact and Efficient Fluid Power	U of Minnesota	MN
Extreme Ultraviolet Science and Technology	Colorado State	CO
Future Renewable Electric Energy Delivery & Mgmt. Systems	North Carolina State U	NC
Integrated Access Networks	U of Arizona	AZ
Mid-IR Tech for Health and the Environment	Princeton	NJ
Quality of Life Technology	Carnegie Mellon/U of Pittsburgh	PA
Revolutionizing Metallic Biomaterials	North Carolina A&T U	NC
Smart Lighting	Rensselaer Polytechnic Institute	NY
Structured Organic Composites	Rutgers	NJ
Subsurface Sensing and Imaging Systems	Northeastern	MA
Synthetic Biology	U of California-Berkeley	CA
Wireless Integrated MicroSystems	U of Michigan	MI
Materials Research Science and Engineering Centers		
Brandeis Materials Research Science and Engineering Center	Brandeis U	MA
Center for Complex Materials	Princeton	NJ
Center for Emergent Materials	Ohio State U	OH
Center for Materials for Information Technology	U of Alabama	AL
Center for Materials Research	Cornell	NY
Center for Materials Science and Engineering	Massachusetts Institute of Tech	MA
Center for Micro- and Nanomechanics of Materials	Brown	RI
Center for Multifunctional Nanoscale Materials Structures	Northwestern	IL
Center for Nanomagnetic Structures	U of Nebraska	NE
Center for Nanoscale Science	Pennsylvania State	PA
Center for Nanostructured Interfaces	U of Wisconsin	WI
Center for Nanostructured Materials	Columbia	NY
Center for Polymer Interfaces and Macromolecular Assemblies	Stanford, UC-Davis, IBM	CA
Center for Research on Interface Structures and Phenomena	Yale	CT
Center for Response-Driven Polymeric Films	U of Southern Mississippi	MS
Center for Science and Engineering of Materials	California Institute of Tech	CA
Center for Semiconductor Physics in Nanostructures	U of Oklahoma, U of Arkansas	OK, AR
Ferroelectric Liquid Crystals Materials Research Center	U of Colorado-Boulder	CO
Genetically Engineered Materials Science and Engineering Center	U of Washington	WA

Laboratory for Research on the Structure of Matter	U of Pennsylvania	PA
Materials Research Center	U of Chicago	IL
Materials Research Science and Engineering Center	Carnegie Mellon	PA
Materials Research Science and Engineering Center	Johns Hopkins	MD
Materials Research Science and Engineering Center	Harvard	MA
Materials Research Science and Engineering Center	Georgia Institute of Tech	GA
Materials Research Science and Engineering Center	New York U	NY
Materials Research Science and Engineering Center	U of California-Santa Barbara	CA
Materials Research Science and Engineering Center	U of Maryland	MD
Materials Research Science and Engineering Center	U of Minnesota	MN
Materials Research Science and Engineering Center on Polymers	U of Massachusetts	MA
Renewable Energy Materials Science and Engineering Center	Colorado School of Mines	CO
Nanoscale Science and Engineering Centers		
Affordable Nanoengineering of Polymer Biomedical Devices	Ohio State	OH
Center for Environmental Implications of Nanotechnology	Duke	NC
Center for Integrated and Scalable Nanomanufacturing	U of California-Los Angeles	CA
Directed Assembly of Nanostructures	Rensselaer Polytechnic Institute	NY
Electronic Transport in Molecular Nanostructures	Columbia	NY
High Rate Nanomanufacturing	Northeastern, U of New Hampshire, U of Mass-Lowell	MA, NH
Integrated Nanomechanical Systems	U of California-Berkeley, Cal Tech, Stanford, U of California-Merced	CA
Integrated Nanopatterning and Detection Technologies	Northwestern	IL
Molecular Function at the Nano/Bio Interface	U of Pennsylvania	PA
Nanotechnology in Society Network: Center at ASU	Arizona State U	AZ
Nanotechnology in Society Network: Center at UCSB	U of California-Berkeley	CA
Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems	U of Illinois-Urbana Champaign	IL
Nanoscale Systems in Information Technologies	Cornell	NY
Nanoscience in Biological and Environmental Engineering	Rice	TX
National Nanomanufacturing Network: Center for Hierarchical Manufacturing	U of Massachusetts-Amherst	MA
Predictive Toxicology Assessment & Safe Implementation of Nanotechnology in the Environment (CEIN)	U of California-Los Angeles	CA
Probing the Nanoscale	Stanford, IBM	CA
Science of Nanoscale Systems and their Device Applications	Harvard	MA
Templated Synthesis and Assembly at the Nanoscale	U of Wisconsin-Madison	WI
Science and Technology Centers		
Adaptive Optics	U of California-Santa Cruz	CA
Advanced Materials for Purification of Water Systems	U of Illinois-Urbana Champaign	IL
Behavioral Neuroscience	Georgia State U	GA
Biophotonics Science and Technology	U of California-Davis	CA
Center for Remote Sensing of Ice Sheets	U of Kansas	KS
Coastal Margin Observation and Prediction	Oregon Health and Science U	OR
Earth Surface Dynamics	U of Minnesota-Twin Cities	MN
Embedded Networked Sensing	U of California-Los Angeles	CA
Environmentally Responsible Solvents and Processes	U of North Carolina-Chapel Hill	NC
Integrated Space Weather Modeling	Boston U	MA
Layered Polymeric Systems	Case Western Reserve U	OH
Materials and Devices for Information Technology Research	U of Washington	WA
Microbial Oceanography: Research and Education	U of Hawaii-Manoa	HI
Multi-Scale Modeling of Atmospheric Processes	Colorado State U	CO
Nanobiotechnology	Cornell	NY
Sustainability of Semi-Arid Hydrology and Riparian Areas	U of Arizona	AZ

Ubiquitous Secure Technology	U of California-Berkeley	CA
Science of Learning Centers		
Center for Excellence for Learning in Education, Science, & Tech.	Boston U	MA
Pittsburgh Science of Learning Center - Studying Robust Learning with Learning Experiments in Real Classrooms	Carnegie Mellon	PA
LIFE Center - Learning in Formal and Informal Environments	U of Washington	WA
Spatial Intelligence and Learning Center	Temple	PA
The Temporal Dynamics of Learning Center	U of California-San Diego	CA
Visual Language and Visual Learning	Gallaudet	DC

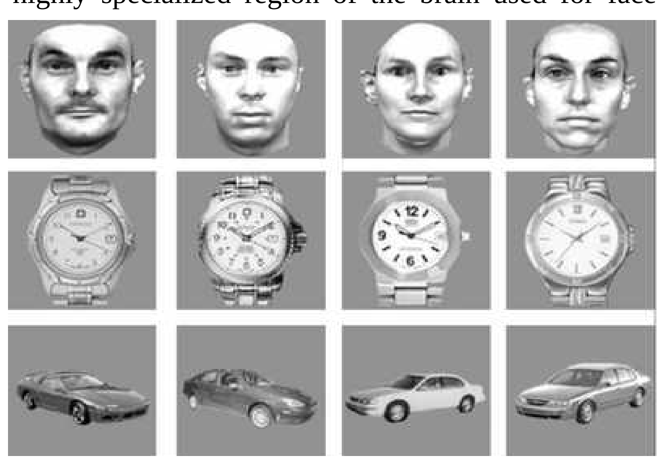
Recent Research Highlights

► **Restoring Speech to Paralyzed Individuals:** At the Center for Excellence for Learning in Education, Science, and Technology (CELEST), an NSF Science of Learning Center, a Boston University research team has succeeded in creating synthetic speech sounds from the thoughts of a paralyzed volunteer while the volunteer imagined producing those sounds. The volunteer suffers from locked-in syndrome, a fully paralyzed condition due to a brain-stem stroke, but he is fully conscious because his higher brain centers were spared. The researchers designed a special electrode that was implanted into the region of the volunteer's brain that controls speech movements. A system translates neural signals measured from the electrode into the speech sounds being thought of while the electrode measurements are being made. So far the sounds have been created offline; the implant recipient's brain signals were recorded to a computer disk and later analyzed by the system to reproduce the speech sounds. The researchers plan to implement a real-time version of the system that allows the volunteer to hear the speech sounds while thinking them.



This figure displays the Neural Decoder and Speech Synthesizer. *Credit: Image courtesy of Frank Guenther, Boston University.*

► **Memory Advantage for Faces:** Researchers at the NSF-funded Temporal Dynamics of Learning Center at the University of California at San Diego found that humans can hold more faces than other images in short-term memory. Humans have a highly specialized region of the brain used for face processing, but apparently this expert skill requires time. Researchers at Vanderbilt University found when participants studied faces or objects for a brief amount of time – half a second – they stored fewer faces than objects such as watches and cars in visual short-term memory. They believe this is because faces are more complex and require more time to be encoded. When participants were given added time to encode the images – up to four seconds – an advantage for faces over objects emerged. Interestingly, only upright faces, with which we are most familiar, and not upside-down faces, show this advantage. This work challenges previous models that assume the capacity of visual short-term memory is inflexible.

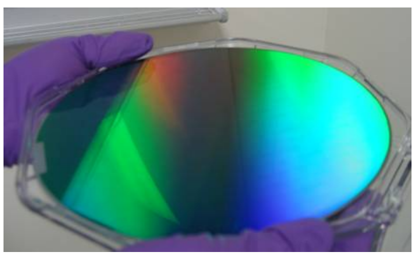


This image shows sample stimuli like those used in Curby & Gauthier (2007) to demonstrate a visual short-term memory advantage for faces over other non-face objects. *Credit: Kim Curby & Isabel Gauthier.*

► **Discera Success Due to NSF-funded Technology:** In 2004, start-up company Discera introduced to the market its proprietary, award winning PureSilicon Resonator technology to provide an effective replacement solution to quartz crystal, ceramic, and other frequency control and timing products. Discera's resonators offer a significant breakthrough in technology used to create the industry's most advanced and economical frequency control and RF circuits. These products uniquely address the miniaturization requirements of digital consumer products and other mobile applications. Resonator-based timing devices are found in all cell phones and radios, for example. Through strategic partnerships with foreign suppliers of wireless products, Discera is expected to capture a significant share of the $3.5 billion worldwide timing market. The company's success is the result of a spin-off technology from an NSF-funded Engineering Research Center at the University of Michigan.

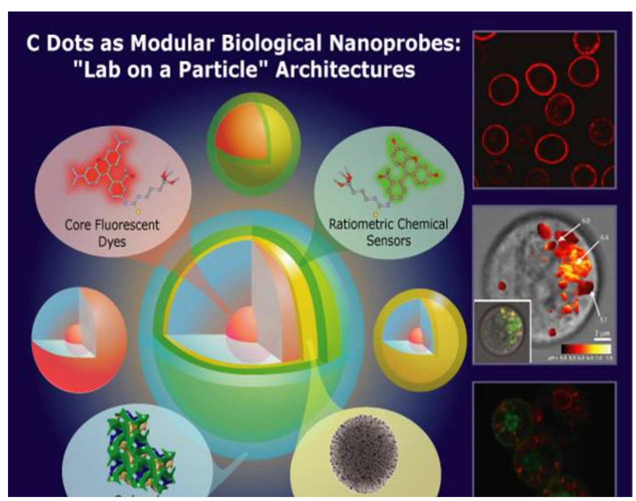
Discera was featured on the cover of EE Times. *Credit: EE Times.*

► **Environmental Technology Adapted for Medical Imaging and Treatment:** The NSF Science and Technology Center for Environmentally Responsible Solvents and Processes at the University of North Carolina conducts research to protect people from hazardous chemicals. The center recently adapted a technology developed to reduce the environmental impact of the microelectronics industry for medical diagnoses and therapy purposes. The "Particle Replication in Non-wetting Templates" technology produces nanoparticles in a wide variety of sizes and shapes that serve as carriers of conventional anti-tumor drugs and other medicines, or as contrast agents that enhance X-ray and MRI scans for better diagnosis. The particles can be targeted to specific sites in the body. The new technology is now a cornerstone of the Carolina Center of Cancer Nanotechnology Excellence.



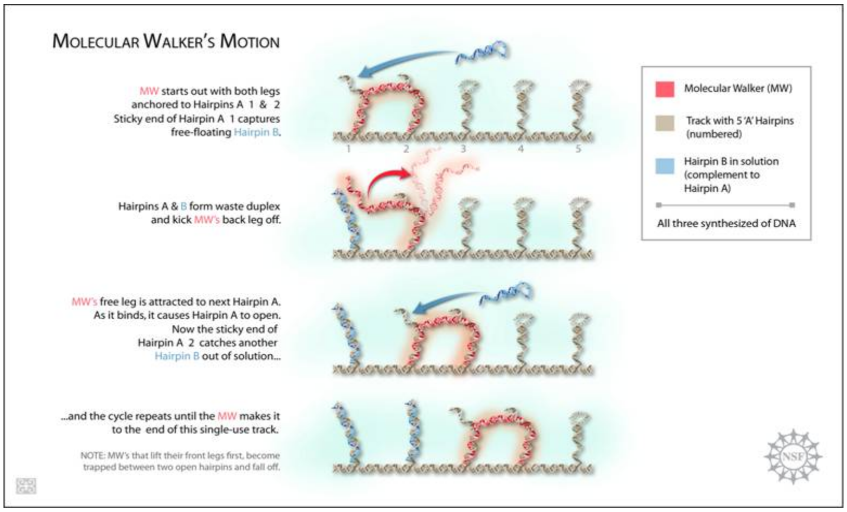
The 8-inch master disc that looks multi-colored in the photo can produce templates which in turn (for the same size) can produce on the order of 10 billion engineered particles. *Credit: Stephanie Gratton and Joseph DeSimone.*

► **Lab-on-a-Particle:** Researchers at the Cornell University Materials Research Science and Engineering Center have developed nanoscale particles that can be loaded with molecular "cargo," such as a drug or other therapeutic agent. When delivered to their target, the nanoscale particles release their cargo and then sense the reaction to the release. These multifunctional nanoparticles form the basis of a "Lab-on-a-Particle" – nanoscale structures capable of performing multiple tasks. By modifying the structure of the particle and its payload, the researchers are developing a new class of materials capable of seeking out specific cellular locations, delivering payloads of therapeutic agents to these locations, and subsequently monitoring the cell's response to these agents. These materials will give researchers the ability to monitor drug therapy in real time. Ultimately, the combined delivery of a drug or therapeutic agent with a sensing capability of its efficacy could revolutionize medicine.



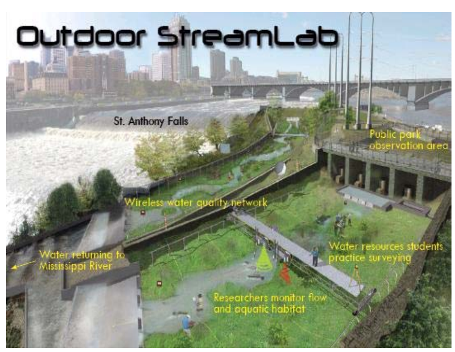
The schematic shows the structure of Cornell Dots (C-Dots) which are porous spherical particles built of multiple shells such as an onion. The inner core is a fluorescent dye that acts as a sensor, intermediate shells can be loaded with drugs or other therapeutic agents, while the outer most shell can be functionalized to stick to specific targets in a cell, such as shown in the center photo at right. *Credit: Uli Wiesner.*

► **Molecular Walker Takes Baby Steps:** Researchers with the Center for Molecular Cybernetics report they are able to program the pathways by which DNA molecules self-assemble and hence to engineer diverse dynamic functions at the molecular level. This capability is essential for something like the memory of a DNA computer, which would need large groups of molecules that can toggle from the on/off position in a fast and reliable fashion. To illustrate their approach for encoding self-assembly and disassembly pathways into DNA sequences, the researchers experimentally demonstrated the locomotion of a two-legged DNA walker that moves along a DNA track without human intervention. Exploiting self-assembly is essential to constructing a molecule with the desired features. In addition to computers, dynamic molecular systems also have great potential for medical therapies and biosensing applications.



Researchers have synthesized a molecular structure designed from single and double-stranded pieces of DNA that responds to a similarly modeled track by walking down it autonomously. The walker places foot-over-foot as each appendage is attracted biochemically to the next hairpin along the track. As foot and hairpin make contact, the hairpin unravels. The free end of the hairpin then catches a complementary hairpin that floats freely in the surrounding solution. Both hairpins coil together to form a double helix and release the walker's foot for its next stride. If the walker reaches the end of the track successfully, it leaves behind non-reusable material, and the track is spent. If the walker lifts the wrong foot and finds itself trapped between two open hairpins, it falls off and never reaches the end of the track. *Credit: Zina Deretsky, National Science Foundation after figure by Peng Yin, Harry M. T. Choi, Colby R. Calvert and Niles A. Pierce, California Institute of Technology.*

► **A River Runs Through It: Outdoor StreamLab:** The National Center for Earth Surface Dynamics, a NSF-sponsored Science and Technology Center, and St. Anthony Falls Laboratory hosted a grand opening celebration for their Outdoor StreamLab in Minnesota. The lab is a premier research facility using two abandoned flood-bypass channels associated with the St. Anthony Falls. The lab enables groundbreaking science and both formal and informal education opportunities. Historically, research in habitat restoration, dam removal, channel realignment, and bank stabilization has been limited to separate indoor laboratory and field work studies. The Outdoor StreamLab enables laboratory-quality measurements within a field-scale reach, bringing the best of both worlds together in one publicly visible facility. Water has been flowing in the Riparian Basin since the grand opening and multiple research projects are underway. Plans are to develop the adjacent Riverine Corridor. Interest in the StreamLab spans many areas, including agricultural engineering, biology, civil engineering, ecology, geology, soil sciences, and water resources sciences. Research participation will include educators, federal and state agencies, and consultants from private industry.



Outdoor StreamLab. *Credit: Efi Foufoula*

CLIMATE CHANGE SCIENCE PROGRAM

Climate has a pervasive effect on the U.S. through its impact on the environment, natural resources, and the economy. To respond to the challenge of understanding climate and climate variability, the Climate Change Science Program (CCSP) was established in 2002 (www.climatescience.gov) as a follow-on to the U.S. Global Change Research Program (USGCRP). It is providing the Nation and the world with the science-based knowledge to predict change, manage risk, and take advantage of opportunities resulting from climate change and climate variability. Research conducted through CCSP builds on the scientific advances of the last few decades and deepens our understanding of how the interplay between natural factors and human activities affects the climate system. The CCSP engages thirteen U.S. agencies in a concerted interagency program of basic research, comprehensive observations, integrative modeling, and development of products for decision-makers. NSF provides support for a broad range of fundamental research activities that provide a sound scientific basis for decisions in mission-oriented agencies and the Nation at large.

The Earth's climate is determined by highly complex interactions between and among the atmosphere, hydrosphere, cryosphere, geosphere, and biosphere. NSF programs address these components by investing in fundamental discovery, utilizing the full range of intellectual resources of the scientific community; research infrastructure that provides advanced capabilities; and innovative educational activities. As a key participating agency in the CCSP, NSF encourages interdisciplinary activities and focuses particularly on Earth system processes and the consequences of change. High priorities for the agency include data acquisition and information management activities necessary for global change research; the enhancement of models designed to improve our understanding of Earth system processes and the feedbacks that link ecosystems and the physical climate; the development of new, innovative Earth observing instruments and platforms; and the development of advanced analytic research methods. NSF also supports fundamental research on the general processes used by organizations to identify and evaluate policies for mitigation, adaptation, and other responses to varying environmental conditions. Through its investment, NSF contributes to CCSP by providing a comprehensive scientific foundation for many of the synthesis and analysis products identified in the CCSP Strategic Plan.

Climate Change Science Program Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request
Biological Sciences	$15.10	$15.10	$20.00	$46.00
Engineering	1.00	1.00	-	1.00
Geosciences	157.72	163.00	25.00	209.00
Mathematical and Physical Sciences	6.90	6.69	2.67	7.13
Social, Behavioral and Economic Sciences	15.48	15.48	3.00	18.48
Office of Polar Programs	10.50	18.30	44.79	18.30
Total, Climate Change Science Program	$206.70	$219.57	$95.46	$299.91

Totals may not add due to rounding.

FY 2010 Areas of Emphasis

NSF's FY 2010 investment in CCSP increases by $80.34 million, or 36.6 percent, over the FY 2009 Current Plan level of $219.57 million. The Directorates for Biological Sciences and Geosciences together contribute the largest portion of this increase, totaling $76.90 million. Specific foci include:

- Supporting a broad research portfolio in carbon cycling, biodiversity, and ecological systems including major themes such as abrupt environmental changes; balancing the carbon budget; water, ice, and ecosystems; and the impact of ocean acidification; expanding the Nation's workforce trained to address complex environmental challenges; and strengthening computing infrastructure;
- Enhancing scalability of climate and ecosystem models to move climate modeling from the global to the regional scale; move ecological modeling from the local to the regional scale; and improve predictability at multiple scales to inform decision makers; and
- Improving, upgrading and deploying critical environmental observing platforms and systems.

The overarching themes of the CCSP program in FY 2010 are as follows:

Atmospheric Composition – NSF programs in tropospheric and stratospheric chemistry will continue in FY 2010 to address the composition of the atmosphere and its relation to climate variability and change, and linkages between the atmosphere and the biosphere, land surface, oceans, and cryosphere. Studies of the transport and transformation of gaseous constituents and aerosols provide insights into the radiative and cloud nucleating properties of the atmosphere. Greenhouse gases are particularly important since they are the principal absorbers and re-radiators of heat. Results of these studies serve as important inputs for the assessment reports of the Intergovernmental Panel on Climate Change (IPCC).

Climate Variability and Change – In FY 2010, NSF programs will continue to emphasize climate variability and change across temporal and spatial scales, supporting observational campaigns and numerous analytical and modeling activities. These activities will improve parameterizations of unresolved dynamics and address biases in global climate models. A newer focus is on changes in the Atlantic Meridional Overturning Circulation and its interactions with the atmosphere to improve understanding of the processes and explore possible future changes, particularly those that may happen abruptly. The Community Climate System Model will continue to improve through incorporation of small-scale ocean processes, aerosol radiative forcing, stratospheric dynamics, interactive chemistry and biogeochemical cycles. Coupled climate model studies on decadal predictability at regional scales will be initiated and will include exploratory research on initialized climate modeling. Analyses of model output will focus on extreme climate events, such as hurricanes, droughts, and major ecological disturbances, in order to determine the mechanisms responsible and to evaluate their representation in models. Studies of paleoclimatology will continue to be supported as a means to provide baseline data on natural climate variability from the past and from key climatic regions. These studies improve our understanding of the natural variability of the climate system and in particular will enable reconstructions and evaluations of past environmental change as inputs for model validations.

The Global Water Cycle – NSF supports research to understand all aspects of the global water cycle. Relevant programs will continue to explore ways to utilize more effectively the wide range of hydrologic data types – continuous and discrete information from a variety of platforms – for research purposes. A community-initiated Hydrologic Information System, that can provide data access and analysis tools, continues to expand, serving both research and operational communities. Data from process studies will be used to refine models through parameterizations of sub-grid processes, particularly the fluxes of water through the Earth system. High resolution cloud system models are being refined to address the persistent problems of moist convection and cloud processes – two of the more challenging and uncertain components in climate change calculations. NSF will expand capabilities at its Critical Zone Observatories which are devoted to studying integration and coupling of Earth surface processes as mediated by the presence and flux of fresh water. The Sustainability of Semi-arid Hydrology and Riparian Areas (SAHRA) Science and Technology Center, working with regional stakeholders, is translating research advances into useful products and addressing uncertainty.

Land-Use and Land-Cover Change – Several NSF programs continue to address key aspects of land-use and land-cover change through studies in ecological rates of change and related aspects of biodiversity, Arctic systems, temporal variability, biophysical feedbacks to the climate system, water and energy influences on vegetative systems, and diverse human influences on land use.

Global Carbon Cycle – NSF provides support for a wide variety of carbon cycle research activities, from the underlying biological and geophysical processes to critical long-running oceanic time series stations and the Keeling CO_2 record as well as planning and data management. FY 2010 investigations will continue to examine a wide range of topics in terrestrial and marine ecosystems and their relations to the carbon cycle. Research in terrestrial settings will explore, for example, carbon storage, delivery of carbon by rivers, carbon fluxes from wetlands and high-latitude soils, the role of microbial processes, and submarine groundwater discharge in the oceans, ocean acidification and remineralization in mesopelagic zones. Studies on the role of ocean acidification and the capacity of the oceans to absorb carbon will be highlighted, as will research on the coupling of nitrogen and carbon cycles - both are critical to improvement of ocean and global carbon models. Carbon cycle studies will integrate observational data into models to provide insights for understanding key aspects of the global carbon cycle and feedbacks on the climate system and on strategies to investigate and adapt to climate change through CO_2 sequestration.

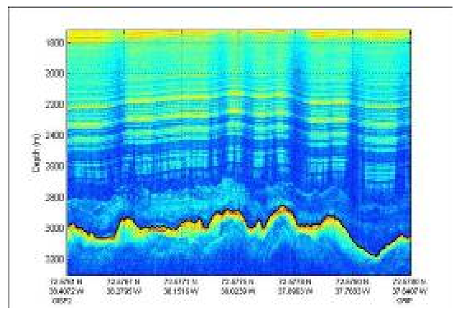
Ecosystems – Several NSF programs address terrestrial and marine ecosystems through observational, experimental, modeling, and laboratory studies. The Long Term Ecological Research (LTER) Program supports the collection of time-series data on key ecosystem processes and funds research on the drivers of ecosystem change in terrestrial and marine systems. The Global Ocean Ecosystem Dynamics program and follow-on activities will continue studies on the impact of global ocean changes on marine ecosystems through specific syntheses focused on the North Atlantic, the North Pacific and the Southern Ocean. Research will continue to focus on understanding the impact of increasing carbon dioxide on ocean pH levels (ocean acidification) and the impacts on marine organisms, ecosystems and chemistry from tropical coral reefs to polar regions.

Human Contributions and Responses – NSF supports basic research on the processes through which people (individually, in groups, or through organizations) interact with natural environmental systems. FY 2010 funding supports projects that focus on decision-making under uncertainty associated with climate change. These projects are expected to produce new knowledge and tools that should facilitate improved decision-making by various stakeholder groups trying to deal with uncertainties associated with future climate variability and change. In addition, climate studies will be a major theme in NSF's cross directorate program, Dynamics of Coupled Human and Natural Systems, which examines the complex interactions and feedbacks between these systems.

Recent Research Highlights

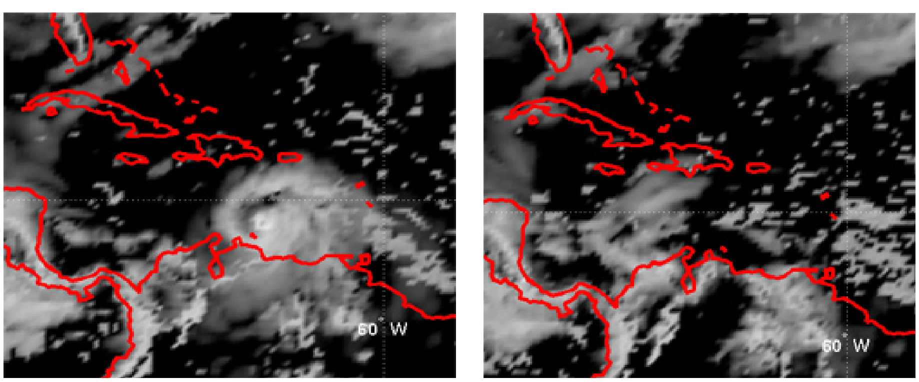
► **New Ways to Image Ice Sheets:** NSF-supported researchers at the Center for Remote Sensing of Ice Sheets (CReSIS) have been developing new ways to image the base of the polar ice sheets. CReSIS is conducting multidisciplinary research that will result in technology, new data sets, and models necessary to achieve a better understanding of the mass balance of the Antarctic and Greenland ice sheets and their contributions to sea-level rise. The center is developing several sensors (radar and seismic) and platforms (UAVs) that will provide long-term benefits to the polar community as enabling technologies for various other investigations. The sensors will also have wide applications outside of the polar community. One of these advanced sensors is a synthetic aperture radar that can sound ice and map layers with fine resolution. It can also image the ice-bed interface and has produced the first successful demonstration of imaging through 3-km-thick ice. This sensor has the potential to revolutionize the study of ice sheets. This work is jointly supported by the Office of Integrative Activities and the Office of Polar Programs (both Arctic and Antarctic sections).

Collecting Data in Greenland. *Credit: CReSIS University of Kansas.*



Internal Layers in the Greenland Ice Sheet. *Credit: CReSIS University of Kansas.*

► **Innovative Satellite System Improves Weather Forecasts, Provides Climate Data:** A revolutionary system of six microsatellites is significantly improving weather forecasts and monitoring climate change with unprecedented accuracy. The Constellation Observing System for Meteorology, Ionosphere, and Climate is a joint collaboration between the United States and Taiwan, based on a design provided by the University Corporation for Atmospheric Research. The system's unique global coverage provides unprecedented information on the lower stratosphere. Measurements from the system have led to significant improvements in our ability to predict and understand atmospheric phenomena, such as hurricanes and other severe weather hazards, by providing extremely accurate data with better coverage in time and space than were previously available. The system also demonstrates pioneering technology in its use of GPS signals for atmospheric measurements.



These images show how well a computer model was able to simulate the early development of Hurricane Ernesto in the eastern Caribbean. Each image shows a 66-hour forecast of cloud-water concentration (resembling a satellite photo). The forecasts are valid for 8:00 p.m. AST on August 25, 2006. In the first image, the model's starting-point conditions included 15 COSMIC profiles of atmospheric conditions in and near the Caribbean. In the second image, the profiles were not included, and the model was unable to show Ernesto's formation. *Credit: Yongsheng Chen, NCAR.*

NATIONAL NANOTECHNOLOGY INITIATIVE

NSF's contribution to the multiagency National Nanotechnology Initiative (NNI) encompasses the systematic understanding, organization, manipulation, and control of matter at the atomic, molecular, and supramolecular levels in the size range of 1 to 100 nanometers. Novel materials, devices, and systems – with their building blocks designed on the scale of nanometers – open up new directions in science, engineering, and technology with potentially profound implications for society. With the capacity to control and manipulate matter at this scale, science, engineering, and technology are realizing revolutionary advances in areas such as individualized pharmaceuticals, new drug delivery systems, more resilient materials and fabrics, catalysts for industry, and order-of-magnitude faster computer chips.

National Nanotechnology Initiative Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Plan	FY 2009 ARRA Estimate	FY 2010 Request
Biological Sciences	$58.73	$56.60	-	$56.60
Computer and Information Science and Engineering	14.51	11.00	-	11.00
Engineering	144.45	140.02	35.00	148.00
Geosciences	10.29	6.33	-	6.33
Mathematical and Physical Sciences	173.73	178.06	72.81	195.86
Office of International Science and Engineering	0.50	-	-	-
Social, Behavioral and Economic Sciences	2.25	1.67	-	1.67
Subtotal, Research and Related Activities	$404.46	$393.68	$107.81	$419.46
Education and Human Resources	4.10	3.50	-	3.50
Total, National Nanotechnology Initiative	$408.56	$397.18	$107.81	$422.96

FY 2010 NNI Funding. NSF contributes to the goals and eight program component areas (PCAs) outlined in the NNI Strategic Plan (www.nano.gov). Environmental, health and safety implications of nanotechnology, including development of predictive toxicity of nanomaterials, will be investigated in three dedicated multidisciplinary centers and over other 50 smaller groups with a total annual budget of $29.9 million. The modes of support include single investigator, multidisciplinary team, center, and network awards.

Fundamental Nanoscale Phenomena and Processes. The FY 2010 Request includes $154.74 million for fundamental research and education, with special emphasis on:

- *Novel phenomena, quantum control, and basic engineering processes* – to discover and understand phenomena and design processes specific at the nanoscale, including new phenomena in materials, mechanics, chemistry, biology, electronics, and optics. A focus will be on the understanding and use of self assembly from basic principles and on multiple scales. Potential applications include use of quantum phenomena in systems and quantum computing, and new devices and processes for advanced communications and information technologies. A new program on "Macromolecular, Supramolecular and Nanostructures" will be established.
- *Biosystems at the nanoscale* – to support study of biologically based or inspired systems that exhibit novel properties and potential applications. Potential applications include improved drug delivery, biocompatible nanostructured materials for implantation, exploiting of functions of cellular organelles, devices for research in genomics, proteomics and cell biology, food and plant systems, and nanoscale sensory systems, such as miniature sensors for early detection of cancer. A focus will

be on understanding and simulation of cells, tissues, and nervous systems, with application to biomedicine and neuromorphic engineering.

- *Converging science and engineering at the nanoscale* – The convergence of nanotechnology with information technology, modern biology, and social sciences will reinvigorate discoveries and innovation in almost all areas of the economy. This theme includes investments in (a) nano-biology interface and improving human performance, (b) nano-information interface research, and (c) nano-neurosciences.
- *Multi-scale, multi-phenomena theory, modeling, and simulation at the nanoscale* – to support theory, modeling, large-scale computer simulation and new design tools, and infrastructure in order to understand, control, and accelerate development in new nanoscale regimes and systems. A special focus will be on simulations with atomic precision, time resolution of chemical reactions, and for domains of engineering and biological relevance. Another focus will be on predictive methods of nanomaterials' macroscopic properties from their nanostructure.

Nanomaterials. The FY 2010 Request includes $80.44 million for discovery of novel nanoscale and nanostructured materials, and improving the comprehensive understanding of the properties of nanomaterials (ranging across length scales and including interface interactions). A special focus will be gaining control of nanoscale features and devices with an atomic level of precision. Another focus will be design and synthesis, in a controlled manner, of nanostructured materials with targeted properties. Research on the discovery, understanding, and control of materials at the nanoscale will be critical to the development and success of innovative technologies, including communications, catalysts, energy, healthcare, and manufacturing. An example is the Caltech center for nanomaterials for alternative energy applications focus on developing the components for a solar water splitting system.

Nanoscale Devices and Systems. The FY 2010 Request includes $43.77 million for R&D that applies the principles of nanoscale science and engineering to create novel, or to improve existing, devices and systems. This includes the incorporation of nanoscale or nanostructured materials to achieve improved performance or new functionality, and developing new concepts to understand interactions among nanoscale devices in complex systems, including the physical, chemical, and biological interactions between nanostructures and device components. A special focus will be on the architecture and emerging behavior of nanosystems, and on nanomanufacturing of active nanostructures and nanosystems.

Nanoelectronics beyond silicon nanotechnology and complementary metal-oxide superconductors (CMOS) research will explore ultimate limits to scaling of features and alternative physical principles for devices employed in sensing, storage, communication, and computation. The research activity in this area will help develop innovative technologies, including replacing electron charge as information carrier, bottom-up device assembly technologies at the atomic and molecular levels, and new system architectures using nanoscale components.

A special focus will be on nano-informatics for better communication and nanosystem design. It includes defining the ontology of terms, interconnecting databases, using specific informatics tools, and connecting to bioinformatics.

Instrumentation Research, Metrology, and Standards for Nanotechnology. The FY 2010 Request includes $18.52 million for R&D to create new tools needed to advance nanotechnology research and commercialization, including next-generation instrumentation for characterization, measurement, synthesis, and design of materials, structures, devices, and systems. A special challenge is developing tools for measuring and restructuring matter with atomic precision, for time resolution of chemical reactions, and for domains of biological and engineering relevance.

Nanomanufacturing. The FY 2010 Request includes $22.45 million to support new concepts for high rate synthesis and processing of nanostructures, nanostructured catalysts, nanobiotechnology methods, fabrication methods for devices, and assembling them into nanosystems and then into larger scale structures of relevance in industry and in the medical field. R&D is aimed at enabling scaled-up, reliable, cost effective manufacturing of nanoscale materials, structures, devices, and systems. A special focus will be creating active nanostructures and complex nanosystems. This will include R&D and integration of ultra-miniaturized top-down processes, increasingly complex bottom-up or self-assembly processes, and developing novel concepts for high-rate synthesis and processing of nanostructures and nanosystems.

Major Research Facilities and Instrumentation Acquisition. The FY 2010 Request includes $38.47 million for user facilities, acquisition of major instrumentation, and other activities that develop, support, or enhance the scientific infrastructure for the conduct of nanoscale science, engineering, and technology research and development. It also supports ongoing operations of the National Nanotechnology Infrastructure Network (NNIN), Network for Computational Nanotechnology (NCN), National Network for Nanomanufacturing (NNN), and National High Magnetic Field Laboratory (NHMFL). The networks are planned to have over 90,000 users in FY 2010. The investment will support facilities for 17 ongoing Nanoscale Science and Engineering Centers (NSEC).

Environmental, Health and Safety. The FY 2010 Request includes $29.90 million, an increase of $1.99 million over the FY 2009 Plan for research primarily directed at environmental, health, and safety (EHS) implications and methods for reducing the respective risks of nanotechnology development. NSF, the Environmental Protection Agency (EPA), the U.S. Department of Agriculture (USDA), and the European Union (EU) will collaborate for the preparation of a joint solicitation on nano EHS in FY 2010. Basic research will support understanding of underlying phenomena and processes. Research on both implications and applications of nanotechnology will address the sources of nanoparticles and nanostructured materials in the environment (in air, water, soil, biosystems, and working environment), as well as the non-clinical biological implications. The safety of manufacturing nanoparticles is investigated in eight centers: NSEC at Rice University (evolution of manufacturing nanoparticles in the wet environment), NSEC at Northeastern University (occupational safety during nanomanufacturing), NSEC at University of Pennsylvania (interaction between nanomaterials and cells), NSEC at University of Wisconsin, Madison (effect of nanostructured polymers on EHS), NSEC at University of California, Berkeley (building a system for detecting exposure to individual and portable nanomaterials), NSEC at the University of Ohio (nanoscale devices for monitoring and healing), NSEC at University of Massachusetts, Amherst, (clearinghouse on occupational safety), and National Nanotechnology Infrastructure Network (with two nanoparticle characterization centers at the University of Minnesota and Arizona State University). Environmental implications of nanotechnology, including development of new measurement methods for nanoparticle characterization and toxicity of nanomaterials will be investigated in two dedicated multidisciplinary centers (Centers for Environmental Implications of Nanotechnology at UCLA and Duke University). It aims to conduct fundamental research on the interactions between nano-particles and materials and the living world at all scales. An essential element of this will be research on methods and instrumentation for nano-particle detection, characterization, and monitoring, including interactions of nano-materials with cellular constituents, metabolic networks and living tissues, bioaccumulation and its effects on living systems, and the impacts of nanostructures dispersed in the environment. This work will support regulatory and mission agencies in developing science-based standards for risk assessments, such as those needed by the National Institute of Standards and Technology (NIST), EPA, the Food and Drug Administration (FDA) and other agencies to develop standards for and to regulate nano-materials. NSF will provide supplements to NSECs for nano EHS on a competitive basis.

Education and Societal Dimensions. The FY 2010 Request includes $34.67 million, an increase of $2.60 million over the FY 2009 Plan, for various research and other activities that address the broad implications of nanotechnology for society, including education and social aspects, such as:

- Education-related activities, such as development of materials for schools, curriculum development for nanoscience and engineering, development of new teaching tools, undergraduate programs, technical training, and public outreach ($28.04 million). Two networks for nanotechnology education with national outreach will be supported: The Nanotechnology Center for Learning and Teaching (NCLT) and the Network for Nanoscale Informal Science Education (NISE).
- Research directed at identifying and quantifying the broad implications of nanotechnology for society, including social, economic, workforce, educational, ethical, and legal implications ($5.78 million). The application of nanoscale technologies will stimulate far-reaching changes in the design, production, and use of many goods and services. Factors that stimulate scientific discovery at the nanoscale will be investigated, effective approaches to ensure the safe and responsible development of nanotechnology will be explored and developed, and the potential for converging technologies to improve human performance will be addressed. The Nanotechnology in Society Network will extend its national and international network.
- NSF will support activities of a new Society for the Study of Nanoscience and Emerging Technologies with an international network of researchers, students, stakeholders, and policymakers. A study to assess and compare the capability of research centers in nanotechnology and other emerging technologies to integrate broader societal considerations and social sciences into their work. This study is coordinated with a European effort using the same methodology.

Coordination with Other Agencies. The NSF program is coordinated with 25 departments and agencies through the National Science and Technology Council's subcommittee on Nanoscale Science, Engineering and Technology (NSET). Examples of specific coordination efforts are: Nanomanufacturing (Department of Defense (DOD)/NIST); Environmental issues (EPA/ National Institute of Environmental Health Sciences (NIEHS)/USDA); NSECs, NNIN and Network for Computational Nanotechnology (NCN) centers and networks (DOD/ National Aeronautics and Space Administration (NASA)/ Department of Energy (DOE)/ National Institutes of Health (NIH)); nanoelectronics (NIST, DOD), simulations in nanoelectronics (DOD/NASA); and research and training activities (DOD/NIH).

NNI by Program Component Area

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Plan	FY 2009 ARRA Estimate	FY 2010 Request
1. Fundamental Nanoscale Phenomena & Processes	$154.28	$146.42	$38.52	$154.74
2. Nanomaterials	72.87	74.59	27.74	80.44
3. Nanoscale Devices & Systems	44.63	42.26	9.16	43.77
4. Instr. Research, Metrology, & Standards for Nanotech	21.78	17.61	3.37	18.52
5. Nanomanufacturing	20.71	21.90	3.20	22.45
6. Major Research Facilities & Instrumentation Acquisition	29.14	34.42	17.73	38.47
7. Environmental Health & Safety	29.22	27.91	2.69	29.90
8a. Education	28.55	26.60	4.96	28.79
8b. Societal Dimensions (ELSI)	7.38	5.47	0.44	5.88
Total, National Nanotechnology Initiative	$408.56	$397.18	$107.81	$422.96

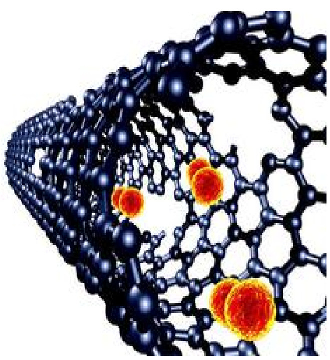
Totals may not add due to rounding.

Recent Research Highlights

► **Safer by the Sip:** The discovery of unexpected magnetic interactions between ultra-small specks of rust is leading scientists at Rice University's Center for Biological and Environmental Nanotechnology to develop a revolutionary, low-cost technology for cleaning arsenic from drinking water. Nanoparticles of iron oxide (magnetite) can remove 200 times more arsenic from water than the same mass of larger commercial materials. The technology holds promise for millions of people in India, Bangladesh, and other developing countries where thousands of cases of arsenic poisoning each year are linked to poisoned wells. When prepared in a nanocrystalline form, magnetite not only soaks up more arsenic, most likely due to the larger available surface area of the nanomagnets, it also binds more strongly, resulting in less desorption of arsenic. Researchers hope results will lead to better water treatment solutions.

Arsenic binds easily to iron oxide nanocrystals allowing it to be removed from drinking water when the "nano-rust" is fished out of solution by a low-field magnet. *Credit: Center for Biological and Environmental Nanotechnology.*

► **New Type of Nanotube Capsules Offer Safer, More Precise Medical Images:** Reducing the toxicity of medical imaging agents is critical to improving the delivery of medical services. Rice University researchers developed the first water-soluble, nanotube-based biocompatible contrast agent for use in computed tomography (CT) X-ray imaging. The new tool sequesters the medical imaging agent safely inside an ultra-short nanotube capsule. The new tool also offers the potential to detect disease at the cellular level when it is most treatable. Current imaging agents are designed to remain outside of cells and to clear from the body quickly due to their high toxicity. The new technology loads iodine, the imaging agent, inside single-walled carbon nanotubes that have been modified to make them more compatible with the human body. The agent can be used inside cells and for long periods due to its reduced toxicity and water solubility.



Ultra-short, single-walled carbon nanotubes can be loaded with contrast agents for enhanced medical imaging. *Credit: Center for Biological and Environmental Nanotechnology.*

NETWORKING AND INFORMATION TECHNOLOGY R&D

The National Science Foundation is a primary federal agency supporting the Networking and Information Technology Research and Development (NITRD) program. NSF's NITRD portfolio includes all funding in the Directorate for Computer and Information Science and Engineering (CISE) and the Office of Cyberinfrastructure (OCI), and all of the agency's directorates also contribute. Additionally, NSF makes research, education, or research infrastructure investments in every NITRD Program Component Area (PCA). In FY 2010, NITRD represents approximately 16 percent of the agency's budget.

Networking and Information Technology Research and Development Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request
Biological Sciences	$83.50	$86.15	-	$93.00
Computer and Information Science and Engineering	535.26	573.74	235.00	633.00
Engineering	19.20	20.70	-	23.70
Geosciences	15.56	18.98	-	22.98
Mathematical and Physical Sciences	76.03	78.93	21.90	86.82
Social, Behavioral and Economic Sciences	22.84	17.00	3.00	22.80
Office of Cyberinfrastructure	185.15	199.28	80.00	219.00
Subtotal, Research and Related Activities	$937.54	$994.78	$339.90	$1,101.30
Education and Human Resources	9.00	9.50	-	9.50
Total, NITRD Request	$946.54	$1,004.28	$339.90	$1,110.80

Totals may not add due to rounding.

NSF's FY 2010 Request continues strong support for NITRD. NSF's Assistant Director for CISE is co-chair of the NITRD Subcommittee of the National Science and Technology Council's Committee on Technology. In addition, NSF works in close collaboration with other NITRD agencies and participates at the co-chair level in seven of the eight PCA Coordinating Groups.

NITRD Funding in FY 2010

Large Scale Networking ($110.63 million): CISE will continue support for activities in the Network Science and Engineering (NetSE) program, which includes the Future Internet Design (FIND) program, and for the Network Technology and Systems (NeTS) program. NetSE focuses on understanding the complexity of networks due to scale and heterogeneity of components, from devices to people; and on revolutionary network architectures for the future. OCI will renew its International Research Network Connections (IRNC) activity which will include opportunities to fund experimental networks.

Cybersecurity and Information Assurance ($67.36 million): NSF will continue to fund research on cybersecurity foundations, network security, and systems software that supports the objectives of the *Federal Plan for Cyber Security and Information Assurance Research and Development*. CISE will devote $40.0 million to research in usability, theoretical foundations, and privacy to support the Comprehensive National Cybersecurity Initiative. Support will continue for several centers, including one devoted to the scientific exploration of new technology that will radically transform the ability of organizations to design, build, and operate trustworthy information systems for critical infrastructure, and one investigating software architectures, tamper-resistant hardware, cryptographic protocols and verification systems as applied to electronic voting systems.

High-End Computing Research and Development (R&D) ($106.56 million): OCI and CISE will support the development of simulation, optimization and analysis tools that exploit the potential of petascale computing to advance the frontiers of scientific and engineering research. NSF's investment in Science and Engineering Beyond Moore's Law will focus on revolutionary new computing hardware technologies, as well as related programming models, languages and tools, all of which promise to inform the computing systems of the future.

High-End Computing Infrastructure and Applications ($314.34 million): Continuation of the acquisition of a high performance computing system in OCI is included at an annual level of $50.0 million. OCI is following-up the existing TeraGrid activity with eXtreme Digital (XD). XD will provide computational, storage, networking and visualization resources to the open science and engineering communities.

CISE will invest in research infrastructure resources to support the acquisition, enhancement, and operation of state-of-the-art infrastructures and facilities that enable high-quality computing research and education in a diverse range of institutions and projects.

Several NSF directorates will increase their investments in this PCA to capitalize on the growing importance of cyberinfrastructure in furthering their research and education goals. For example, MPS and ENG will increase activity in modeling and simulation of complex systems, development of numerical algorithms and software implementations that push the boundaries of computing infrastructure, and use of the grid computing infrastructure.

MPS will strengthen support of research and education activities that contribute to and utilize the Virtual Astronomical Observatory, a federation of astronomical databases. Support of other databases and digital libraries also will increase. MPS will support enhanced participation of remote access to instrumentation and increased connection of institutions that are distant from each other, such as a minority institution and its partner.

GEO will continue to support state-of-the-art computing systems and data management services at the National Center for Atmospheric Research (NCAR). Part of this high performance computing environment, the Climate Simulation Laboratory (CSL), helps keep the U.S. at the forefront of 21st century climate science.

ENG will increase support of virtual organizations to leverage distributed physical experimentation, data collection, modeling and analysis capabilities using high-end computing and large scale networking infrastructures.

BIO will invest in activities to broaden access to and usability of high performance computing resources in the biological sciences. Current biology applications claim substantial HPC computing resources that are narrowly focused in specific areas of biology. With increasing availability of large amounts of diverse data from plant, animal and microbial genomics to ecosystems modeling, additional areas of biology will likely require expanded access to and development of HPC resources.

High Confidence Software and Systems ($74.80 million): As part of the Cyber-enabled Discovery and Innovation (CDI) investment, CISE will support research on software for tomorrow's complex cyber-physical systems, such as smart automobiles, sensor nets for environmental monitoring, and embedded medical devices, and similarly in mobile, portable, and pervasive computing devices, such as cell phones, digital cameras, flexible displays, radio-frequency identification (RFIDs), multi-media multi-modal handhelds, and household robots.

ENG will increase support of novel cyber-physical systems that combine the physical sensing and actuation functions with the computing and control functions into tightly-coupled high confidence systems.

Human Computer Interaction and Information Management ($283.39 million): The multidisciplinary CDI emphasis will focus on creation of new knowledge from digital data, including novel algorithms, data mining, and dimension reduction methodologies, new visualization methods to enhance human cognition, and innovative technologies to address data confidentiality, privacy, security, provenance, and regulatory issues.

BIO's investments in this area will facilitate discovery through tools that integrate the published literature with the expanding universe of digital data collections, expand capacity for understanding through virtual environments that provide an intuitive display of the complex networks of interactions among organisms and their environments, and make it practical for scientists to search vast collections of biological images simply and quickly.

NSF will focus increased attention on the issues of federation, preservation, curation, and access to large, heterogeneous collections of scientific data and information. High capacity data management and high capacity computing are increasing challenges for a growing number of research communities. OCI will develop activities for a robust and resilient national and global digital data framework for preservation and access to the resources and products of the digital age. OCI will invest in data, modeling paradigm and software interoperability in the area of virtual organizations.

SBE and CISE are co-funding a new solicitation, with the first awards expected in FY 2010 on Socio-Computational Systems, encouraging research on the interaction between people and machines.

ENG's investment in this area will focus on creating new pathways to connect researchers with each other and with state-of-the-art experimental facilities. ENG will also invest in curation of data generated by the large number of geographically dispersed sensors that will be used for real-time control of complex systems.

Software Design and Productivity ($58.48 million): CISE will support research on the scientific and engineering principles for developing software for tomorrow's complex cyber-based systems. Advances in software foundations, including new computational models, techniques, languages, tools, metrics, and processes for developing and analyzing software for these complex systems, will be pursued.

BIO, through its Biological Databases and Informatics program, will promote new ways of enabling science through the use of cyberinfrastructure, including new visual programming environments and integrated information systems that allow an entire community of experts to contribute simultaneously to understanding genome dynamics.

ENG will invest in developing new algorithms and software that can efficiently scale to the petascale levels. ENG will also invest in virtual organizations to enhance the productivity of researchers by providing them access to computational tools, specialized facilities and observational data from anywhere in the world.

Social, Economic and Workforce ($95.24 million): Through CDI, NSF will support investments that infuse computational thinking into computing education at all levels and in all fields of science and engineering.

CISE will continue to support the Broadening Participation in Computing program, aimed at significantly increasing the number of students who are U.S. citizens and permanent residents receiving post secondary degrees in the computing disciplines. CISE also will continue support to revitalize undergraduate education in computing through the CISE Pathways to Revitalized Undergraduate Computing Education (CPATH) program, begun in FY 2006. The CPATH vision is of a U.S. workforce with the computing competencies and computational thinking skills imperative to the Nation's health, security and prosperity in the 21st century.

OCI will support activities in cyber-learning that will pursue new opportunities for using cyberinfrastructure as a platform for providing effective online laboratory experiences to students and teachers. In collaboration with partners across NSF, OCI will support creative explorations and demonstrations of the use of cyberinfrastructure to integrate research with education, the development of innovative technologies that will facilitate the integration of research and education, and research on how educators and students interact with cyberinfrastructure along with exploring novel uses of cyberinfrastructure.

EHR will continue to study the impact of information and communication technology on educational practice, new approaches to using technology in education, application and adaptation of technologies to promote learning in a variety of fields and settings, and the effects of technology on learning, and efforts that advance teaching and learning opportunities in nanotechnology and/or cyberinfrastructure. Additionally, in FY 2010, EHR will fund research that highlights the educational use of information tools that operate seamlessly across formal and informal learning environments and across traditional computers, mobile devices and newly emerging information and communications.

SBE will continue to study the impact of IT on educational practice, new approaches to using technology in education, application and adaptation of technologies to promote learning in a variety of fields and settings, and the effects of technology on learning, and efforts that advance teaching and learning opportunities in nanotechnology and/or cyberinfrastructure through the Science of Learning Centers (SLC) Program.

BIO will strengthen IT capabilities in all biological sub-disciplines through support for postdoctoral fellowships in bioinformatics; integrative graduate programs that combine training in biology and computer sciences (via the NSF-wide Integrative Graduate Education and Research Traineeship (IGERT) program); undergraduate summer institutes in bioinformatics through the interagency Bioengineering and Bioinformatics Summer Institutes program; and other mechanisms.

NITRD by Program Component Area
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request
Large Scale Networking	$88.61	$99.00	$60.37	$110.63
Cybersecurity and Information Assurance	57.36	63.26	26.38	67.36
High End Computing R&D	82.92	77.55	36.48	106.56
High End Computing Infrastructure and Applications	285.13	323.42	62.33	314.34
High Confidence Software and Systems	57.33	62.09	37.01	74.80
Human-Computer Interaction and Info Management	248.28	250.32	67.68	283.39
Software Design and Productivity	51.29	54.81	10.89	58.48
Social/Economic/Workforce	75.63	73.83	38.76	95.24
Total, NITRD Request	$946.54	$1,004.28	$339.90	$1,110.80

Totals may not add due to rounding.

Recent Research Highlights

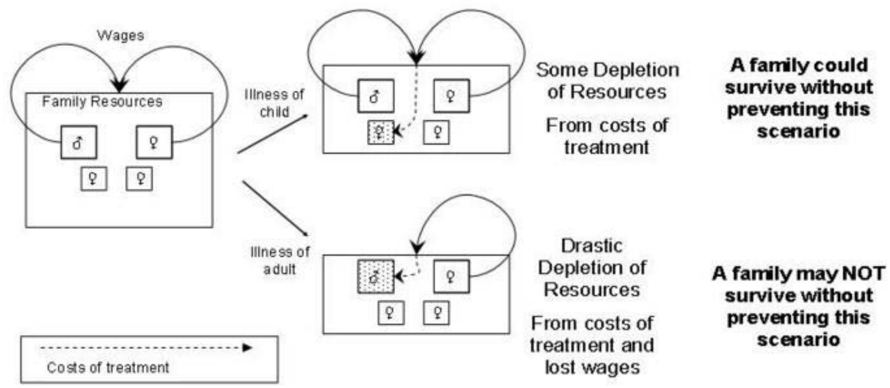
► **Making Bridges Safer:** Using the Sensor Network Highway Bridge Testbed, University of California at San Diego researchers are developing essential strategies for monitoring the condition of highway bridges and constructed facilities. The testbed draws upon research innovations in sensor networks, data archiving and management database procedures, system identification techniques, machine learning tools, and visualization capabilities to assess long-term and sudden changes in the bridge's structural condition. Decision-support tools developed detect and assess, in real-time, damage caused by natural or man-made events and/or progressive environmental deterioration. These tools will save lives by identifying problems before imminent failures, and they facilitate post-event response after a failure. Further, they accrue cost savings in maintenance and can extend a bridge's useful lifetime.

UC San Diego Voigt Drive/I-5 bridge testbed, (a) Side view, and (b) Locations of camera and deployed antennae for sensor network data transmission. *Credit: (Top) A. Elgamal and M. Fraser at University of California, San Diego; (Bottom) ©2009 Google-Imagery ©2009 DigitalGlobe, GeoEye, U.S. Geological Survey*

► **Protecting the Nation's Power Grid:** Researchers from the University of Illinois at Urbana-Champaign, Dartmouth College, Cornell University, and Washington State University are addressing the challenge of how to protect the nation's power grid. Our electric power infrastructure depends on the health of underlying computing and communication networks, which are at serious risk from both malicious cyber attacks and accidental failures. The research plan focuses on securing the devices, communications, and data systems that make up the power grid to ensure trustworthy operations during normal conditions, cyber-attacks, and power emergencies. Two years into the project, progress has been made at all levels: hardware development and support; establishment of protocols; basic research to provide direction for the next-generation IT infrastructure for the power grid; and development of a testbed environment for experimenting with next-generation infrastructure.

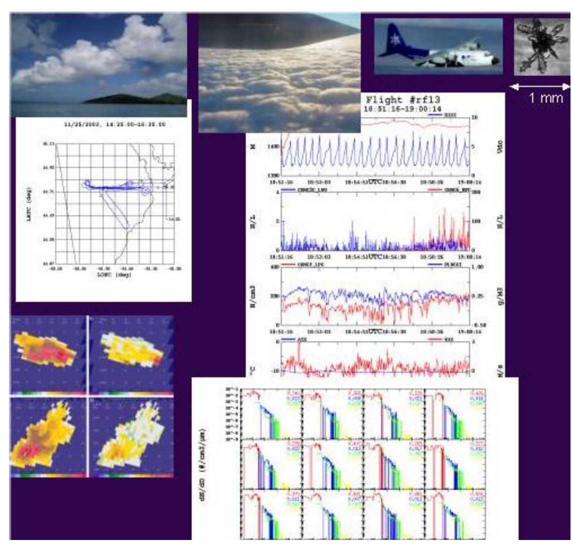
TCIP researchers work to provide end-to-end secure and real-time power grid monitoring and control. *Credit: http://commons.wikimedia.org/wiki/File:Ligne_haute-tension.jpg.*

► **Interactions between Disease and Economics in the Developing World**: The effects of disease in developing regions around the world drastically burden individuals, families, and communities. There are direct economic costs associated with treatment, and indirect costs associated with lost wages and productivity. Existing economic models in infectious disease epidemiology have focused on cost-benefit analyses of public health intervention strategies, where costs are frequently estimated in terms of cumulative disease incidence and money, and benefits are estimated by "numbers of new cases (or deaths) prevented". NSF funded researchers have gone one step deeper, using computational and mathematical models to analyze the relationship between disease and economic pressures on individuals, communities, and families. Preliminary results demonstrate that the holistic cost of disease in a population can be reduced by preferentially allocating health resources to wage-earners. The models show that this optimizes the long-term health of whole families and the communities.



A schematic of economic and health processes feeding off each other. *Credit: Fred Roberts, DIMACS.*

► **Why is this Cloud Raining on Me?:** To better understand atmospheric processes that affect both global climate phenomena and daily weather events, we rely upon complex observations and sophisticated models that consider the effects of atmospheric clouds and their dynamics. Cumulus clouds, for example, present over much of the globe, affect heat patterns and amounts of moisture, and modulate the level of radiation entering and leaving the Earth's atmosphere. These and other types of clouds influence long-standing, fundamental questions about precipitation. Observational data collected through multiple modalities such as ground based radars and aircraft flying through the clouds are combined with highly complex cloud models and other atmospheric, aquatic, and land-based measurements and models, to analyze and predict possible weather scenarios, including precipitation. A collaborative team of computer and atmospheric scientists at Purdue University and the University of Utah have produced advances in comparative and correlative multivariate visualizations that have improved interpretation of modeling studies and results.

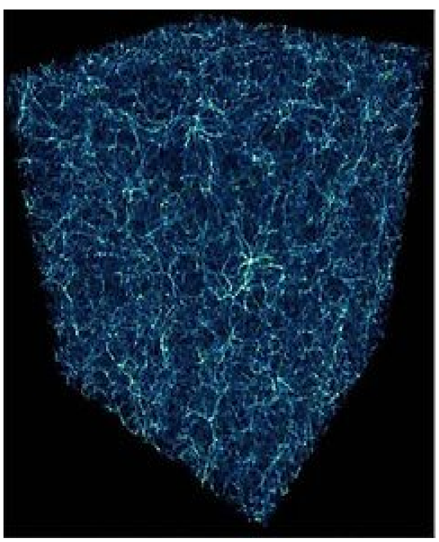


Many different types of data at a variety of scales and timelines are necessary to bring together for analysis of cloud patterns and prediction of precipitation patterns. The new interactive visual system for atmospheric phenomena enables analysis, correlation and hypothesis testing to gain new insight into the factors that control precipitation. *Credit: Purdue University. D. Ebert and Sonia Lasher-Trapp.*

► **Liquidity Costs in Agricultural Futures Markets Easier to Estimate with Teragrid:** Researchers at the University of Illinois at Urbana-Champaign used sales data for lean hogs and live cattle from the Chicago Mercantile Exchange to test their new method of measuring costs in agricultural futures markets. Initially, each day's worth of data required an entire day to process on a desktop computer, so they turned to TeraGrid resources for the critical computation and human resources needed to evaluate their simulations. The program still takes an entire day to run, but the team has the calculations for all of the days of the month, not just one. Studies done by the researchers and the models used will enable better predictions of how the agricultural economy moves and how those moves will in turn affect the customer.

These charts show the Bid-Ask spread estimates for live cattle and lean hogs in research conducted by Julieta Frank and Philip Garcia. RM (Roll) is a serial covariance estimator, TW (Thompson and Waller) is a mean absolute price change estimator, HAS (Hasbrouck) is a Gibbs sampler estimator using a truncated distribution of "C", and ABS is a Gibbs sampler estimator using absolute values of "C"; "C" refers to cost of liquidity. *Credit: Julieta Frank and Philip Garcia, Office for Futures and Options Research, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign.*

► **What Are Baryons and Why Do They Matter?:** Much of the gaseous mass of the universe is bound up in a tangled web of cosmic filaments that stretch for hundreds of millions of light-years, according to a new supercomputer study by University of Colorado researchers. A significant portion of the gas is in the filaments that connect galaxy clusters and is hidden from direct observation. According to the standard cosmological model, the universe consists of about 25 percent dark matter, 70 percent dark energy, and only 5 percent normal matter. The latter consists primarily of baryons-hydrogen, helium and heavier elements. Observations cannot account for about 40 percent of the baryons. Many astrophysicists believe the missing baryons are in the intergalactic medium. As astronomers begin to see these filaments and understand their nature, they will learn more about the missing baryons in the Universe.



A portion of a supercomputer simulation of the universe. The bright object in the center is a galaxy cluster about 1 million-billion times the mass of the Sun. In between the filaments, which store most of the universe's mass, are giant, spherical voids nearly empty of matter. *Credit: Matthew Hall (NCSA), Brian O'Shea (LANL) and Eric Hallman (University of Colorado, Boulder).*

SELECTED CROSSCUTTING PROGRAMS

NSF crosscutting programs include interdisciplinary programs and programs that are supported by multiple directorates. Examples of major crosscutting activities include the following:

ADVANCE: A budget of $21.02 million for ADVANCE in FY 2010, an increase of $230,000 above the FY 2009 Current Plan, will fund transformative efforts to address the systemic barriers to women's full participation in academic science and engineering (S&E). ADVANCE will broaden the spectrum of institutions participating in the program such as predominantly undergraduate institutions, teaching intensive colleges, community colleges, minority-serving institutions and women's colleges through the IT-Catalyst program component, which provides support to institutions to undertake institutional self-assessment activities. The funding will also support new awards under the Institutional Transformation (IT) program component as well as an overall program evaluation and data collection to capture the impact of prior ADVANCE awards. The dissemination and adaptation of models and strategies that have demonstrated effectiveness, as well as research on gender in academics, will continue to be supported through the Partnerships for Adaptation, Implementation, and Dissemination (PAID) program component.

Climate Change Education Program: The FY 2010 Request provides $10.0 million for the Climate Change Education (CCE) program, equal to the FY 2009 Current Plan. The Directorates for Education and Human Resources, Geosciences, Biological Sciences, and the Office of Polar Programs will support this new multi-disciplinary, multi-faceted climate change education program to enable a variety of partnerships, including those among K-12 education, higher education, the private sector, and related non-profit organizations, in both formal and informal settings, as well as relevant education and/or climate-related policymakers. It will support individual investigators and multidisciplinary teams of STEM researchers and educators in a range of activities, including those local, regional, and/or global in scope.

Faculty Early Career Development (CAREER): The FY 2010 Request provides $203.80 million for CAREER, an increase of $21.17 million over the FY 2009 Current Plan of $182.63 million. This will result in approximately 60 more CAREER awards than in FY 2009. CAREER awards support exceptionally promising college and university junior faculty who are committed to the integration of research and education and who are most likely to become the academic leaders of the 21st century.

Graduate Fellowships and Traineeships: The FY 2010 Request provides $245.19 million for NSF's three flagship graduate fellowship and traineeship programs. This funding will enable NSF to support an estimated 5,250 graduate students.

- $122.0 million for the Graduate Research Fellowship (GRF) program, an increase of $6.94 million over the FY 2009 Current Plan, will support graduate students in all STEM fields. Funding will support an estimated 2,990 fellows, including 1,654 new fellows. GRF is widely recognized as a unique fellowship grant program because it supports the broad array of science and engineering disciplines across all fields as well as international research activity. In FY 2009, NSF received thousands of applications for these highly prestigious and competitive awards and intends to support approximately 2,633 fellows, including 1,228 new fellows, with funds from both NSF's omnibus and Recovery Act appropriations. The FY 2010 Request for GRF is increased to provide opportunities for more U.S. citizens, nationals, and permanent resident aliens. GRF is an FY 2010 Presidential Initiative. NSF will triple the number of new fellows supported by FY 2013.

- $68.88 million for the Integrative Graduate Education and Research Traineeship (IGERT) program, an increase of $5.68 million above the FY 2009 Current Plan, will support comprehensive Ph.D. programs that are innovative models for interdisciplinary education and research and that prepare students for academic and non-academic careers. Funding will support an estimated 1,500 IGERT trainees. Additional funds for this program are well justified. Abt Associates, Inc. prepared an evaluation of the initial impacts of IGERT in February 2006 and concluded that "the IGERT program has been successful in achieving its goal of improving graduate educational programs in science and engineering….It has also begun to achieve its goal of catalyzing a cultural change in American graduate education…"

- $54.31 million for the Graduate STEM Fellowships in K-12 Education (GK-12) program, a decrease of $3.05 million below the FY 2009 Current Plan. The GK-12 program strengthens partnerships between higher education institutions and local school districts by providing universities the opportunity to become engaged with a program that features outreach to K-12 schools in a manner that benefits both their teachers and students. GK-12 fellows interact with teachers in K-12 schools, improving communication and teaching skills while enriching STEM instruction in K-12 schools. Preliminary evaluative findings conducted in 2005 by AIR Associates indicate that GK-12 is meeting its goal of enabling graduate students in STEM disciplines to acquire additional skills that will prepare them for professional and scientific careers. In 2007, the program engaged Abt Associates, Inc. in the development of a thorough evaluation of the program to provide data related to the success of GK-12. The first draft of the results is expected in the summer of 2009. FY 2010 funding will support an estimated 760 graduate fellows.

Long-Term Ecological Research (LTER): The FY 2010 Request provides $27.94 million, an increase of $2.85 million above the FY 2009 Current Plan. LTER supports fundamental ecological research that requires long time periods and large spatial scales. This program supports a coordinated network of more than two dozen field sites that focus on: 1) understanding ecological phenomena that occur over long temporal and broad spatial scales; 2) creating a legacy of well-designed and documented ecological experiments; 3) conducting major syntheses and theoretical efforts; and 4) providing information necessary for the identification and solution of environmental problems. LTER field sites represent a diversity of habitats in continental North America, the Caribbean, Pacific Ocean, and the Antarctic, including coral reefs, deserts, estuaries, lakes, prairies, various forests, alpine and Arctic tundra, urban areas and production agriculture. Increased support in FY 2010 will enhance networking activities so that LTER sites can collaborate with the National Ecological Observatory Network (NEON) and other NSF environmental observatories.

Research Experiences for Teachers: (RET): The FY 2010 Request for NSF's RET program totals $5.67 million, an increase of $100,000 above the FY 2009 Current Plan of $5.57 million. Funding will provide pre-service and in-service K-12 teachers with discovery-based learning experiences.

Research Experiences for Undergraduates (REU): The FY 2010 Request for NSF's REU program totals $67.70 million, an increase of $3.94 million above the FY 2009 Current Plan of $63.76 million. The increase proposed for FY 2009 is consistent with the recent (July 2006) external evaluation of REU by SRI International. It found that undergraduate students who participate in hands-on research are more likely to pursue advanced degrees and careers in science, technology, engineering and mathematics (STEM) fields. REU supplements support active research participation by undergraduate students in any area of research funded by the NSF by providing supplements to research grants. REU sites involve students in research who might not otherwise have the opportunity, particularly those from institutions where research programs are limited. A significant fraction of the student participants come from outside the host institutions. Some REU grants have been extended to the freshman and sophomore levels to enhance retention and graduation rates. In FY 2009 efforts will be made to create partnerships between community colleges and baccalaureate degree granting institutions to provide research opportunities for community college STEM students and faculty. In FY 2010, efforts to involve students at earlier stages in their undergraduate experience will continue.

Research in Undergraduate Institutions (RUI): The FY 2010 Request for NSF's RUI program totals $35.16 million, an increase of $2.30 million above the FY 2009 Current Plan of $32.86 million. The RUI activity supports research by faculty members of predominantly undergraduate institutions through the funding of (1) individual and collaborative research projects, (2) the purchase of shared-use research instrumentation, and (3) Research Opportunity Awards for work with NSF-supported investigators at other institutions.

Science and Technology Centers (STCs): The FY 2010 Request for the Science and Technology Centers program totals $57.79 million, a decrease of $3.82 million below the FY 2009 Current Plan of $61.61 million. For additional information, see the NSF Centers Programs section of this chapter.

PERFORMANCE INFORMATION

This chapter describes how the Foundation monitors progress toward the strategic outcome goals that underpin the FY 2010 Request.

The following table summarizes the FY 2010 funding requirements for NSF's strategic outcome goals.

This chapter includes information on how NSF evaluates the impact of its investments under the strategic outcome goals of Discovery, Learning, Research Infrastructure, and Stewardship; the agency's performance assessment framework; and examples from STEM education programs of how performance evaluation is used to inform program design and improvement in three directorates.

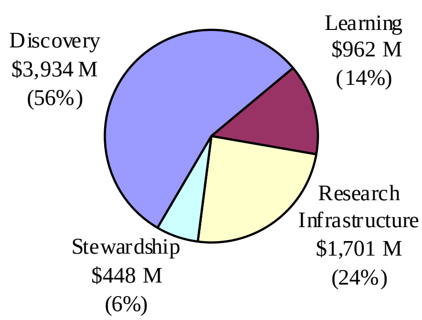
For more information about NSF's performance assessment activities and annual performance reports, see NSF's Budget and Performance Website: www.nsf.gov/about/performance/.

National Science Foundation
By Strategic Outcome Goal
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change over FY 2009 Current Plan Amount	Change over FY 2009 Current Plan Percent
Discovery	$3,290.24	$3,509.02	$1,597.32	$3,934.06	$425.04	12.1%
Learning	848.74	896.71	261.78	962.14	65.43	7.3%
Research Infrastructure	1583.76	1673.27	1140.90	1701.14	27.87	1.7%
Stewardship	361.31	411.40	2.00	447.66	36.26	8.8%
Total, NSF	$6,084.04	$6,490.40	$3,002.00	$7,045.00	$554.60	8.5%

Totals may not add due to rounding.

NSF's FY 2010 Request by Strategic Goal



NSF'S STRATEGIC FRAMEWORK

NSF's Strategic Plan for FY 2006 – 2011, (www.nsf.gov/pubs/2006/nsf0648/nsf0648.jsp) established four long-term strategic goals as the framework for the agency's activities and performance.

- *Discovery* – Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit, and establishing the nation as a global leader in fundamental and transformational science and engineering.
- *Learning* – Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.
- *Research Infrastructure* – Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure, and experimental tools.
- *Stewardship* -- Support excellence in science and engineering research and education through a capable and responsive organization.

STRATEGIC OUTCOME GOAL 1: DISCOVERY

Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit, and establishing the Nation as a global leader in fundamental and transformational science and engineering.

Investments in *Discovery* support cutting-edge research that yield new and important discoveries and promote the development of new knowledge and techniques within and across traditional boundaries. These investments enable NSF to meet its mission of promoting the progress of science while at the same time helping to maintain the Nation's capacity to excel in science and engineering, particularly in academic institutions. The results of NSF-funded research projects provide a rich foundation for broad and useful applications of knowledge and the development of new technologies. Support in this area also promotes the education and training of the next generation of scientists and engineers by providing them with an opportunity to participate in discovery-oriented projects.

To evaluate research and education outcomes under *Discovery*, NSF convenes an external expert group, the Advisory Committee for GPRA Performance Assessment (AC/GPA), which determines whether the Foundation has demonstrated significant achievement under this goal. In FY 2008, the AC/GPA determined that NSF had achieved this goal. At its June 2009 meeting, the AC/GPA will discuss ways to enhance NSF's performance assessment activities and framework. The committee's recommendations will inform the Foundations' framework for performance evaluation in FY 2010.

Resources Required for FY 2010: Successful achievement of this goal is dependent on NSF receiving the resources outlined below.

Support of Discovery Goal by Appropriation

(Dollars in Millions)

	R&RA	EHR	MREFC	AOAM	OIG	Total
Discovery	$3,755.16	$178.90	-	-	-	$3,934.06

Means and Strategies for Success: NSF's ongoing portfolio of investments and continuing priorities are outlined in this budget submission. In addition, the following long-term investment priorities associated with the strategic goal of *Discovery* have been identified for increased emphasis or additional funding during the period of the Strategic Plan, FY 2006-2011:

- Promote transformational, multidisciplinary research.
- Investigate the human and social dimensions of new knowledge and technology.
- Further U.S. economic competitiveness through basic research that can lead to new, valuable, and marketable technologies.
- Foster research that improves our ability for sustainable living on Earth.
- Advance fundamental research in computational science and engineering, and in fundamental, applied, and interdisciplinary mathematics and statistics.

STRATEGIC OUTCOME GOAL 2: LEARNING

Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.

Leadership in today's knowledge economy requires scientists and engineers and a national workforce that is scientifically, technically, and mathematically strong. Investments in *Learning* aim to improve the quality and reach of science, engineering, and mathematics education and enhance student achievement. Each year, NSF supports an estimated 200,000 people – teachers, students, and researchers at every educational level and across all disciplines in science and engineering. In FY 2009, that number is expected to increase.

Embedded in all NSF programs are efforts to build a more inclusive, knowledgeable, and globally-engaged workforce that fully reflects the strength of the Nation's diverse population. Because science and engineering increasingly address global questions of significant societal importance, today's research requires globally-engaged investigators working collaboratively across agencies and international organizations to apply the results of research to long-standing global challenges.

To evaluate research and education outcomes under *Learning*, NSF convenes an external expert group, the Advisory Committee for GPRA Performance Assessment (AC/GPA), which determines whether the Foundation has demonstrated significant achievement under this goal. In FY 2008, the AC/GPA determined that NSF had achieved this goal. At its June 2009 meeting, the AC/GPA will discuss ways to enhance NSF's performance assessment activities and framework. The committee's recommendations will inform the Foundations' framework for performance evaluation in FY 2010.

Resources Required for FY 2010: Successful achievement of this goal is dependent on NSF receiving the resources outlined below.

Support of Learning Goal by Appropriation

(Dollars in Millions)

	R&RA	EHR	MREFC	AOAM	OIG	Total
Learning	$314.00	$648.14	-	-	-	$962.14

Means and Strategies for Success: NSF's ongoing portfolio of investments and continuing priorities are outlined in this budget submission. In addition, the following long-term investment priorities, associated with NSF's Strategic Outcome Goal of *Learning*, have been identified for increased emphasis or additional funding during 2006-2011.

- Build strong foundations and foster innovation to improve K-12 teaching, learning, and evaluation in science and mathematics.
- Advance the fundamental knowledge base on learning, spanning a broad spectrum from humans to animals and machines.
- Develop methods to effectively bridge critical junctures in STEM education pathways.
- Prepare a diverse, globally-engaged STEM workforce.
- Integrate research with education, and build capacity.
- Engage and inform the public in science and engineering through informal education.

STRATEGIC OUTCOME GOAL 3: RESEARCH INFRASTRUCTURE

Build the Nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure, and experimental tools.

NSF investments in *Research Infrastructure* provide state-of-the-art tools for research and education, such as multi-user research facilities, distributed instrumentation networks and arrays, accelerators, telescopes, research vessels, aircraft, and earthquake simulators. In addition, investments in internet-based and distributed user facilities are increasing as a result of rapid advances in computer, information, and communication technologies. NSF support for large multi-user facilities helps create state-of-the-art research platforms vital to new discoveries and the progress of research. NSF support may include construction, upgrades, operations, maintenance, and personnel needed to assist scientists and engineers in the conduct of research at such facilities. NSF consults with other agencies and international partners to avoid duplication and optimize capabilities for U.S. researchers. NSF also supports the work of Science Resources Statistics, which fulfills the mandate of the NSF Act to provide an information resource on the science and engineering enterprise.

To evaluate research and education outcomes under *Research Infrastructure*, NSF convenes an external expert group, the Advisory Committee for GPRA Performance Assessment (AC/GPA), which determines whether the Foundation has demonstrated significant achievement under this goal. In FY 2008, the AC/GPA determined that NSF had achieved this goal. At its June 2009 meeting, the AC/GPA will discuss ways to enhance NSF's performance assessment activities and framework. The committee's recommendations will inform the Foundations' framework for performance evaluation in FY 2010

Resources Required for FY 2010: Successful achievement of this goal is dependent on NSF receiving the resources outlined below.

Support of Research Infrastructure Goal by Appropriation

(Dollars in Millions)

	R&RA	EHR	MREFC	AOAM	OIG	Total
Research Infrastructure	$1,567.87	$15.98	$117.29	-	-	$1,701.14

Means and Strategies for Success: NSF's ongoing portfolio of investments and continuing priorities are outlined in this budget submission. In addition, the following long-term investment priorities, associated with the strategic goal of *Research Infrastructure*, have been identified for increased emphasis or additional funding during the period of the Strategic Plan, FY 2006-2011:

- Fill the gaps in our ability to provide enabling research infrastructure.
- Identify and support the next generation of large research facilities.
- Develop a comprehensive, integrated cyberinfrastructure to drive discovery in all fields of science and engineering.
- Strengthen the Nation's collaborative advantage by developing unique networks and innovative partnerships.

STRATEGIC OUTCOME GOAL 4: STEWARDSHIP

Support excellence in science and engineering research and education through a capable and responsive organization.

The *Stewardship* strategic outcome goal is fundamental to NSF's leadership in achieving success through its investments in science, engineering, and education research. The Foundation's *Stewardship* goal priorities include improving the quality of the merit review process, NSF's service to the science and engineering community, management of large facilities, and the efficiency and effectiveness of administrative and management procedures. Broadening participation from underrepresented groups and diverse institutions is also a high priority.

Within the Foundation, specific program or administrative units assume leadership for monitoring the progress of performance targets under *Stewardship*. In FY 2008, NSF achieved 22 out of the 23 *Stewardship* milestones and measures. Among those achievements were:

- surpassing the Foundation-wide dwell time goal of notifying investigators within six months on whether their proposals will be recommended for funding,
- publishing NSF's broadening participation portfolio of programs on NSF's website (www.nsf.gov/od/broadeningparticipation/bp_portfolio.jsp),
- initiating the development of a searchable database of NSF proposal reviewers,
- surpassing the major multi-user facilities operations goal of keeping operating time lost in those facilities to less than ten percent, and
- achieving all post-award monitoring measures and e-Government performance measures.

Resources Required for FY 2010: Successful achievement of this goal is dependent on NSF receiving the resources outlined below.

Support of Stewardship Goal by Appropriation

(Dollars in Millions)

	R&RA	EHR	MREFC	AOAM	NSB	OIG	Total
Stewardship	$96.21	$14.74	-	$318.37	$4.34	$14.00	$447.66

Means and Strategies for Success: NSF's ongoing portfolio of investments and continuing priorities are outlined in this budget submission. Among the long-term investment priorities identified in the Strategic Plan for *Stewardship* are:

- Strengthen our traditional partnerships and develop new collaborations with other agencies, organizations, and corporations, identifying common goals that can unite and focus partnerships.
- Expand efforts to broaden participation from underrepresented groups and diverse institutions in all NSF activities.
- Improve our processes to recruit and select highly qualified reviewers and panelists.
- Continue as an exemplar in science ethics.
- Enhance the processes for management and oversight of large facilities.

ASSESSING THE PERFORMANCE OF RESEARCH AND EDUCATION PROGRAMS

The Government Performance and Results Act (GPRA) requires that federal agencies develop a strategic plan, establish annual performance goals, and report annually on the progress made toward achieving these goals. GPRA poses a challenge to agencies like NSF that support long-term scientific research. It is often not possible to link outcomes to annual investments because results in basic research and education can be unpredictable. Serendipitous results can be the most interesting and important. Science and engineering research projects can generate discoveries in an unrelated area, and it can take years to recognize the impacts of those discoveries.

To assess the impact of our science and engineering investments, NSF relies for the most part on the qualitative judgment of experts. The value of external expert review was affirmed in two studies by the Committee on Science, Engineering, and Public Policy (COSEPUP) of the National Research Council. In a 2001 report, the committee stated "Because we do not know how to measure knowledge while it is being generated and when its practical use cannot be predicted, the best we can do is ask experts in the field – a process called *expert review* – to evaluate research regularly while it is in progress."[1]

NSF's external evaluation panels consist of the Foundation-wide Advisory Committee for GPRA Performance Assessment (AC/GPA), program-specific Committees of Visitors (COVs), and other external or third-party evaluations. The AC/GPA meets annually to review the previous year's research and education outcomes. Committees of Visitors are convened once every three years for each of NSF's programs. See pages 7-8 for more information about the AC/GPA and COV processes.

In FY 2010, the following COVs will be convened to review program management and outcomes:

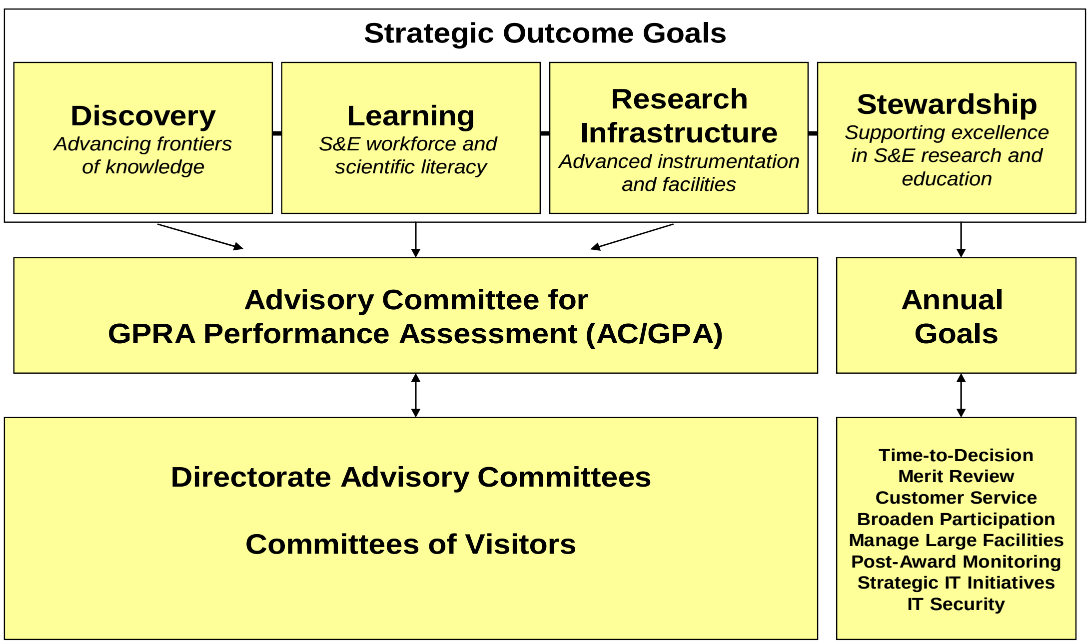
Directorate/Office	***Program***
Biological Sciences	Biological Infrastructure
Education & Human Resources	Scholarships (S-Stem in FY 2007) Scholarship for Services Alliances for Graduate Education & the Professoriate Centers for Research Excellence in Science & Technology Historically Black Colleges & Universities-Undergrad Prog. Louis Stokes Alliances for Minority Participation Tribal Colleges & Universities Program CAREER Program
Engineering	Engineering Education & Centers Industrial Innovation & Partnerships

[1] *Implementing the Government Performance and Results Act for Research: A Status Report* is available at www.nap.edu/catalog.php?record_id=10106.

	Emerging Frontiers in Research & Innovation
Geosciences	Atmospheric Sciences Earth Sciences Geosciences Education and Diversity programs
Mathematical & Physical Sciences	Chemistry Mathematical Sciences
Social, Behavioral & Economic Sciences	Social and Economic Sciences
Office of Integrative Activities	Major Research Instrumentation

A schedule of COV evaluations planned through FY 2011, as well as a list of external evaluations completed during FY 2008, is available in NSF's FY 2008 Annual Performance Report (Appendix D): www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf0922

NSF'S PERFORMANCE ASSESSMENT FRAMEWORK



Advisory Committee for GPRA Performance Assessment (AC/GPA)

The AC/GPA, composed of about 20 scientists, engineers, and educators, conducts an annual agency-wide review of NSF's investments in research and education under its strategic outcome goals. The Committee reviews a large number of program outcomes, or "highlights," written by program officers to demonstrate the accomplishments of principal investigators. The Committee's charge is to determine whether the Foundation demonstrated significant achievement under the goals and submit a report to the NSF Director. The committee's conclusions and recommendations are included in NSF's Annual Performance Report. At its meeting in June 2009, the AC/GPA will discuss ways to enhance NSF's performance evaluation framework.

Directorate and Special Topic Advisory Committees (ACs)

Each directorate and office has an AC that normally meets twice a year to provide guidance on priorities, address program effectiveness, and review COV reports and management's response to COV recommendations. Advisory Committees are chartered and subject to Federal Advisory Committee Act (FACA) rules. COVs are subcommittees of NSF directorate advisory committees. NSF also has four advisory committees focused on the topics of: Equal Opportunities in Science and Engineering, Environmental Research and Education, Astronomy and Astrophysics, and Business and Operations.

Committees of Visitors (COVs)

Each division or crosscutting program is assessed by a Committee of Visitors once every three years. A COV typically consists of up to 20 external experts, selected to ensure independence, programmatic coverage, and geographic balance, and they represent academia, industry, government, and the public sector. They meet for two or three days to review and assess program priorities, program management, and award accomplishments or outcomes. Approximately one-third of NSF's divisions are assessed each year.

COVs are asked to comment on program activities as they relate to NSF's strategic outcome goals, justify their findings, and provide supporting examples or statements. Each COV prepares a report and the division or program that is being reviewed must prepare a response. These reports and responses are submitted to the parent advisory committee and to the Director of NSF. COV recommendations must be addressed by the division director, and appropriate actions must be taken to comply. All reports and responses are public and posted on NSF's website at: www.nsf.gov/od/oia/activities/cov/covs.jsp.

Verification and Validation of Performance Goals

The Government Accountability Office (GAO) has provided guidance to federal agencies on how to provide confidence that the policies and procedures underlying performance reporting are complete, accurate, and consistent.[2] Following that guidance, NSF engaged IBM Global Business Services (IBM) to conduct an independent validation and verification (V&V) review of its annual performance information, data, and processes. IBM assessed the validity of the data and verified the reliability of the methods used to collect, process, maintain, and report data, and reviewed NSF's information systems based on GAO standards for application controls. IBM's FY 2008 V&V report to NSF concluded that:

> *NSF relies on sound business practices, internal controls, and manual checks of system queries to ensure accurate performance reporting. NSF maintains adequate documentation of its processes and data to allow for an effective V&V review. Based on this comprehensive review, IBM has confidence in the systems, policies, and procedures used by NSF to generate results for the described performance measures. NSF continues to take concerted steps to improve the quality of their systems and data. We commend NSF for this effort to confirm the reliability of its GPRA data and results, and the quality of its processes for collecting, processing, maintaining, and reporting data for its performance goals.*[3]

[2] *GAO Guide to Assessing Agency Annual Performance Plans,* GAO/GGD-10.1.20.

[3] IBM Global Business Services, *NSF Fiscal Year 2008 - Performance Measurement Verification and Validation Report,* October 22, 2008.

PERFORMANCE EVALUATION AND PROGRAM IMPROVEMENT: EXAMPLES FROM NSF'S LEARNING PORTFOLIO

NSF's *Learning* portfolio consists of the science, technology, engineering, and mathematics (STEM) education programs within the Directorate for Education and Human Resources (EHR), as well as programs such as those in the Engineering and Geosciences directorates described later in this chapter. The portfolio includes a wide range of programs for K-12 students and teachers, undergraduate students, graduate students, postdoctoral fellows, and informal science education and lifelong learning – nearly 60 programs in total. NSF is committed to improving the quality of STEM education as part of our vision of "advancing discovery, innovation and education beyond the frontiers of current knowledge and empower future generations in science and engineering."

NSF recognizes that evaluations of the *Learning* portfolio offer timely opportunities for program improvement and redesign. The Foundation is increasing its efforts to improve the quality of program evaluations, implement more evaluations, and build Foundation-wide capacity in this area. Evaluations of programs in the *Learning* portfolio, both by external organizations and groups and by NSF program staff, are also an integral part of the Foundation's current effort to develop performance metrics for STEM education programs. It must be recognized, however, that there is a range of evaluation goals, questions, metrics, and designs in use, and that different types of evaluation programs are employed for activities at different stages of their progress.

An evaluation framework for STEM education programs currently under discussion within NSF is:

EVALUATION FRAMEWORK FOR STEM EDUCATION (LEARNING) PROGRAMS

Formulation of evaluation goals and metrics	***Data gathering***	***Design and implementation of studies to examine outcomes, impact, program contribution***	***Design and implementation of long-term follow up for impact***
Creating logic models; Analyzing the portfolio; Framing questions for accountability and program improvement; Developing metrics	Establishing monitoring systems; Conducting surveys; Compiling project-level evaluations; Describing strategies within the portfolio; Review by experts	Studies comparing outcomes before and after program; Studies comparing well-defined strategies within program; Analysis of R&D contribution via expert review	Longitudinal studies; Network analysis; Citation review; Syntheses

The following examples of program evaluations recently conducted or ongoing in EHR, the Engineering Directorate, and the Geosciences Directorate illustrate the use of performance evaluation to improve program design and implementation.

Directorate for Education and Human Resources (EHR)

The Directorate for Education and Human Resources (EHR) supports about 30 programs that focus on the improvement of STEM education within the United States from the K-12 level through graduate student and professional levels, and in both formal school settings as well as informal learning environments. All of these programs undergo periodic external evaluation over and above the standard NSF evaluation process through Committees of Visitors. In addition, all projects (awards) supported by EHR must contain an evaluation plan and progress is monitored by program directors throughout the course of the award. Evaluations of three key EHR programs are described below: the Advanced Technological Education (ATE) program, the Graduate Research Fellowship (GRF) program, and the Math and Science Partnership (MSP) program.

The **Advanced Technological Education (ATE) Program** focuses on the education of technicians for the high-technology fields that drive our Nation's economy. With an emphasis on two-year colleges, the program involves partnerships between academic institutions and employers to promote improvement in the education of science and engineering technicians at the secondary school and undergraduate levels.

Each year since 2000, the Evaluation Center at Western Michigan University has surveyed all centers and projects that have been active for at least one year (about 170). A survey tracks evaluation of projects' development of materials, professional development of teachers, program improvement, and student recruitment and retention. More than 80,000 students took at least one course in an ATE-funded project in 2007, and about equal numbers of two-year college faculty and high school teachers and workers from industry were part of the 49,000 who took part in ATE-funded professional development. More than 2,600 curricula and other educational materials were developed by 57 ATE programs during 2007, and ATE initiatives developed about 1,500 new articulation agreements between high schools and two-year colleges and between two-year and four-year colleges. Center surveys and other information about the ATE Program are available at: www.wmich.edu/evalctr/ate/.

The **Graduate Research Fellowship (GRF) Program** is NSF's flagship program for support of graduate students. It provides three years of support for graduate study leading to research-based master's or doctoral degrees, and is intended for students who are in the early stages of their graduate study in disciplines supported by the Foundation. The program provides a stipend and a cost-of-education allowance. A student survey and program evaluation of the 1979-1988 cohort conducted by WestEd found that GRF students complete the Ph.D. at higher rates than any other comparable population, have shorter time to degree completion, reach faculty positions with greater frequency, and enjoy higher rates of career productivity than most peer groups. The WestEd report was published in 2002 and is available at www.nsf.gov/pubs/2002/nsf02080/start.htm. The National Opinion Research Center (NORC) has just begun another three-year program evaluation, which will focus on the 1989-1998 cohort, and will include a follow-up study of the fellows' graduate experiences and career outcomes.

Equally if not more important for program evaluation are the assessments and recommendations of Committees of Visitors. As a result of recommendations made by two COVs in 2003 and 2007, the GRF program staff introduced more precise and efficient program management practices. Those practices include: converting to an entirely electronic application and panel review process; developing revised eligibility criteria to allow more advanced graduate students to apply; and increasing the flexibility of how the graduate students may use their fellowships. The 2007 COV recommended that the Program staff expand their outreach to minority-serving institutions in order to increase the numbers of applicants from underrepresented groups who apply for and win fellowships. As a result of the outreach activities, which included more visits to those institutions, partnerships with other federal agencies, and an enhanced website, a record number of applications was submitted in FY 2009.

The **Math and Science Partnership (MSP) Program** is a major research and development effort now active in 35 states, Puerto Rico, and the Virgin Islands. It supports innovative partnerships to improve K-12 student achievement in mathematics and science. MSP projects are expected to raise the achievement levels of all students and significantly reduce achievement gaps in the mathematics and science performance of diverse student populations. The MSP program coordinates with the Mathematics and Science Partnerships program of the U.S. Department of Education in the expectation that effective innovations in mathematics and science education will be disseminated into wider practice. The two programs are significant components of the America COMPETES Act of 2007 (Public Law 110-69).

An external evaluation of the MSP Program is underway by the COSMOS Corporation, in collaboration with Brown University, George Mason University, the McKenzie Group, and Vanderbilt University. The approach developed for the evaluation of the MSP Program was a series of over 20 studies, and program evaluators have begun to publish the design and early results of these studies in peer-reviewed journals. Most recently, the entire Fall 2008 issue - Volume 83, Issue 4 - of the *Peabody Journal of Education* was devoted to the MSP Program evaluation. Project-level evaluations have been in place since the inception of the MSP program, and MSP has provided technical assistance in evaluation to the partnership projects through senior evaluators at the University of Wisconsin-Madison and Utah State University. A product of the interaction between the technical assistance teams, with significant impact on projects by guiding them to effective project-level evaluation, is *Evidence: An Essential Tool – Planning for and Gathering Evidence using the Design-Implementation-Outcomes (DIO) Cycle of Evidence*, which is available at (www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf0531)

MSPNet (www.mspnet.org) supports real-time sharing of strategies and information within the MSP community. Through a common data collection system, the program collects a range of data regarding partnership profiles; types of services offered; engagement by faculty, businesses, and K-12 teachers; and impacts on the teaching force, as well as on student learning. The system allows the program to track longitudinally many elements of the MSP Program, including student achievement in mathematics and science.

In summary, EHR is providing leadership and advancing methodology in comprehensive project-level and program evaluation of STEM education investments. The directorate's programs span a research and development spectrum, and the evaluation efforts are designed to answer questions important for continual program improvement and change, as well as to assess program impact and effectiveness. EHR STEM education program evaluations are typically multifaceted and employ multiple methods. They include evaluation planning (e.g., formulation of goal-related questions and performance measures), data-gathering for portfolio analysis and description, studies of impact and outcomes for program justification, and longitudinal studies for follow-up and impact.

Directorate for Engineering (ENG)

The Division of Engineering Education and Centers (EEC) encourages the integration of engineering research and education to accelerate technological and educational innovation, and improve the quality and diversity of engineering graduates entering the technical workforce. The EEC portfolio includes research to advance our understanding of how students learn engineering, and research on how to improve the attraction and retention of engineering students at all levels of education.

The EEC Division recently funded an external evaluation of two of its programs in engineering education: How People Learn Engineering (HPLE) and Department Level Reform (DLR). HPLE is part of the Innovations in Engineering Education and Curriculum and Infrastructure (IEECI) program. DLR focuses on innovations in curriculum at the department level that involve significant changes in teaching methods, with less emphasis on lectures and more emphasis on teaming and hands-on experiences; better use of technology; and increased emphasis on teaching communication skills to students. The Science and Technology Policy Institute (STPI) conducted the evaluations.

In its review of 37 HPLE research grants, STPI concluded that the typical grantee explores a well-defined research agenda, specifies the concepts to be studied and how they will be measured, pays close attention to data collection and analysis and the potential for its application, produces curricula or other materials as a result of the research activity, and communicates findings broadly. The study recommended that longitudinal outcome assessments be conducted to track the extent to which HPLE-based ideas impact the global engineering education community.

In its review of 20 DLR grants, STPI found that each DLR team accomplished significant curriculum reforms consistent with the National Academy of Engineering (NAE) recommendation that engineering concepts and designs be introduced early in students' undergraduate education in an effort to motivate them to obtain graduate degrees. The reforms also mapped to the Accreditation Board for Engineering and Technology (ABET) criteria that focus on what engineering students should learn, including techniques, skills, and engineering tools that are used by practicing engineers. The study recommended several options for short term and longer term assessments.

The Division of Engineering Education and Centers also supports the Engineering Research Center program, which encourages the integration of engineering research and education. Since 2000, EEC has supported several external evaluations of the ERC program. One of those evaluations, *Designing the Next Generation of NSF Engineering Research Centers: Insights from Worldwide Practice*, conducted by STPI in 2007, helped identify best practices in several countries that NSF will take into account in designing the next generation of ERCs – the so-called "Gen-4" ERCs. Some of the study's recommendations were: develop more flexible Intellectual Property Rights policies, be creative in encouraging commercialization, and support true collaborative research through partnerships and networks. Another study was conducted in 2007 on strategic planning in ERCs, and several studies were conducted on innovations generated by research at ERCs, the impact on industry of interaction with ERCs, and the impact of ERCs on institutional and cultural change in participating institutions.

More information about recent external evaluations of programs within the Division of Engineering Education and Centers is available at: www.erc-assoc.org/topics/6-nsf-policies.html. (See "Summary of ERC Study Findings 2001-2008")

Directorate for Geological Sciences (GEO)

Two overarching goals for the STEM education programs within the Directorate for Geosciences are:

- To develop a skilled and diverse geoscience workforce for the future that is prepared to work in an increasingly interdisciplinary field, and
- To advance public knowledge and understanding of geoscience content, because of its societal relevance.

GEO's education, outreach, and diversity investments are tightly coupled to its research programs. Emphasis is placed on programs for undergraduates, K-12 teachers, and postdoctoral programs, and programs that engage scientists in education and outreach. Several programs emphasize development and dissemination of best practices, in order to serve a larger audience of learners.

Three GEO programs are described below: GEO-Teach, Opportunities for Enhancing Diversity in the Geosciences (OEDG), and Centers for Ocean Science Education Excellence (COSEE).

GEO-Teach aims to improve the quality of secondary school geoscience instruction at a national scale. The emphasis is on developing effective and sustainable models for scaling up high quality teacher professional development and training activities that increase content knowledge, improve pedagogy, and engage the broader scientific community.

To date there has been one GEO-Teach competition, held at the end of FY 2006, in which two three-year cooperative agreements were awarded:

- The Earth System Science Education Alliance (ESSEA) Project. The principal investigators are at the Institute for Global Environmental Strategies. The purpose of the project is to create a national network of 43 partner and affiliate institutions providing online and face-to-face pre- and in-service teacher preparation resources.
- Transforming Earth Systems Science Education (TESSE) Project. This is a partnership of investigators at the University of New Hampshire, Pennsylvania State University, Dillard University, and Elizabeth City State University. The purpose is to provide pre-service teacher training and in-service professional development in Earth Systems Science.

The evaluation design and methods used, as well as performance metrics, are embedded in the project descriptions. Some preliminary findings from the evaluations indicate that significant progress has been made in establishment of online courses, that participants are actively engaged (attending project conferences, giving presentations, and developing modules to share with their networks), and that formative feedback is being used to increase effectiveness and improve partnership collaboration.

Opportunities for Enhancing Diversity in the Geosciences (OEDG) is aimed at increasing the number of members of underrepresented groups who are involved in formal pre-college geoscience education programs, pursue post-secondary degrees in the geosciences, enter geoscience careers, and participate in informal geoscience education programs. The emphasis is on developing and disseminating best practices for broadening participation in the geosciences, building capacity at minority-serving institutions, and leveraging existing networks and resources. About 95 projects have been awarded to date through two "track" options.

An OEDG program-wide evaluation is being conducted through a five-year contract that was re-awarded in 2008 to the American Institutes for Research (AIR). Track One projects have evaluation support through this contract, while Track Two projects are required to have robust evaluations conducted by an external evaluator. GEO program directors are currently analyzing preliminary results from the evaluations.

Centers for Ocean Science Education Excellence (COSEE) has the goal of improving the broader impacts capabilities of ocean scientists by connecting them to formal and informal educators. Each of the 11 centers promotes activities reflecting their strengths and interests. There is also a COSEE Network Central Coordinating Office and a National Advisory Committee. COSEE supports a broad range of activities (including public lectures, workshops, publications, citizen science activities, and improving displays and materials at public science centers) that foster the engagement of ocean scientists in improving the public understanding of ocean science topics. The major scientific emphases include climate change, ocean chemistry/acidification, coastal ecosystems/environmental issues, and ocean observing education.

Each center has its own evaluation effort, and there is also a network-level evaluation. NSF conducts site visits of the centers and has regular communication with PIs. NSF is currently restructuring the COSEE evaluation effort, aiming to put stronger focus on the impact of activities at the Centers and at the network level, in particular highlighting the impact of the centers' activities on the ocean sciences research community and the public.

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FY 2010 Appropriations Language

National Science Foundation

RESEARCH AND RELATED ACTIVITIES

For necessary expenses in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), and the Act to establish a National Medal of Science (42 U.S.C. 1880-1881); services as authorized by 5 U.S.C. 3109; maintenance and operation of aircraft and purchase of flight services for research support; acquisition of aircraft; and authorized travel; $5,733,240,000, to remain available until September 30, 2011, of which not to exceed $570,000,000 shall remain available until expended for polar research and operations support, and for reimbursement to other Federal agencies for operational and science support and logistical and other related activities for the United States Antarctic program: *Provided* That, from funds specified in the fiscal year 2010 budget request for icebreaking services, up to $54,000,000 shall be available for the procurement of polar icebreaking services: *Provided further*, That the National Science Foundation shall only reimburse the Coast Guard for such sums as are agreed to according to the existing memorandum of agreement: *Provided further*, That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation.

EDUCATION AND HUMAN RESOURCES

For necessary expenses in carrying out science and engineering education and human resources programs and activities pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including services as authorized by 5 U.S.C. 3109, authorized travel and rental of conference rooms in the District of Columbia, $857,760,000, to remain available until September 30, 2011.

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

For necessary expenses for the acquisition, construction, commissioning, and upgrading of major research equipment, facilities, and other such capital assets pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including authorized travel, $117,290,000, to remain available until expended.

AGENCY OPERATIONS AND AWARD MANAGEMENT

For agency operations and award management necessary in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875); services authorized by 5 U.S.C. 3109; hire of passenger motor vehicles; not to exceed $9,000 for official reception and representation expenses; uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; rental of conference rooms in the District of Columbia; and reimbursement of the Department of Homeland Security for security guard services; $318,370,000: *Provided*, That contracts may be entered into under this heading in fiscal year 2010 for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year.

OFFICE OF INSPECTOR GENERAL

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, as amended, $14,000,000.

OFFICE OF THE NATIONAL SCIENCE BOARD

For necessary expenses (including payment of salaries, authorized travel, hire of passenger motor vehicles, the rental of conference rooms in the District of Columbia, and the employment of experts and consultants under section 3109 of title 5, United States Code) involved in carrying out section 4 of the National Science Foundation Act of 1950, as amended (42 U.S.C 1863) and Public Law 86-209 (42 U.S.C. 1880 et seq.), $4,340,000: *Provided*, That not to exceed $2,500 shall be available for official reception and representation expenses.

SUMMARY OF FY 2010 BUDGETARY RESOURCES BY APPROPRIATION

(DOLLARS IN MILLIONS)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	CHANGE OVER FY 2009 Plan Amount	Percent
RESEARCH AND RELATED ACTIVITIES						
Appropriation	$4,821.47	$5,183.10	$2,500.00	$5,733.24	$550.14	10.6%
Supplemental	22.50					
Unobligated Balance Available Start of Year[1]	22.63	1.01				
Unobligated Balance Available End of Year	-1.01					
Unobligated Balance Rescission P.L. 110-161	-17.17					
Adjustments to Prior Year Accounts[2]	7.06					
Subtotal, R&RA	4,855.48	5,184.11	2,500.00	$5,733.24	$549.13	10.6%
Transferred to other funds[3]	-2.24			-		
Total Budgetary Resources	$4,853.24	$5,184.11	$2,500.00	$5,733.24	$549.13	10.6%
EDUCATION AND HUMAN RESOURCES[4]						
Appropriation	$725.60	$845.26	$100.00	$857.76	$12.50	1.5%
Supplemental	40.00					
Unobligated Balance Available Start of Year	0.10	0.27				
Unobligated Balance Available End of Year	-0.27					
Unobligated Balance Rescission P.L. 110-161	0.04					
Adjustments to Prior Year Accounts[2]	0.79					
Total Budgetary Resources	$766.26	$845.53	$100.00	$857.76	$12.23	1.4%
MAJOR RESEARCH EQUIPMENT & FACILITIES CONSTRUCTION						
Appropriation	$220.74	$152.01	$400.00	$117.29	-$34.72	-22.8%
Unobligated Balance Available Start of Year	27.60	51.16				
Unobligated Balance Available End of Year	-66.43					
Unobligated Balance Rescission P.L. 110-161	-15.27					
Adjustments to Prior Year Accounts[2]	0.21					
Total Budgetary Resources	$166.85	$203.17	$400.00	$117.29	-$85.88	-42.3%
AGENCY OPERATIONS AND AWARD MANAGEMENT						
Appropriation	$281.79	$294.00	$0.00	$318.37	$24.37	8.3%
Unobligated Balance Available Start of Year	-					
Unobligated Balance Available End of Year	-					
Unobligated Balance Rescission P.L. 110-161	-					
Adjustments to Prior Year Accounts[2]	0.25					
Total Budgetary Resources	$282.04	$294.00	-	$318.37	$24.37	8.3%

Totals may not add due to rounding.

[1]FY 2008 Actual includes $5.46 million provided by the U.S. Department of State for an award to the U.S. Civilian Research and Development Foundation that was a carryover from FY 2007 and was obligated in FY 2008.

[2]Adjustments include upward and downward adjustments to prior year obligations.

[3]FY 2008 Actual excludes an NSF appropriation transfer to the Office of Science and Technology Policy for costs associated with Science & Technology Policy Institute.

[4]Excludes $121.03 million in obligations in FY 2008 and an estimated $100 million in FY 2009 and FY 2010 receipts from H-1B Nonimmigrant Petitioner Fees.

SUMMARY OF FY 2010 BUDGETARY RESOURCES BY APPROPRIATION

(DOLLARS IN MILLIONS)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	CHANGE OVER FY 2009 Plan Amount	Percent
NATIONAL SCIENCE BOARD						
Appropriation	$3.97	$4.03		$4.34	$0.31	7.7%
Unobligated Balance Available Start of Year	-	0.14				
Unobligated Balance Available End of Year	-0.15					
Unobligated Balance Rescission P.L. 110-161	-					
Adjustments to Prior Year Accounts[2]						
Total Budgetary Resources	$3.82	$4.17	-	$4.34	$0.17	4.1%
OFFICE OF INSPECTOR GENERAL						
Appropriation	$11.43	$12.00	$2.00	$14.00	$2.00	16.7%
Unobligated Balance Available Start of Year	0.71	0.25				
Unobligated Balance Available End of Year	-0.25					
Unobligated Balance Rescission P.L. 110-161	-0.46					
Adjustments to Prior Year Accounts[2]	0.40					
Total Budgetary Resources	$11.83	$12.25	$2.00	$14.00	$1.75	14.3%
TOTAL DISCRETIONARY, NATIONAL SCIENCE FOUND	$6,084.04	$6,543.23	$3,002.00	$7,045.00	$501.77	7.7%
EDUCATION AND HUMAN RESOURCES, H-1B						
Appropriation, Mandatory	104.43	100.00	-	100.00	-	0.0%
Unobligated Balance Available Start of Year	63.37					
Unobligated Balance Available End of Year	-50.83					
Unobligated Balance Rescission P.L. 110-161	.					
Adjustments to Prior Year Accounts[2]	4.14					
Total Budgetary Resources	$121.11	$100.00	-	$100.00	$0.00	0.0%
TOTAL, NATIONAL SCIENCE FOUNDATION	$6,205.15	$6,643.23	$3,002.00	$7,145.00	$501.77	7.6%

Totals may not add due to rounding.

[2]Adjustments include expired balances, and upward and downward adjustments to prior year obligations.

NSF FY 2010 FUNDING BY PROGRAM

(Dollars in Millions)

PROGRAM	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
BIOLOGICAL SCIENCES						
MOLECULAR AND CELLULAR BIOSCIENCES	$112.28	$121.26	$60.00	$128.83	$7.57	6.2%
INTEGRATIVE ORGANISMAL SYSTEMS	200.04	211.62	60.00	221.84	10.22	4.8%
ENVIRONMENTAL BIOLOGY	110.71	120.38	70.00	133.92	13.54	11.2%
BIOLOGICAL INFRASTRUCTURE	109.86	116.80	20.00	130.14	13.34	11.4%
Research Resources	*47.87*	*47.61*	-	*56.25*	*8.64*	18.1%
Human Resources	*35.78*	*39.36*	*20.00*	*41.00*	*1.64*	4.2%
Centers [1]	*26.21*	*29.83*	-	*32.89*	*3.06*	10.3%
EMERGING FRONTIERS[1]	82.73	85.75	50.00	118.27	32.52	37.9%
Total, BIO[2]	$615.62	$655.81	$260.00	$733.00	$77.19	11.8%
COMPUTER AND INFORMATION SCIENCE AND ENGINEERING						
COMPUTING & COMMUNICATION FOUNDATIONS	$143.63	$156.93	$41.50	$174.83	$17.90	11.4%
COMPUTER & NETWORK SYSTEMS	174.16	188.31	92.57	209.87	21.56	11.4%
INFORMATION & INTELLIGENT SYSTEMS	139.33	150.26	60.50	167.56	17.30	11.5%
INFORMATION TECHNOLOGY RESEARCH	78.14	78.24	40.43	80.74	2.50	3.2%
Total, CISE[2]	$535.26	$573.74	$235.00	$633.00	$59.26	10.3%
ENGINEERING						
CHEMICAL, BIOENGINEERING, ENVIRONMENTAL & TRANSPORT SYSTEMS	$132.81	$146.02	$60.40	$160.11	$14.09	9.6%
CIVIL, MECHANICAL & MANUFACTURING INNOVATION	161.11	174.84	57.76	191.66	16.82	9.6%
ELECTRICAL, COMMUNICATIONS & CYBER SYSTEMS	83.60	87.35	45.84	95.75	8.40	9.6%
INDUSTRIAL INNOVATION & PARTNERSHIPS[3]	130.72	141.23	55.00	156.00	14.77	10.5%
SBIR/STTR	[109.07]	[119.21]	[50.00]	[132.52]	[13.31]	[11.2%]
ENGINEERING EDUCATION & CENTERS	116.02	117.45	32.00	132.00	14.55	12.4%
EMERGING FRONTIERS IN RESEARCH & INNOVATION	25.23	26.45	14.00	29.00	2.55	9.6%
Total, ENG[2]	$649.49	$693.34	$265.00	$764.52	$71.18	10.3%

[1] Centers move from Emerging Frontiers to the Division of Biological Infrastructure in FY 2010. SLC will be cofunded with the Directorate for Social, Behavioral and Economic Sciences beginning in FY 2010. Funding for the Science of Learning Centers (SLC) is shown comparably for all years.

[2] In FY 2010, Science of Learning Centers (SLC) is transferred from the Office of Integrative Activities and is co-funded by SBE and relevant research directorates. Funding for SLC is shown comparably for all years.

[3] Funding for the Partnerships for Innovation (PFI) and Science of Learning Centers (SLC) is removed for all years for comparability. Management responsibilities for PFI and SLC are transferred to the Directorate for Engineering and the Directorate for Social, Behavioral and Economic Sciences, respectively, in FY 2010.

NSF FY 2010 FUNDING BY PROGRAM

(Dollars in Millions)

PROGRAM	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
GEOSCIENCES						
ATMOSPHERIC & GEOSPACE SCIENCES	$230.03	$244.60	$68.20	$269.16	$24.56	10.0%
EARTH SCIENCES	157.82	171.00	85.22	186.85	15.85	9.3%
INTEGRATIVE & COLLABORATIVE EDUCATION AND RESEARCH	56.96	61.17	79.58	93.92	32.75	53.5%
OCEAN SCIENCES	313.06	330.36	114.00	359.07	28.71	8.7%
Total, GEO	$757.87	$807.13	$347.00	$909.00	$101.87	12.6%
MATHEMATICAL AND PHYSICAL SCIENCES						
ASTRONOMICAL SCIENCES	$217.90	$228.62	$85.80	$250.81	$22.19	9.7%
CHEMISTRY	194.62	211.35	103.00	238.60	27.25	12.9%
MATERIALS RESEARCH	262.55	282.13	106.90	308.97	26.84	9.5%
MATHEMATICAL SCIENCES	211.75	226.18	98.00	246.41	20.23	8.9%
PHYSICS	251.64	274.47	96.30	296.08	21.61	7.9%
MULTIDISCIPLINARY ACTIVITIES	32.67	33.21	-	39.13	5.92	17.8%
Total, MPS	$1,171.13	$1,255.96	$490.00	$1,380.00	$124.04	9.9%
SOCIAL, BEHAVIORAL AND ECONOMIC SCIENCES						
SOCIAL AND ECONOMIC SCIENCES	$93.40	$95.14	$42.00	$101.14	$6.00	6.3%
BEHAVIORAL AND COGNITIVE SCIENCES	87.30	88.70	43.00	96.90	8.20	9.2%
OFFICE OF MULTIDISCIPLINARY ACTIVITIES	18.51	17.66	-	24.34	6.68	37.8%
SCIENCE RESOURCES STATISTICS	28.66	38.80	-	34.62	-4.18	-10.8%
Total, SBE[2,4]	$227.87	$240.30	$85.00	$257.00	$16.70	6.9%

[4]In FY 2010, the Office of Multidisciplinary Activities (OMA) is created, and program funding responsibilities are transferred from SES and BCS to OMA. Also in FY 2010, Science of Learning Centers (SLC) is transferred from the Office of Integrative Activities to SBE and split between BCS and OMA. Funding for OMA and SLC is shown comparably for all years.

NSF FY 2010 FUNDING BY PROGRAM

(Dollars in Millions)

PROGRAM	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Current Plan Amount	Change Over FY 2009 Current Plan Percent
OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING[5]	$47.77	$44.03	$14.00	$49.00	$4.97	11.3%
OFFICE OF CYBERINFRASTRUCTURE	$185.15	$199.28	$80.00	$219.00	$19.72	9.9%
OFFICE OF POLAR PROGRAMS						
ARCTIC SCIENCES	$91.19	$98.26	$92.00	$108.70	$10.44	10.6%
ANTARCTIC SCIENCES	59.06	65.25	66.50	72.50	7.25	11.1%
ANTARCTIC INFRASTRUCTURE & LOGISTIC	240.08	246.87	15.50	273.60	26.73	10.8%
U.S. Antarctic Logistical Support Activities	[67.63]	[67.52]	-	[67.52]	-	-
POLAR ENVIROMENT, HEALTH & SAFETY	5.91	6.29	-	7.20	0.91	14.5%
USCG POLAR ICEBREAKING	50.89	54.00	-	54.00	-	-
Total, OPP	$447.13	$470.67	$174.00	$516.00	$45.33	9.6%
INTEGRATIVE ACTIVITIES[6]						
EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)	[120.00]	[133.00]	[50.00]	[147.12]	[14.12]	[10.6%]
MAJOR RESEARCH INSTRUMENTATION	[93.87]	[100.00]	[300.00]	[100.00]	-	-
ACADEMIC RESEARCH INFRASTRUCTURE	-	-	[200.00]	-	-	-
Total, IA[3]	$214.48	$241.34	$550.00	$271.12	$29.78	12.3%
U.S. ARCTIC RESEARCH COMMISSION	$1.47	$1.50	-	$1.60	$0.10	6.7%
Total, RESEARCH AND RELATED ACTIVITIES	$4,853.25	$5,183.10	$2,500.00	$5,733.24	$550.14	10.6%
EDUCATION AND HUMAN RESOURCES						
RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS	$212.30	$226.50	-	$229.50	$3.00	1.3%
UNDERGRADUATE EDUCATION	254.00	283.23	85.00	289.91	6.68	2.4%
Curriculum, Laboratory and Instructional Development	*82.68*	*85.41*	-	*86.99*	*1.58*	*1.8%*
Workforce Development	*123.45*	*136.82*	*60.00*	*144.70*	*7.88*	*5.8%*
Math and Science Partnership	*47.87*	*61.00*	*25.00*	*58.22*	*-2.78*	*-4.6%*
GRADUATE EDUCATION	159.59	181.50	15.00	181.44	-0.06	-0.0%
HUMAN RESOURCE DEVELOPMENT	140.37	154.03	-	156.91	2.88	1.9%
Undergraduate/Graduate Student Support	*83.01*	*87.50*	-	*90.10*	*2.60*	*3.0%*
Research & Education Infrastructure	*40.81*	*47.28*	-	*47.28*	-	-
Opportunities for Women and Persons with Disabilities	*16.56*	*19.25*	-	*19.53*	*0.28*	*1.5%*
Total, EHR[7]	$766.26	$845.26	$100.00	$857.76	$12.50	1.5%

[5]FY 2008 Actual includes $5.46 million in funds provided by the U.S. Department of State for an award to the US Civilian Research and Development Foundation that was a carryover from FY 2007 and was obligated in FY 2008.

[6]In FY 2008 NSF transferred $2.24 million to the Office of Science and Technology Policy for costs associated with Science & Technology Policy Institute.

[7]Excludes $121.03 million in obligations in FY 2008, and an estimated $100.0 million in FY 2009 and FY 2010 receipts from H-1B Nonimmigrant Petitioner Fees.

NSF FY 2010 FUNDING BY PROGRAM

(Dollars in Millions)

PROGRAM	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Current Plan Amount	Change Over FY 2009 Current Plan Percent
MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION	$166.85	$152.01	$400.00	$117.29	-$34.72	-22.8%
AGENCY OPERATIONS AND AWARD MANAGEMENT	$282.04	$294.00	-	$318.37	$24.37	8.3%
NATIONAL SCIENCE BOARD	$3.82	$4.03	-	$4.34	$0.31	7.7%
OFFICE OF INSPECTOR GENERAL	$11.83	$12.00	$2.00	$14.00	$2.00	16.7%
NATIONAL SCIENCE FOUNDATION	$6,084.04	$6,490.40	$3,002.00	$7,045.00	$554.60	8.5%

Totals may not add due to rounding.

Revised May 21, 2009

QUANTITATIVE DATA TABLE

NATIONAL SCIENCE FOUNDATION

Research and Development Special Analysis

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan		FY 2009 ARRA	FY 2010 Request
Support of R&D					
Conduct of Research and Development					
Basic Research	$3,715.52	$4,029.73	$2,000.00	~~$2,500.00~~	$4,452.87
Applied Research	419.71	400.47		-	374.61
Subtotal, Conduct of R&D	4,135.23	4,430.20	2,000.00	~~2,500.00~~	4,827.48
R&D Facilities					
Land, Building and Fixed Equipment	20.45	16.57	200.00	-	23.39
Major Equipment	350.67	385.73	700.00	~~400.00~~	439.13
Subtotal, R&D Facilities & Major Equipment	371.12	402.30	900.00	~~400.00~~	462.52
Total, Support of R&D	4,506.35	4,832.50		2,900.00	5,290.00
Non-Investment Activities	721.52	751.25		2.00	795.42
Education and Training	856.18	906.65		100.00	959.58
TOTAL	$6,084.05	$6,490.40		$3,002.00	$7,045.00

Totals may not add due to rounding.
Numbers in red font are revisions made May 21, 2009 for the FY 2009 ARRA Estimates

Revised May 21, 2009

QUANTITATIVE DATA TABLE

RESEARCH AND RELATED ACTIVITIES

Research and Development Special Analysis

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan		FY 2009 ARRA	FY 20010 Request
Support of R&D					
Conduct of Research and Development					
Basic Research	$3,638.81	$3,969.73	$2,000.00	~~$2,500.00~~	$4,391.87
Applied Research	411.82	394.47		-	368.11
Subtotal, Conduct of R&D	4,050.63	4,364.20	2,000.00	~~2,500.00~~	4,759.98
R&D Facilities					
Land, Building and Fixed Equipment	20.45	16.57	200.00	-	23.39
Major Equipment	183.82	233.72	300.00	-	321.84
Subtotal, R&D Facilities & Major Equipment	204.27	250.29	500.00	-	345.23
Total, Support of R&D	4,254.90	4,614.49		2,500.00	5,105.21
Non-Investment Activities	397.13	413.22		-	429.71
Education and Training	201.21	155.39		-	198.32
TOTAL	$4,853.24	$5,183.10		$2,500.00	$5,733.24

Totals may not add due to rounding.

Numbers in red font are revisions made May 21, 2009 for the FY 2009 ARRA Estimates

QUANTITATIVE DATA TABLE

EDUCATION AND HUMAN RESOURCES

Research and Development Special Analysis

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA	FY 2010 Request
Support of R&D				
Conduct of Research and Development				
Basic Research	$76.71	$60.00	-	$61.00
Applied Research	7.89	6.00	-	6.50
Subtotal, Conduct of R&D	84.60	$66.00	-	$67.50
R&D Facilities				
Land, Building and Fixed Equipment	-	-	-	-
Major Equipment	-	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-	-
Total, Support of R&D	84.60	66.00	-	67.50
Non-Investment Activities	26.69	28.00	-	29.00
Education and Training	654.97	751.26	$ 100.00	761.26
TOTAL	$766.26	$845.26	$ 100.00	$857.76

Totals may not add due to rounding.

QUANTITATIVE DATA TABLE

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

Research and Development Special Analysis

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA	FY 2010 Request
Support of R&D				
Conduct of Research and Development				
Basic Research	-	-	-	-
Applied Research	-	-	-	-
Subtotal, Conduct of R&D	-	-	-	-
R&D Facilities				
Land, Building and Fixed Equipment	-	-	-	-
Major Equipment	$166.85	$152.01	$400.00	$117.29
Subtotal, R&D Facilities & Major Equipment	166.85	152.01	400.00	117.29
Total, Support of R&D	166.85	152.01	400.00	117.29
Non-Investment Activities	-	-	-	-
Education and Training	-	-	-	-
TOTAL	$166.85	$152.01	$400.00	$117.29

Totals may not add due to rounding.

QUANTITATIVE DATA TABLE

AGENCY OPERATIONS AND AWARD MANAGEMENT

Research and Development Special Analysis

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA	FY 2010 Request
Support of R&D				
Conduct of Research and Development				
Basic Research	-	-	-	-
Applied Research	-	-	-	-
Subtotal, Conduct of R&D	-	-	-	-
R&D Facilities				
Land, Building and Fixed Equipment	-	-	-	-
Major Equipment	-	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-	-
Total, Support of R&D	-	-	-	-
Non-Investment Activities	$282.04	$294.00	-	$318.37
Education and Training	-	-	-	-
TOTAL	$282.04	$294.00	-	$318.37

Totals may not add due to rounding.

QUANTITATIVE DATA TABLE

OFFICE OF INSPECTOR GENERAL

Research and Development Special Analysis

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA	FY 2010 Request
Support of R&D				
Conduct of Research and Development				
Basic Research	-	-	-	-
Applied Research	-	-	-	-
Subtotal, Conduct of R&D	-	-	-	-
R&D Facilities				
Land, Building and Fixed Equipment	-	-	-	-
Major Equipment	-	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-	-
Total, Support of R&D	-	-	-	-
Non-Investment Activities	$11.83	$12.00	$2.00	$14.00
Education and Training	-	-	-	-
TOTAL	$11.83	$12.00	$2.00	$14.00

Totals may not add due to rounding.

QUANTITATIVE DATA TABLE

NATIONAL SCIENCE BOARD

Research and Development Special Analysis

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA	FY 2010 Request
Support of R&D				
Conduct of Research and Development				
Basic Research	-	-	-	-
Applied Research	-	-	-	-
Subtotal, Conduct of R&D	-	-	-	-
R&D Facilities				
Land, Building and Fixed Equipment	-	-	-	-
Major Equipment	-	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-	-
Total, Support of R&D	-	-	-	-
Non-Investment Activities	$3.83	$4.03	-	$4.34
Education and Training	-	-	-	-
TOTAL	$3.83	$4.03	-	$4.34

Totals may not add due to rounding.

OBJECT CLASSIFICATION
NSF Consolidated Obligations
(Dollars in Millions)

Object Class Code	Standard Title	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request
11.1	Full-time permanent	$129	$143	-	$156
11.3	Other than fulltime permanent	13	12	-	13
11.5	Other personnel compensation	8	7	-	8
11.8	Special personal service payment	2	2	-	2
	Total personnel compensation	152	165	-	179
12.1	Civilian personnel benefits	35	40	-	42
21.0	Travel and transportation of persons	26	29	-	31
23.1	Rental payments to GSA	22	25	-	26
23.3	Communications, utilities, and miscellaneous charges	5	2	-	2
25.1	Advisory and assistance services[1]	88	96	2	105
25.2	Other services	16	15	-	17
25.3	Purchases of goods and services from Government accounts	20	14	-	14
25.4	Operation and maintenance of facilities	382	369	-	369
25.5	Research and development contracts	7	19	30	19
25.7	Operation and maintenance of equipment[1]	38	24	-	21
26.0	Supplies and materials	5	4	-	4
31.0	Equipment[1]	5	7	-	7
41.0	Grants, subsidies, and contributions	5,283	5,749	2,970	6,209
	Total, Direct obligations [2]	$6,084	$6,558	$3,002	$7,045

Totals may not add due to rounding.

[1]In FY 2008 IT contracts in object class 25.1 are reclassified as 25.7.

[2]Excludes obligations for the Donations, H-1B Nonimmigrant Petitioners, and reimbursable accounts.

REIMBURSABLE ACTIVITY

Reimbursements for the Research and Related Activities Appropriation and the Education and Human Resources Appropriation are realized from other federal agencies that have entered into interagency agreements with the Foundation. NSF enters into agreements (including Memoranda of Understanding) with other U.S. government agencies, as authorized by the NSF Act, 42 U.S.C. 1870 (c) and the Economy Act: 31 U.S.C. 1535, under which NSF assumes some responsibility for activities supported by these agencies. These activities can include jointly funded projects and programs, support of research operations and logistics, and access to NSF supported research facilities.

Reimbursements by Agency

(Dollars in Millions)

DEPARTMENT/AGENCY	FY 2008 Actual
DEFENSE	
Air Force	$12.2
Army	$5.3
Other DOD (DARPA, NSA & Intelligence Agency)	$11.7
Subtotal, DOD	$29.2
Interior	$1.0
CIA	$4.0
Commerce (Including NOAA)	$6.3
Education	$1.0
Energy	$7.5
Environmental Protection Agency	$1.7
Executive Office of the President	$2.1
State	$1.0
Agriculture	$1.5
Health & Human Services	$22.6
Homeland Security	$6.7
NASA	$8.7
National Archives	$1.9
Transportation	$1.8
OTHER (less than $500,000)	$0.6
TOTAL REIMBURSEMENTS	**$97.6**

Since the 1980s, the number of interagency agreements NSF handles has increased dramatically. This increase is indicative of the growth in the breadth and complexity of the Foundation's programmatic activity. Consistent with applicable legislation and GAO decisions, agreements include reimbursement for costs that are incurred in the management and administration of these awards.

In FY 2008 the largest portion of NSF's reimbursable activity came from joint activities with the Department of Defense (29.9 percent), the Department of Health and Human Services (23.2 percent), National Aeronautics and Space Administration (8.9 percent), the Department of Energy (7.7 percent) and the Department of Homeland Security (6.9 percent). Reimbursable activities with the Department of Defense were primarily for the management of the National Center for Atmospheric Research (NCAR). Reimbursable activities with the Department of Health and Human Services are for non-medical biological research such as the human frontiers science program and the Macromolecular Structure Database (MSD) program.

NSF Personnel Summary of Permanent Appointments

Statutory Pay Systems	FY 2008 Actual Appointments
ES	76
AD	323
GS/GM-15	86
GS/GM-14	136
GS/GM-13	127
GS-12	91
GS-11	80
GS-10	15
GS-9	76
GS-8	45
GS-7	77
GS-6	12
GS-5	7
GS-4	-
Subtotal, GS/GM	752
Total, Permanent Appointments	1,151
Average Salary	$107,017

All data are for permanent appointments.

EXPLANATION OF CARRYOVER FOR FY 2009 BY ACCOUNT

The National Science Foundation carried over a total unobligated balance of $118.02 million from prior year appropriations ($67.19 million in discretionary funds and $50.83 million in mandatory funds). The use for carryover funds is described below.

- Within the **Research and Related Activities (R&RA)** appropriation, $556,677 was carried forward into FY 2009. This amount is from several awards/contracts from various programs that were not ready for obligation in FY 2008.

- Within the **Education and Human Resources (EHR)** appropriation, a total of $2,764 was carried forward into FY 2009.

- Within the **Major Research Equipment and Facilities Construction (MREFC)** appropriation, a total of $66.43 million was carried forward into FY 2009 and will be applied to ongoing projects.

  South Pole Station Modernization carried forward a total of $2.26 million into FY 2009. The carryover will be applied toward the logistics and warehousing facility at South Pole, completion of exterior activities for the elevated station, and demolition of the existing station and other construction as the project approaches its scheduled completion in 2010.

  A total of $3.0 million was carried forward into FY 2009 for the National Ecological Observatory Network (NEON) in anticipation of two upcoming reviews for NEON.

  A total of $5.91 million was carried forward into FY 2009 for the Ocean Observatories Initiative (OOI). These funds are expected to be obligated in summer 2009, upon the initiation of the cooperative agreement for the project.

  A total of $7.90 million was carried forward into FY 2009 for the IceCube Neutrino Observatory (IceCube). The carryover will be applied toward data warehousing, systems upgrade, labor and materials, logistics support, and remaining construction costs.

  A total of $47.36 million was carried forward into FY 2009 for the Alaska Region Research Vessel (ARRV). The carryover will be applied to planning, shipyard contract award, design verification, and ordering long lead equipment items.

- Within the **Office of Inspector General (OIG)** appropriation, a total of $253,612 was carried forward into FY 2009. Funds will be used to procure an electronic work-paper system, audit contracts, and fund personnel compensation costs.

- Within the **H-1B Nonimmigrant Petitioner** account (Mandatory), $50.83 million was carried forward into FY 2009.

  The H-1B funding at NSF support two primary programs, the ITEST program, and the S-STEM program. In FY 2008, NSF obligated $121.03 million in these two programs.

  NSF's carryover into FY 2009 for H-1B funded programs is $50.83 million, $9.79 million in ITEST, $21.08 million in S-STEM, and $19.96 million in 4th Qtr. receipts (see below).

Distribution of FY 2008 Carryover into FY 2009
(Dollars in Millions)

	FY 2008 Carryover from FY 2007	*Rescission*	Adjusted FY 2007 Carryover	FY 2009 Carryover from FY 2008
Research and Related Activities	$22.63	*-$17.17*	$5.46	$0.56
Education and Human Resources	0.10	*-0.10*	-	-
Major Research Equipment and Facilities Construction	27.60	*-15.27*	12.33	66.38
Office of Inspector General	0.71	*-0.46*	0.25	0.25
Subtotal (Discretionary)	**51.04**	***-33.00***	**18.04**	**67.19**
H-1B Nonimmigrant Petitioner (Mandatory)	63.37	-	63.37	50.83
Total	**$114.41**	***-$33.00***	**$81.41**	**$118.02**

Totals may not add due to rounding.

FULL BUDGETARY COSTING

The tables below show two methods for allocating the full budgetary cost of the NSF FY 2010 Budget Request. The first shows the full budgetary costs allocated to each of NSF's operating directorates. The second shows these costs allocated to three of NSF's strategic outcome goals: Discovery, Learning, and Research Infrastructure. Stewardship, NSF's fourth strategic goal encompasses the indirect costs to be allocated under full budgetary costing. These allocations represent part of the process, using readily available information, by which NSF achieved the integration of budget, cost, and performance.

What is Full Budgetary Cost? OMB Circular A-11 defines "full-cost" as the sum of all budget resources used by an agency to achieve program outputs and outcomes. These include both *direct* program costs and *indirect* costs, which generally include administrative costs and other activities that are not directly attributable to a single program or activity. For two of NSF's appropriations, Research and Related Activities (R&RA) and Education and Human Resources (EHR), all funds are directly attributable to directorates and outcome goals. For NSF's other appropriations, Major Research Equipment and Facilities Construction (MREFC), Agency Operations and Award Management (AOAM), the National Science Board (NSB), and the Office of Inspector General (OIG) funds are distributed using the methodologies described below.

Allocation by Directorate

The current budget structure contains program activities within R&RA and EHR that equate to directorates. Therefore, R&RA and EHR funding is already aligned by directorate. MREFC funds projects that are managed by a particular NSF directorate. Therefore, each MREFC project can be directly associated with a particular directorate. In addition, each managing directorate is responsible for the initial planning, design, and follow-on operations and maintenance costs that are funded through R&RA. The MREFC program funds are assigned to the managing directorate responsible for oversight of a particular project. (Table 1)

All budget items funded through the AOAM, NSB, and OIG appropriations accounts are defined as Stewardship and are allocated to directorates. More than half of the AOAM account can be precisely associated with an individual directorate. These direct AOAM budget items consist of distributed funding for travel, training, equipment, supplies, incentive awards, and premium pay. Also, space rental and personnel compensation and benefits (PC&B) of employees in a particular directorate are attributed to that directorate in the financial accounting system.

Once direct AOAM budget items that are associated with a particular directorate have been assigned, then budget items associated with the Office of Information and Resource Management (IRM), Office of Budget, Finance and Award Management (BFA), the staff offices in the Office of the Director (OD), the NSB, and OIG are allocated. These indirect AOAM budget items are allocated to a particular directorate based on its proportion of the total FY 2010 Request. The FY 2010 NSB and OIG budgetary costs are assigned using the same methodology as the Indirect AOAM costs total. (Table 1)

Allocations by Strategic Outcome Goal

The full budgetary costing by Discovery, Learning, and Research Infrastructure was derived by using the same methodology as stated above, except the Direct AOAM budget items, Indirect AOAM budget items, and total NSB, and OIG funding were assigned using the strategic goal percentages for each directorate. (Table 2)

FY 2010 FULL BUDGETARY COSTING

Table 1: Allocation of Major Research Equipment and Facilities Construction (MREFC),
Agency Operations and Award Management (AOAM), National Science Board (NSB), and the Office of Inspector General (OIG)
(Dollars in Thousands)

FY 2010 Congressional Request	**BIO**	**CISE**	**ENG**	**GEO**	**MPS**	**SBE**	**OCI**	**OISE**	**OPP**	**IA**	**SUBTOTAL**	**EHR**	**TOTAL**
R&RA & EHR	**$733,000**	**$633,000**	**$764,520**	**$909,000**	**$1,380,000**	**$257,000**	**$219,000**	**$49,000**	**$517,600**	**$271,120**	**$5,733,240**	**$857,760**	**$6,591,000**
MREFC													
AdvLIGO					46,300						**$46,300**		**$46,300**
ALMA Construction					42,760						**$42,760**		**$42,760**
ARRV											-		-
ATST					10,000						**$10,000**		**$10,000**
EarthScope											-		-
HIAPER											-		-
IceCube Neutrino Observatory					950						**$950**		**$950**
NEES											-		-
NEON											-		-
OPP DOJ Judgment LC-130s									3,000		**$3,000**		**$3,000**
OOI				14,280							**$14,280**		**$14,280**
RSVP											-		-
Scientific Ocean Drilling											-		-
South Pole Station Modernization											-		-
Terascale Computing Systems											-		-
MREFC Subtotals	**-**	**-**	**-**	**$14,280**	**$100,010**	**-**	**-**	**-**	**$3,000**	**-**	**$117,290**	**-**	**$117,290**
Total FY 2010 Submission by Activity including MREFC	**$733,000**	**$633,000**	**$764,520**	**$923,280**	**$1,480,010**	**$257,000**	**$219,000**	**$49,000**	**$520,600**	**$271,120**	**$5,850,530**	**$857,760**	**$6,708,290**
STEWARDSHIP													
Direct AOAM													
Space Rental	3,400	1,991	3,370	2,972	3,830	3,186	276	1,103	1,287		$21,415	$3,585	$25,000
PC&B	26,061	15,260	25,826	22,774	29,347	24,417	2,113	8,452	9,861		$164,111	$27,469	$191,580
Distributed AOAM	1,928	1,129	1,910	1,684	2,171	1,806	156	625	729		$12,138	$2,032	$14,170
Direct AOAM Subtotals	**$31,389**	**$18,380**	**$31,106**	**$27,430**	**$35,348**	**$29,409**	**$2,545**	**$10,180**	**$11,877**		**$197,664**	**$33,086**	**$230,750**
Indirect AOAM Cost Allocation	11,919	6,980	11,812	10,416	13,421	11,167	966	3,866	4,510		$75,057	$12,563	$87,620
Direct & Indirect AOAM Subtotals	**$43,308**	**$25,360**	**$42,918**	**$37,846**	**$48,769**	**$40,576**	**$3,511**	**$14,046**	**$16,387**		**$272,721**	**$45,649**	**$318,370**
NSB Allocation	**$590**	**$346**	**$585**	**$516**	**$665**	**$553**	**$48**	**$191**	**$223**		**$3,717**	**$622**	**$4,340**
OIG Allocation	**$1,905**	**$1,115**	**$1,887**	**$1,664**	**$2,145**	**$1,784**	**$154**	**$618**	**$721**		**$11,993**	**$2,007**	**$14,000**
NSF TOTAL	**$778,803**	**$659,821**	**$809,910**	**$963,306**	**$1,531,589**	**$299,913**	**$222,713**	**$63,855**	**$537,931**	**$271,120**	**$6,138,961**	**$906,038**	**$7,045,000**

FY 2010 FULL BUDGETARY COSTING

Table 2: Allocation by Discovery, Learning, and Research Infrastructure
(Dollars in Thousands)

Total Directorate FY 2010	**BIO**	**CISE**	**ENG**	**GEO**	**MPS**	**SBE**	**OCI**	**OISE**	**OPP**	**IA**	**R&RA**	**EHR**	**TOTAL**
Discovery	590,258	585,863	706,790	518,398	1,007,153	233,868	46,611	47,837	126,576	160,177	4,023,531	192,273	**4,215,805**
Learning	54,998	41,367	67,685	44,843	71,301	14,106	13,590	15,882	7,601	7,583	338,956	696,590	**1,035,546**
Research Infrastructure	133,547	32,591	35,435	400,065	453,135	51,939	162,512	**136**	403,754	103,360	1,776,474	17,175	**1,793,649**
FULL BUDGETARY COST	**$778,803**	**$659,821**	**$809,910**	**$963,306**	**$1,531,589**	**$299,913**	**$222,713**	**$63,855**	**$537,931**	**$271,120**	**$6,138,961**	**$906,038**	**$7,045,000**

Totals may not add due to rounding.

National Science Foundation
Summary Tables
FY 2009 Total Appropriations

(Dollars in Millions)

NSF by Account	**FY 2008 Actual**	**FY 2009 Current Plan**	**FY 2009 ARRA Estimate**	**FY 2009 Total Appropriations**
BIO	$615.62	$655.81	$260.00	$915.81
CISE	535.26	573.74	235.00	808.74
ENG *(less SBIR/STTR)*	540.42	574.13	215.00	789.13
SBIR/STTR	109.07	119.21	50.00	169.21
GEO	757.87	807.13	347.00	1,154.13
MPS	1,171.13	1,255.96	490.00	1,745.96
SBE	227.87	240.30	85.00	325.30
OCI	185.15	199.28	80.00	279.28
OISE	47.77	44.03	14.00	58.03
OPP	447.13	470.67	174.00	644.67
IA	214.48	241.34	550.00	791.34
U.S. Arctic Research Commission	1.47	1.50	-	1.50
Research & Related Activities	**$4,853.25**	**$5,183.10**	**$2,500.00**	**$7,683.10**
Education & Human Resources	**$766.26**	**$845.26**	**$100.00**	**$945.26**
Major Research Equipment & Facilities Construction	**$166.85**	**$152.01**	**$400.00**	**$552.01**
Agency Operations & Award Management	**$282.04**	**$294.00**	-	**$294.00**
National Science Board	**$3.82**	**$4.03**	-	**$4.03**
Office of Inspector General	**$11.83**	**$12.00**	**$2.00**	**$14.00**
Total, NSF	**$6,084.04**	**$6,490.40**	**$3,002.00**	**$9,492.40**

* Totals may not add due to rounding.

(Dollars in Millions)

NSF by Strategic Goal	**FY 2008 Actual**	**FY 2009 Current Plan**	**FY 2009 ARRA Estimate**	**FY 2009 Total Appropriations**
Discovery	$3,290.24	$3,509.02	$1,597.32	$5,106.34
Learning	848.74	896.71	261.78	1,158.49
Research Infrastructure	1,583.76	1,673.27	1,140.90	2,814.17
Stewardship	361.31	411.40	2.00	413.40
Total, NSF	**$6,084.04**	**$6,490.40**	**$3,002.00**	**$9,492.40**

* Totals may not add due to rounding.

National Science Foundation
By Account and Strategic Outcome Goal
FY 2009 American Recovery and Reinvestment Act Appropriations

(Dollars in Millions)

NSF Accounts	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate: Discovery	Learning	Research Infrastructure	Stewardship	FY 2009 ARRA Estimate
FY 2008 Total Actual	**$6,084.04**		**$3,290.24**	**$848.74**	**$1,583.76**	**$361.31**	
FY 2009 Current Plan		**$6,490.40**	**$3,509.02**	**$896.71**	**$1,673.27**	**$411.40**	**$3,002.00**
BIO	$615.62	$655.81	241.64	18.36	-	-	$260.00
CISE	535.26	573.74	182.18	20.82	32.00	-	235.00
ENG *(less SBIR/STTR)*	540.42	574.13	180.68	24.32	10.00	-	215.00
SBIR/STTR	109.07	119.21	50.00	-	-	-	50.00
GEO	757.87	807.13	236.61	37.54	72.85	-	347.00
MPS	1,171.13	1,255.96	363.41	40.04	86.55	-	490.00
SBE	227.87	240.30	78.30	6.70	-	-	85.00
OCI	185.15	199.28	60.50	2.50	17.00	-	80.00
OISE	47.77	44.03	2.50	11.50	-	-	14.00
OPP	447.13	470.67	151.50	-	22.50	-	174.00
IA	214.48	241.34	50.00	-	500.00	-	550.00
U.S. Arctic Research Commission	1.47	1.50	-	-	-	-	-
Research & Related Activities	**$4,853.25**	**$5,183.10**	**$1,597.32**	**$161.78**	**$740.90**	-	**$2,500.00**
Education & Human Resources	**$766.26**	**$845.26**	-	**$100.00**	-	-	**$100.00**
Major Research Equipment & Facilities Construction	**$166.85**	**$152.01**	-	-	**$400.00**	-	**$400.00**
Agency Operations & Award Management	**$282.04**	**$294.00**	-	-	-	-	-
National Science Board	**$3.82**	**$4.03**	-	-	-	-	-
Office of Inspector General	**$11.83**	**$12.00**	-	-	-	**$2.00**	**$2.00**
Total, National Science Foundation	**$6,084.04**	**$6,490.40**	**$1,597.32**	**$261.78**	**$1,140.90**	**$2.00**	**$3,002.00**

Totals may not add due to rounding.

National Science Foundation
By Account and Strategic Outcome Goal
FY 2009 Total Appropriations

(Dollars in Millions)

NSF Accounts	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2009 Total Appropriations: Discovery	Learning	Research Infrastructure	Stewardship	FY 2009 Total Appropriations	Change over FY 2008 Actual: Amount	Change over FY 2008 Actual: Percent	Change over FY 2009 Current Plan: Amount	Change over FY 2009 Current Plan: Percent
FY 2008 Total Actual	**$6,084.04**			**$3,290.24**	**$848.74**	**$1,583.76**	**$361.31**					
FY 2009 Current Plan		**$6,490.40**	**$3,002.00**	**$3,509.02**	**$896.71**	**$1,673.27**	**$411.40**					
BIO	$615.62	$655.81	$260.00	$729.37	$57.72	$117.30	$11.42	$915.81	$300.19	48.8%	$260.00	39.6%
CISE	535.26	573.74	235.00	679.26	58.30	58.60	12.58	808.74	273.48	51.1%	235.00	41.0%
ENG *(less SBIR/STTR)*	540.42	574.13	215.00	649.16	84.24	42.65	13.08	789.13	248.71	46.0%	215.00	37.4%
SBIR/STTR	109.07	119.21	50.00	169.21	-	-	-	169.21	60.14	55.1%	50.00	41.9%
GEO	757.87	807.13	347.00	630.20	68.65	440.53	14.75	1,154.13	396.26	52.3%	347.00	43.0%
MPS	1,171.13	1,255.96	490.00	1,236.88	100.91	389.10	19.07	1,745.96	574.83	49.1%	490.00	39.0%
SBE	227.87	240.30	85.00	253.80	18.53	47.49	5.48	325.30	97.43	42.8%	85.00	35.4%
OCI	185.15	199.28	80.00	94.48	7.15	174.00	3.65	279.28	94.13	50.8%	80.00	40.1%
OISE	47.77	44.03	14.00	39.73	16.30	0.10	1.90	58.03	10.26	21.5%	14.00	31.8%
OPP	447.13	470.67	174.00	261.29	5.58	373.12	4.68	644.67	197.54	44.2%	174.00	37.0%
IA	214.48	241.34	550.00	183.39	4.00	603.04	0.91	791.34	576.86	269.0%	550.00	227.9%
U.S. Arctic Research Commission	1.47	1.50	-	1.50	-	-	-	1.50	0.03	2.0%	-	-
Research & Related Activities	**$4,853.25**	**$5,183.10**	**$2,500.00**	**$4,928.27**	**$421.38**	**$2,245.93**	**$87.52**	**$7,683.10**	**$2,829.85**	**58.3%**	**$2,500.00**	**48.2%**
Education & Human Resources	**$766.26**	**$845.26**	**$100.00**	**$178.07**	**$737.11**	**$16.23**	**$13.85**	**$945.26**	**$179.00**	**23.4%**	**$100.00**	**11.8%**
Major Research Equipment & Facilities Construction	**$166.85**	**$152.01**	**$400.00**	-	-	**$552.01**	-	**$552.01**	**$385.16**	**230.9%**	**$400.00**	**263.1%**
Agency Operations & Award Management	**$282.04**	**$294.00**	-	-	-	-	**$294.00**	**$294.00**	**$11.96**	**4.2%**	-	-
National Science Board	**$3.82**	**$4.03**	-	-	-	-	**$4.03**	**$4.03**	**$0.21**	**5.4%**	-	-
Office of Inspector General	**$11.83**	**$12.00**	**$2.00**	-	-	-	**$14.00**	**$14.00**	**$2.17**	**18.4%**	**$2.00**	**16.7%**
Total, National Science Foundation	**$6,084.04**	**$6,490.40**	**$3,002.00**	**$5,106.34**	**$1,158.49**	**$2,814.17**	**$413.40**	**$9,492.40**	**$3,408.36**	**56.0%**	**$3,002.00**	**46.3%**
H-1B Visa Nonimmigrant Petitioner Fees	*$121.12*	*$100.00*						*$100.00*				
Reimbursables	*$102.30*											
Trust Fund	*$49.48*											
Total NSF, Including H-1B Visa, Reimbursables & Trust Fund	*$6,356.94*	*$6,590.40*	*$3,002.00*	*$5,106.34*	*$1,158.49*	*$2,814.17*	*$413.40*	*$9,592.40*	*$3,235.46*	*50.9%*	*$3,002.00*	*45.6%*
Percent Increase over Prior Year, excluding H-1B Visa				**45.5%**	**29.2%**	**68.2%**	**0.5%**					

Totals may not add due to rounding.

NSTC Crosscuts Summary
FY 2009 Total Appropriations

(Dollars in Millions)

	Climate Change Technology Program				Climate Change Science Programs Includes U.S. Global Change Research Program Climate Change Research Initiative				Networking and Information Technology Research and Development				National Nanotechnology Initiative			
	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2009 Total Approps	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2009 Total Approps	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2009 Total Approps	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2009 Total Approps
BIO	-	-	-	-	$15.10	$15.10	$20.00	$35.10	$83.50	$86.15	-	$86.15	$58.73	$56.60	-	$56.60
CISE	-	-	-	-	-	-	-	-	535.26	573.74	$235.00	808.74	14.51	11.00	-	11.00
ENG	$21.50	$23.50	$2.00	$25.50	1.00	1.00	-	1.00	19.20	20.70	-	20.70	144.45	140.02	$35.00	175.02
GEO	-	-	-	-	157.72	163.00	25.00	188.00	15.56	18.98	-	18.98	10.29	6.33	-	6.33
MPS	-	-	-	-	6.90	6.69	2.67	9.36	76.03	78.93	21.90	100.83	173.73	178.06	72.81	250.87
SBE	-	-	-	-	15.48	15.48	3.00	18.48	22.84	17.00	3.00	20.00	2.25	1.67	-	1.67
OCI	-	-	-	-	-	-	-	-	185.15	199.28	80.00	279.28	-	-	-	-
OISE	-	-	-	-	-	-	-	-	-	-	-	-	0.50	-	-	-
OPP	-	-	-	-	10.50	18.30	44.79	63.09	-	-	-	-	-	-	-	-
IA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R&RA	**$21.50**	**$23.50**	**$2.00**	**$25.50**	**$206.70**	**$219.57**	**$95.46**	**$315.03**	**$937.54**	**$994.78**	**$339.90**	**$1,334.68**	**$404.46**	**$393.68**	**$107.81**	**$501.49**
EHR	-	-	-	-	-	-	-	-	**$9.00**	**$9.50**	-	**$9.50**	**$4.10**	**$3.50**	-	**$3.50**
NSF Total	**$21.50**	**$23.50**	**$2.00**	**$25.50**	**$206.70**	**$219.57**	**$95.46**	**$315.03**	**$946.54**	**$1,004.28**	**$339.90**	**$1,344.18**	**$408.56**	**$397.18**	**$107.81**	**$504.99**

National Science Foundation
Selected Cross-Cutting Programs
FY 2009 Total Appropriations

(Dollars in Millions)

Selected Cross-Cutting Programs		FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2009 Total Appropriations
ADVANCE	Research & Related Activities	19.56	19.54	1.00	20.54
	Education & Human Resources	0.49	1.25	-	1.25
	Total, NSF	**$20.06**	**$20.79**	**$1.00**	**$21.79**
Climate Change Education Program	Research & Related Activities	-	-	-	-
	Education & Human Resources	-	10.00	-	10.00
	Total, NSF	-	**$10.00**	-	**$10.00**
Faculty Early Career Development - CAREER	Research & Related Activities	203.17	182.63	165.00	347.63
	Education & Human Resources	-	-	-	-
	Total, NSF	**$203.17**	**$182.63**	**$165.00**	**$347.63**
Graduate Research Fellowships - GRF	Research & Related Activities	8.13	8.06	45.56	53.62
	Education & Human Resources	87.89	107.00	-	107.00
	Total, NSF	**$96.02**	**$115.06**	**$45.56**	**$160.62**
Graduate Teaching Fellowships in K-12 Education - GK-12	Research & Related Activities	8.20	7.86	2.60	10.46
	Education & Human Resources	46.40	49.50	-	49.50
	Total, NSF	**$54.60**	**$57.36**	**$2.60**	**$59.96**
Integrative Graduate Education and Research Training - IGERT	Research & Related Activities	39.47	38.20	14.02	52.22
	Education & Human Resources	25.29	25.00	-	25.00
	Total, NSF	**$64.76**	**$63.20**	**$14.02**	**$77.22**
Total, Graduate Fellowships & Traineeships	Research & Related Activities	$55.80	$54.12	$62.18	$116.30
	Education & Human Resources	$159.59	$181.50	-	$181.50
	Total, NSF	**$215.39**	**$235.62**	**$62.18**	**$297.80**
Long-Term Research Sites - LTER	Research & Related Activities	25.34	25.09	-	25.09
	Education & Human Resources	-	-	-	-
	Total, NSF	**$25.34**	**$25.09**	-	**$25.09**
Research Experience for Teachers - RET	Research & Related Activities	5.59	5.57	1.50	7.07
	Education & Human Resources	-	-	-	-
	Total, NSF	**$5.59**	**$5.57**	**$1.50**	**$7.07**
Research Experience for Undergraduates - REU	Research & Related Activities	62.67	63.76	18.72	82.48
	Education & Human Resources	-	-	-	-
	Total, NSF	**$62.67**	**$63.76**	**$18.72**	**$82.48**
Research Experience for Undergraduates - REU - Sites Only	Research & Related Activities	47.19	47.12	18.72	65.84
	Education & Human Resources	-	-	-	-
	Total, NSF	**$47.19**	**$47.12**	**$18.72**	**$65.84**
Research Experience for Undergraduates - REU - Supplements Only	Research & Related Activities	15.49	16.64	-	16.64
	Education & Human Resources	-	-	-	-
	Total, NSF	**$15.49**	**$16.64**	-	**$16.64**
Research in Undergraduate Institutions - RUI	Research & Related Activities	32.91	32.86	2.92	35.78
	Education & Human Resources	-	-	-	-
	Total, NSF	**$32.91**	**$32.86**	**$2.92**	**$35.78**
Science and Technology Centers - STCs	Research & Related Activities	64.73	61.61	-	61.61
	Education & Human Resources	-	-	-	-
	Total, NSF	**$64.73**	**$61.61**	-	**$61.61**

Totals may not add due to rounding.

National Science Foundation
Learning Funding by Level of Education
FY 2009 Total Appropriations

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2009 Total Appropriations	FY 2009 Total Approps change over: FY 2008 Actual		FY 2009 Total Approps change over: FY 2009 Plan	
					Amount	Percent	Amount	Percent
K-12 Programs	$47.47	$60.13	$25.00	$85.13	$37.66	79.3%	$25.00	41.6%
Undergraduate Programs	348.27	369.74	94.47	464.21	115.94	33.3%	94.47	25.6%
Graduate & Professional Programs	302.04	315.83	107.42	423.25	121.21	40.1%	107.42	34.0%
Multi-level and Other Programs	150.96	151.01	34.89	185.90	34.94	23.1%	34.89	23.1%
TOTAL, NSF	**$848.74**	**$896.71**	**$261.78**	**$1,158.49**	**$309.75**	**36.5%**	**$261.78**	**29.2%**

National Science Foundation
Research Infrastructure Summary
FY 2009 Total Appropriations

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2009 Total Appropriations	FY 2009 Total Approps change over: FY 2008 Actual Amount	FY 2008 Actual Percent	FY 2009 Plan Amount	FY 2009 Plan Percent
Academic Research Fleet	$75.28	$98.68	$18.00	$116.68	$41.40	55.0%	$18.00	18.2%
Regional Class Research Vessels	-	*0.10*	-	*0.10*	0.10	*N/A*	-	-
RHOV Construction (R/V Alvin Replacement)	-	-	*3.00*	*3.00*	*3.00*	*N/A*	*3.00*	*N/A*
R/V Langseth Construction (R/V Ewing Replacement)	*1.60*	-	-	-	*-1.60*	*-100.0%*	-	*N/A*
Ship Operations and Upgrades	*73.68*	*98.58*	*15.00*	*113.58*	*39.90*	*54.2%*	*15.00*	*15.2%*
Academic Research Infrastructure	-	-	200.00	200.00	200.00	N/A	200.00	N/A
Cornell Electron Storage Ring	14.11	10.50	7.80	18.30	4.19	29.7%	7.80	74.3%
Cornell High Energy Synchrotron Source (CHESS)	5.60	2.51	7.20	9.71	4.11	73.4%	7.20	286.9%
EarthScope: USArray, SAFOD, PBO[1]	19.21	24.31	4.00	28.31	9.10	47.4%	4.00	16.5%
Gemini Observatory	18.69	18.71	-	18.71	0.02	0.1%	-	-
Incorporated Research Institutions for Seismology	11.75	12.00	2.33	14.33	2.58	22.0%	2.33	19.4%
Integrated Ocean Drilling Program[2]	37.41	43.41	25.00	68.41	31.00	82.9%	25.00	57.6%
Large Hadron Collider	18.00	18.00	-	18.00	-	-	-	-
Laser Interferometer Gravitational Wave Observatory	29.50	30.30	-	30.30	0.80	2.7%	-	-
Major Research Equipment & Facilities Construction[3]	192.91	184.78	403.10	587.88	394.97	204.7%	403.10	218.2%
Major Research Instrumentation	93.87	100.00	300.00	400.00	306.13	326.1%	300.00	300.0%
National Astronomy & Ionosphere Center	12.75	11.60	3.10	14.70	1.95	15.3%	3.10	26.7%
National Center for Atmospheric Research	89.07	106.92	13.20	120.12	31.05	34.9%	13.20	12.3%
National High Magnetic Field Laboratory	27.75	26.50	20.00	46.50	18.75	67.6%	20.00	75.5%
National Nanotechnology Infrastructure Network (NNIN)	14.13	16.26	10.00	26.26	12.13	85.9%	10.00	61.5%
National Optical Astronomy Observatories	28.60	29.58	5.60	35.18	6.58	23.0%	5.60	18.9%
National Radio Astronomy Observatories[4]	52.74	60.79	5.40	66.19	13.45	25.5%	5.40	8.9%
National Stem Education Distributed Learning	15.92	16.50	-	16.50	0.58	3.6%	-	-
National Solar Observatory	8.21	8.23	1.40	9.63	1.42	17.2%	1.40	17.0%
National Superconducting Cyclotron Laboratory	19.25	20.50	2.00	22.50	3.25	16.9%	2.00	9.8%
Network for Earthquake Engineering Simulation	19.38	21.82	-	21.82	2.44	12.6%	-	-
Polar Environment, Health & Safety	5.91	6.29	-	6.29	0.38	6.4%	-	-
Polar Facilities and Logistics[5]	328.94	342.18	22.50	364.68	35.74	10.9%	22.50	6.6%
Research Resources[6]	257.02	258.68	68.27	326.95	69.93	27.2%	68.27	26.4%
Science and Technology Policy Institute	-	3.04	-	3.04	3.04	N/A	-	-
Science Resources Statistics	28.30	38.15	-	38.15	9.85	34.8%	-	-
Networking & Computational Resources Infrastructure & Services[7]	151.25	157.00	17.00	174.00	22.75	15.0%	17.00	10.8%
Other Facilities[8]	8.45	6.30	5.00	11.30	2.85	33.7%	5.00	79.4%
Subtotal, Research Infrastructure Support	**$1,584.01**	**$1,673.54**	**$1,140.90**	**$2,814.44**	**$1,230.43**	**77.7%**	**$1,140.90**	**68.2%**
Research Infrastructure Stewardship Offset	**-$0.25**	**-$0.27**	-	**-$0.27**	**-$0.02**	**6.0%**	-	-
RESEARCH INFRASTRUCTURE TOTAL	**$1,583.76**	**$1,673.27**	**$1,140.90**	**$2,814.17**	**$1,230.41**	**77.7%**	**$1,140.90**	**68.2%**

Totals may not add due to rounding.

[1] EarthScope funding includes support provided through the R&RA account for operations and maintenance of the facility. Support provided through the MREFC account for the construction of the project, totaling $4.21 million in FY 2008, is included in the MREFC projects line.

[2] Funding for the Integrated Ocean Drilling Program (IODP) includes support for the continued phase-out of program and contract activities for the Ocean Drilling Program (ODP), predecessor to the IODP. This line also includes support for the operations and maintenance of the Scientific Ocean Drilling Vessel (SODV). Final MREFC support for the SODV, totaling $24,000 in FY 2008, is included on the MREFC projects line.

[3] Funding levels for MREFC projects in this table include support for concept and development associated with these projects provided through the R&RA account, specifically for NEON, OOI, and ATST, initial support fc operations and maintenance provided through the R&RA account, and implementation support provided through the MREFC account. Final support for EarthScope, SODV and SPSM is also included in this line.

[4] Funding for the National Radio Astronomy Observatory (NRAO) includes operation and maintenance support for the Atacama Large Millimeter Array (ALMA). Construction funding for ALMA is included int the MREFC projects line above.

[5] Polar Facilities and Logistics includes support for the operations and maintenance of the South Pole Station Modernization (SPSM) project. Funds provided through the MREFC account for SPSM, totaling $7.57 million in FY 2008, are included in the MREFC projects line.

[6] Funding for Research Resources includes support for the operation and maintenance of minor facilities, infrastructure and instrumentation, field stations, museum collections, etc.

[7] Networking & Computational Resources Infrastructure & Services is the new name for Shared Cyberinfrastructure Tools. Several programs formerly included in Shared Cyberinfrastructure Tools have been reclassified as Disciplinary and Interdisciplinary Research.

[8] Other Facilities includes support for other physics and materials research facilities.

NATIONAL SCIENCE FOUNDATION
EDUCATION AND HUMAN RESOURCES BY PROGRAM
FY 2009 TOTAL APPROPRIATIONS

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2009 Total Appropriations	FY 2009 Total change over FY 2008 Actual	
					Amount	Percent
Undergraduate Education	**$254.00**	**$283.23**	**$85.00**	**$368.23**	**$114.23**	**45.0%**
Curriculum, Laboratory and Instructional Development	*82.68*	*85.41*	*-*	*85.41*	*2.73*	*3.3%*
Course, Curriculum and Laboratory Improvement (CCLI)	37.28	39.21	-	39.21	1.93	5.2%
National STEM Education Distributed Learning (NSDL)	15.92	16.50	-	16.50	0.58	3.6%
STEM Talent Expansion Program (STEP)	29.48	29.70	-	29.70	0.22	0.8%
Workforce Development	*123.45*	*136.82*	*60.00*	*196.82*	*73.37*	*59.4%*
Excellence Awards in Science and Engineering (EASE)	5.57	5.20	-	5.20	-0.37	-6.7%
Robert Noyce Scholarship Program (NOYCE)	55.05	55.00	60.00	115.00	59.95	108.9%
Federal Cyber Service: Scholarship for Service/Cybercorps (SFS)	11.37	15.00	-	15.00	3.63	31.9%
Advanced Technological Education (ATE)	51.46	51.62	-	51.62	0.16	0.3%
Climate Change Education Program (CCE)	-	10.00	-	10.00	10.00	N/A
Math and Science Partnership (MSP)	*47.87*	*61.00*	*25.00*	*86.00*	*38.13*	*79.7%*
Graduate Education	**$159.59**	**$181.50**	**$15.00**	**$196.50**	**$36.91**	**23.1%**
Graduate Research Fellowships (GRF)	87.89	107.00	-	107.00	19.11	21.7%
Graduate STEM Fellows in K-12 Education (GK-12)	46.40	49.50	-	49.50	3.10	6.7%
Integrative Graduate Education and Research Traineeship Program (IGERT)	25.29	25.00	-	25.00	-0.29	-1.2%
Science Masters Program	-	-	15.00	15.00	15.00	N/A
Human Resource Development	**$140.37**	**$154.03**	**-**	**$154.03**	**$13.66**	**9.7%**
Undergraduate/Graduate Student Support	*83.01*	*87.50*	*-*	*87.50*	*4.49*	*5.4%*
Historically Black Colleges and Universities Undergraduate Program (HBCU-UP)	29.74	31.50	-	31.50	1.76	5.9%
Louis Stokes Alliances for Minority Participation (LSAMP)	40.47	42.50	-	42.50	2.03	5.0%
Tribal Colleges and Universities Program (TCUP)	12.80	13.50	-	13.50	0.70	5.5%
Research and Education Infrastructure	*40.81*	*47.28*	*-*	*47.28*	*6.47*	*15.9%*
Alliances for Graduate Education and the Professoriate (AGEP)	15.85	16.75	-	16.75	0.90	5.7%
Centers for Research Excellence in Science and Technology (CREST)	24.95	30.53	-	30.53	5.58	22.3%
Opportunities for Women and Persons with Disabilities	*16.56*	*19.25*	*-*	*19.25*	*2.69*	*16.3%*
ADVANCE	0.49	1.25	-	1.25	*0.76*	*152.6%*
Research in Disabilities Education (RDE)	5.93	6.50	-	6.50	0.57	9.6%
Research on Gender in Science and Engineering (GSE)	10.13	11.50	-	11.50	1.37	13.5%
Research on Learning in Formal and Informal Settings	**$212.30**	**$226.50**	**-**	**$226.50**	**$14.20**	**6.7%**
Discovery Research K-12 (DR-K12)	99.25	108.50	-	108.50	9.25	9.3%
Informal Science Education (ISE)	64.45	66.00	-	66.00	1.55	2.4%
Project and Program Evaluation	6.94	10.00	-	10.00	3.06	44.1%
Research and Evaluation on Education in Science and Engineering (REESE)	41.66	42.00	-	42.00	0.34	0.8%
TOTAL, EDUCATION & HUMAN RESOURCES	**$766.26**	**$845.26**	**$100.00**	**$945.26**	**$179.00**	**23.4%**

Totals may not add due to rounding.

NATIONAL SCIENCE FOUNDATION
FY 2009 TOTAL APPROPRIATIONS BY ACTIVITY AND SUBACTIVITY
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2009 Total Appropriations	FY 2009 Total Appropriations change over: FY 2008 Actual		FY 2009 Plan	
					Amount	Percent	Amount	Percent
Molecular & Cellular Biosciences	$112.28	$121.26	$60.00	$181.26	$68.98	61.4%	$60.00	49.5%
Integrative Organismal Systems	200.04	211.62	60.00	271.62	71.58	35.8%	60.00	28.4%
Environmental Biology	110.71	120.38	70.00	190.38	79.67	72.0%	70.00	58.1%
Biological Infrastructure	83.65	86.97	20.00	106.97	23.32	27.9%	20.00	23.0%
Emerging Frontiers	106.74	113.58	50.00	163.58	56.84	53.3%	50.00	44.0%
TOTAL, BIOLOGICAL SCIENCES	613.42	653.81	260.00	913.81	300.39	49.0%	260.00	39.8%
Computing & Communication Foundations	143.63	156.93	41.50	198.43	54.80	38.2%	41.50	26.4%
Information and Intelligent Systems	139.33	150.26	60.50	210.76	71.43	51.3%	60.50	40.3%
Computer & Network Systems	174.16	188.31	92.57	280.88	106.72	61.3%	92.57	49.2%
Information Technology Research	78.14	78.24	40.43	118.67	40.53	51.9%	40.43	51.7%
TOTAL, COMPUTER & INFORMATION SCIENCE & ENGINEERING	535.26	573.74	235.00	808.74	273.48	51.1%	235.00	41.0%
Chemical, Bioengineering, Environmental, & Transport Systems	132.81	146.02	60.40	206.42	73.61	55.4%	60.40	41.4%
Civil, Mechanical, & Manufacturing Innovation	161.11	174.84	57.76	232.60	71.49	44.4%	57.76	33.0%
Electrical, Communications, & Cyber Systems	83.60	87.35	45.84	133.19	49.59	59.3%	45.84	52.5%
Industrial Innovation & Partnerships	121.53	132.04	55.00	187.04	65.51	53.9%	55.00	41.7%
Engineering Education & Centers	116.02	117.45	32.00	149.45	33.43	28.8%	32.00	27.2%
Emerging Frontiers in Research & Innovation	25.23	26.45	14.00	40.45	15.22	60.4%	14.00	52.9%
TOTAL, ENGINEERING	640.30	684.15	265.00	949.15	308.85	48.2%	265.00	38.7%
Atmospheric & Geospace Sciences	230.03	244.60	68.20	312.80	82.77	36.0%	68.20	27.9%
Earth Sciences	157.82	171.00	85.22	256.22	98.40	62.3%	85.22	49.8%
Integrative & Collaborative Education & Research	56.96	61.17	79.58	140.75	83.79	147.1%	79.58	130.1%
Ocean Sciences	313.06	330.36	114.00	444.36	131.30	41.9%	114.00	34.5%
TOTAL, GEOSCIENCES	757.87	807.13	347.00	1,154.13	396.26	52.3%	347.00	43.0%
Astronomical Sciences	217.90	228.62	85.80	314.42	96.52	44.3%	85.80	37.5%
Chemistry	194.62	211.35	103.00	314.35	119.73	61.5%	103.00	48.7%
Materials Research	262.55	282.13	106.90	389.03	126.48	48.2%	106.90	37.9%
Mathematical Sciences	211.75	226.18	98.00	324.18	112.43	53.1%	98.00	43.3%
Physics	251.64	274.47	96.30	370.77	119.13	47.3%	96.30	35.1%
Multidisciplinary Activities	32.67	33.21	-	33.21	0.54	1.6%	-	-
TOTAL, MATHEMATICAL & PHYSICAL SCIENCES	1,171.13	1,255.96	490.00	1,745.96	574.83	49.1%	490.00	39.0%
Social and Economic Sciences	100.10	103.00	42.00	145.00	44.90	44.9%	42.00	40.8%
Behavioral and Cognitive Sciences	85.12	88.00	43.00	131.00	45.88	53.9%	43.00	48.9%
Science Resources Statistics	29.96	38.80	-	38.80	8.85	29.5%	-	-
TOTAL, SOCIAL, BEHAVIORAL & ECONOMIC SCIENCES	215.18	229.80	85.00	314.80	99.62	46.3%	85.00	37.0%

NATIONAL SCIENCE FOUNDATION
FY 2009 TOTAL APPROPRIATIONS BY ACTIVITY AND SUBACTIVITY
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2009 Total Appropriations	FY 2009 Total Appropriations change over: FY 2008 Actual		FY 2009 Plan	
					Amount	Percent	Amount	Percent
OFFICE OF CYBERINFRASTRUCTURE	185.15	199.28	80.00	279.28	94.13	50.8%	80.00	40.1%
OFFICE OF INTERNATIONAL SCIENCE & ENGINEERING	47.77	44.03	14.00	58.03	10.26	21.5%	14.00	31.8%
Arctic Sciences	91.19	98.26	92.00	190.26	99.07	108.6%	92.00	93.6%
Antarctic Sciences	59.06	65.25	66.50	131.75	72.69	123.1%	66.50	101.9%
Antarctic Infrastructure and Logistics including	240.08	246.87	15.50	262.37	22.29	9.3%	15.50	6.3%
[including US Antarctic Logistical Support Activities]	*[67.63]*	*[67.52]*	*[0.00]*	*[67.52]*	*-0.11*	*-0.2%*	-	-
Polar Environment, Safety, and Health	5.91	6.29	-	6.29	0.38	6.5%	-	-
USCG Polar Icebreaking	50.89	54.00	-	54.00	3.11	6.1%	-	-
TOTAL, OFFICE OF POLAR PROGRAMS	447.13	470.67	174.00	644.67	197.54	44.2%	174.00	37.0%
Experimental Program to Stimulate Competitive Research (EPSCoR)	120.00	133.00	50.00	183.00	63.00	52.5%	50.00	37.6%
Non-EPSCoR Activities	118.56	130.03	500.00	630.03	511.47	431.4%	500.00	384.5%
[Major Research Instrumentation]	*[93.87]*	*[100.00]*	*[200.00]*	*[300.00]*	*206.13*	*219.6%*	*200.00*	*200.0%*
[Academic Research Infrastructure]	*[0.00]*	*[0.00]*	*[300.00]*	*[300.00]*	*300.00*	*N/A*	*300.00*	*N/A*
INTEGRATIVE ACTIVITIES	238.56	263.03	550.00	813.03	574.47	240.8%	550.00	209.1%
UNITED STATES ARCTIC RESEARCH COMMISSION	1.47	1.50	-	1.50	0.03	2.0%	-	-
TOTAL, RESEARCH AND RELATED ACTIVITIES	$4,853.25	$5,183.10	$2,500.00	$7,683.10	$2,829.86	58.3%	$2,500.00	48.2%
Undergraduate Education	254.00	283.23	85.00	368.23	114.23	45.0%	85.00	30.0%
Graduate Education	159.59	181.50	15.00	196.50	36.91	23.1%	15.00	8.3%
Human Resource Development	140.37	154.03	-	154.03	13.66	9.7%	-	-
Research on Learning in Formal and Informal Settings	212.30	226.50	-	226.50	14.20	6.7%	-	-
TOTAL, EDUCATION & HUMAN RESOURCES	$766.26	$845.26	$100.00	$945.26	$179.00	23.4%	$100.00	11.8%
MAJOR RESEARCH EQUIPMENT & FACILITIES CONSTRUCTION	$166.85	$152.01	$400.00	$552.01	$385.17	230.9%	$400.00	263.1%
SALARIES AND EXPENSES	$282.04	$294.00		$294.00	$11.96	4.2%		-
OFFICE OF THE INSPECTOR GENERAL	$11.83	$12.00	$2.00	$14.00	$2.18	18.4%	$2.00	16.7%
OFFICE OF THE NATIONAL SCIENCE BOARD	$3.83	$4.03		$4.03	$0.21	5.4%		-
TOTAL, NATIONAL SCIENCE FOUNDATION	$6,084.04	$6,490.40	$3,002.00	$9,492.40	$3,408.36	56.0%	$3,002.00	46.3%

Totals may not add due to rounding.