MAJOR MULTI-USER RESEARCH FACILITIES

Major Multi-User Research Facilities Funding

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over FY 2012 Estimate Amount	Change Over FY 2012 Estimate Percent
Total, Research and Related Activities	**$913.54**	**$909.70**	**$923.30**	**$13.60**	**1.5%**
Operations and Maintenance of Existing Facilities	*673.63*	*655.37*	*647.35*	*-8.02*	*-1.2%*
Federally Funded R&D Centers	*195.25*	*195.85*	*191.71*	*-4.14*	*-2.1%*
Operations and Maintenance of Facilities under Construction	*17.49*	*44.73*	*72.49*	*27.76*	*62.1%*
R&RA Planning and Concept Development	*27.17*	*13.75*	*11.75*	*-2.00*	*-14.5%*
Major Research Equipment and Facilities Construction	**$125.37**	**$197.06**	**$196.17**	**-$0.89**	**-0.5%**
Total, Major Multi-User Research Facilities	**$1,038.91**	**$1,106.76**	**$1,119.47**	**$12.71**	**1.1%**

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. Planning, and 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 projects under construction funded through NSF's MREFC account is provided in the MREFC chapter.

Major Multi-User Research Facilities Funding

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Change over FY 2012 Estimate Percent
Operations and Maintenance of Existing Facilities	**$673.63**	**$655.37**	**$647.35**	**-$8.02**	**-1.2%**
Engineering					
National Nanotechnology Infrastructure Network (NNIN)	*16.36*	*15.86*	*15.36*	*-0.50*	*-3.2%*
Network for Earthquake Engineering Simulation	*20.10*	*20.50*	*20.50*	*0.00*	*0.0%*
Geosciences					
Academic Research Fleet[1]	*81.67*	*76.75*	*72.00*	*-4.75*	*-6.2%*
EarthScope: USArray, SAFOD, PBO	*26.02*	*25.05*	*26.17*	*1.12*	*4.5%*
Incorporated Research Institutions for Seismology	*12.37*	*12.36*	*11.25*	*-1.11*	*-9.0%*
Integrated Ocean Drilling Program	*53.35*	*44.40*	*38.90*	*-5.50*	*-12.4%*
Mathematical and Physical Sciences					
Arecibo Observatory (formerly NAIC)[2]	*9.26*	*8.70*	*8.20*	*-0.50*	*-5.7%*
Cornell High Energy Synchrotron Source (CHESS) / Cornell Electron Storage Ring (CESR)	*14.12*	*19.67*	*20.00*	*0.33*	*1.7%*
Gemini Observatory	*19.50*	*22.07*	*18.15*	*-3.92*	*-17.8%*
IceCube	*6.90*	*6.90*	*6.90*	*0.00*	*0.0%*
Large Hadron Collider	*18.00*	*18.00*	*18.00*	*0.00*	*0.0%*
Laser Interferometer Gravitational Wave Observatory	*30.30*	*30.40*	*30.50*	*0.10*	*0.3%*
National High Magnetic Field Laboratory	*32.68*	*25.80*	*31.75*	*5.95*	*23.1%*
National Solar Observatory	*9.10*	*9.10*	*8.00*	*-1.10*	*-12.1%*
National Superconducting Cyclotron Laboratory	*21.50*	*21.50*	*21.50*	*0.00*	*0.0%*
Other Facilities[3]	*4.86*	*2.52*	*2.66*	*0.14*	*5.6%*
Polar Programs					
Polar Facilities and Logistics[4]	*297.54*	*295.79*	*297.51*	*1.72*	*0.6%*
Federally Funded Research and Development Centers[5]	**$195.25**	**$195.85**	**$191.71**	**-$4.14**	**-2.1%**
National Center for Atmospheric Research	*98.10*	*98.60*	*92.29*	*-6.31*	*-6.4%*
National Optical Astronomy Observatory	*29.50*	*25.50*	*25.50*	*0.00*	*0.0%*
National Radio Astronomy Observatory[6]	*67.65*	*71.75*	*73.92*	*2.17*	*3.0%*
Operations and Maintenance of Facilities under Construction	**$17.49**	**$44.73**	**$72.49**	**$27.76**	**62.1%**
Advanced Technology Solar Telescope (ATST)	*2.00*	*2.00*	*2.00*	*0.00*	*0.0%*
National Ecological Observatory Network (NEON)		*15.93*	*30.39*	*14.46*	*90.8%*
Ocean Observatories Initiative(OOI)	*15.49*	*26.80*	*40.10*	*13.30*	*49.6%*
R&RA Planning and Concept Development	**$27.17**	**$13.75**	**$11.75**	**-$2.00**	**-14.5%**
Pre-construction Planning[7]	*17.50*	*6.75*	*8.75*	*2.00*	*29.6%*
Concept and Development for MREFC projects	*9.67*	*7.00*	*3.00*	*-4.00*	*-57.1%*
Major Research Equipment and Facilities Construction	**$125.37**	**$197.06**	**$196.17**	**-$0.89**	**-0.5%**
Total, Major Multi-User Research Facilities	**$1,038.91**	**$1,106.76**	**$1,119.47**	**$12.71**	**1.1%**

Totals may not add due to rounding.

[1] An additional $2.0 million in FY 2012 and $1.0 million in FY 2013 for Regional Class Research Vessels is included in pre-construction planning.

[2] The National Astronomy and Ionosphere Center (NAIC) was decertified as an FFRDC in FY 2011 and renamed Arecibo Observatory.

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

[4] In FY 2011, Polar Facilities and Logistics excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 112-10.

[5] Federally Funded R&D Centers does not include support for the Science and Technology Policy Institute, which is an FFRDC but not a multi-user research facility

[6] Operations and Maintenance of ALMA are included in NRAO.

[7] Pre-construction planning includes R&RA funding for potential next-generation major multi-user facilities.

NSF's Facilities Investments in FY 2013

The following pages contain information on NSF's ongoing facilities in FY 2013.

Academic Research Fleet

$73,000,000
-$5,750,000 / -7.3%

Academic Research Fleet
(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$81.67	$78.75	$73.00	-$5.75	-7.3%

The Academic Research Fleet consists of 21 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 in the Directorate of Geosciences (GEO) by the Division of Ocean Sciences (OCE) and the Division of Innovative and Collaborative Education and Research (ICER). In addition to operations, OCE has undertaken selected construction projects based on inter-agency planning and coordination as discussed in the Federal Oceanographic Fleet Status Report published in 2007.

Total Obligations for the Academic Research Fleet
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Operations and Maintenance	$73.67	$74.35	$72.00	$72.30	$73.60	$76.00	$77.40	$78.80
Fleet Renewal:								
Human Occupied Vehicle	8.00	2.40	-	-	-	-	-	-
Regional Class Research Vessel	-	2.00	1.00	1.00	1.00	-	-	-
Total, Academic Research Fleet	**$81.67**	**$78.75**	**$73.00**	**$73.30**	**$74.60**	**$76.00**	**$77.40**	**$78.80**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

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 ocean. Scientists contribute to advances in many areas including climate variability, marine ecosystems, fisheries, and ocean-related natural hazards such as tsunamis through use of these facilities. Vessels in the Academic Research Fleet provide about 62,000 scientist days at sea and permit shipboard training of future oceanographers, with students forming about 25 percent of the sea-going science parties. Participating graduate and undergraduate students interact with scientists and marine technicians, enabling them to gain first-hand exposure to ocean science field research. Increasingly, 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 Office of Naval Research (ONR) and the National Oceanic and Atmospheric Administration (NOAA) 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 federal and state agencies. Within NSF, science is supported through competitive peer-reviewed proposals, most typically funded within OCE and through selected programs in the Division of Earth Sciences (EAR), the Division of Atmospheric and Geospace Sciences (AGS), the Office of Polar Programs (OPP) and the Directorate for Biological Sciences (BIO). Approximately 30 percent of the OCE proposals request ship time; GEO-funded shipboard science has ranged from about $35.0 million to $45.0 million per year over the last five 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. Academic Research Fleet, and science funded by other agencies.

The reduction in ship operation and upgrade costs in FY 2013 is the result of reduced ship demand and the completion of support for the replacement human occupied vehicle *ALVIN*. The FY 2013 Request of $73.0 million will support approximately 2,400 ship operating days.

Facility Report

Fleet Operations

- Oversight: 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 site visits, ship inspections, and participation at UNOLS Council and Subcommittee meetings by NSF program directors. Several program directors within OCE at NSF, at NOAA, and at ONR are involved in the activities and overall oversight of the Academic Research Fleet. NSF conducted a Business Systems Review (BSR) of the R/V *Langseth*, and issued a final report in September 2010. No BSRs are scheduled for 2012 or 2013.
- Management: Management of an operating 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.
- 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. Recent documents supporting this need include the *National Ocean Policy* and the *Final Recommendations of the Interagency Ocean Policy Task Force* of July 19, 2010. Two applicable reports by the National Research Council (NRC) include *Science at Sea: Meeting Future Oceanographic Goals with a Robust Academic Research Fleet* published in 2009, and *Critical Infrastructure for Ocean Research and Societal Needs in 2030* published in 2011. In coordination with UNOLS and the other federal agencies which invest in ocean research, the Interagency Working Group on Facilities (IWG-F), which has been renamed as the Interagency Working Group on Facilities and Infrastructure (IWG-FI) under the National Ocean Policy, published a *Federal Oceanographic Fleet Status Report* in December 2007 reviewing the status and describing plans for modernizing the federal and academic oceanographic research and survey fleet. Ship operations and technical services activities are reviewed internally on the basis of detailed annual reports provided by the operating institutions. Ship operations proposals are exempt from external review by peers, and budgets are negotiated yearly since they are dependent on the number of days the ships will be at sea in support of NSF-funded research programs. Technical services awards are reviewed every three years and negotiated annually.

Fleet Modernization

- Oversight: The NSF coordinator for fleet modernization activities 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 as required.
- Regional Class Research Vessel (RCRV): NSF is continuing analysis, planning, and development activities for potential new Regional Class Research Vessels. NSF has held several discussions with the NOAA Office of Marine and Aviation Operations to explore the potential for collaboration between the two agencies on the design of the RCRV and the modernization efforts being considered for the NOAA mid-size vessels. In addition, NSF is an active participant in the IWG-FI Ship Subcommittee, which is developing the first draft of an update to the 2007 Federal Oceanographic Fleet Status Report, an action in the draft National Ocean Policy Implementation Plan. The role of the RCRV in meeting the needs across the government agencies for research vessels in support of ocean science research is an integral aspect of the Fleet Status Report Update. Decisions on proceeding to further development stages will be based upon NSF, National Science Board, and interagency reviews.

Other Ongoing Activities

- Development and construction of a deep submergence capability to replace the submersible human occupied vehicle *(HOV) ALVIN* continues in FY 2012 and will complete in FY 2013. This project, begun in FY 2004, to design and build an all-new submersible, experienced significant cost over-runs in 2008 and was subsequently re-scoped and placed on a revised review path, which included a Preliminary Design Review (PDR) in December 2009, and a Final Design Review (FDR) in September 2010. The FDR Panel recommended the project continue and felt the budget was adequately defined. The Panel also recommended NSF partner with the Navy, specifically Naval Sea Systems Command (NAVSEA), to certify the operational capability and safety of *ALVIN*. NSF subsequently entered into an interagency agreement with NAVSEA to do so, and the Woods Hole Oceanographic Institution (WHOI) team is supporting this effort.

  The re-scoped *ALVIN* Upgrade Project would potentially be accomplished in two phases. Phase I is the integration of a new titanium 6,500-meter-capable personnel sphere with existing *ALVIN* vehicle components. Initial Phase I operations will provide a depth capability of 4,500 meters, the limit of the current *ALVIN* components to be retained during Phase I. A potential Phase II would provide upgrades to permit operations to a depth of 6,500 meters, but there has been no implicit or explicit commitment to proceed with Phase II at this time. The cost increase over previous estimates was due to delays in schedule, increases in labor costs and levels of effort, and a rise in titanium prices. Certification for operation of the Phase I vehicle is scheduled for fall 2012, with an anticipated return to normal science operations in early 2013.

Renewal/Recompetition/Termination:

Ships supported by NSF are operated by academic institutions, each having a cooperative agreement with NSF. All ship cooperative agreements will be renewed in 2012 using the NSB-approved criteria and review by an external panel. Awardees are subject to additional oversight measures, including Business System reviews conducted by NSF. In FY 2012, NSF announced the retirement of the *R/V Oceanus*. Subsequent review revealed that the Oceanus was better suited to anticipated needs on the West Coast than a similar vessel, the *R/V Wecoma*. Thus, to better and more cost effectively serve the needs of the ocean research community, the *R/V Oceanus* is being transferred to the West Coast and will be operated by Oregon State University and the *R/V Wecoma* will be removed from service.

Alaska Region Research Vessel (R/V *SIKULIAQ*)

The Research Vessel *SIKULIAQ* (formerly known as the Alaska Region Research Vessel) represents NSF's first major contribution to fleet renewal in over twenty years. Construction of the *SIKULIAQ* was funded completely through the MREFC account, partially with American Reinvestment and Recovery Act (ARRA) funds. Shipyard construction began in early CY 2011, and science operations are anticipated to begin in early CY 2014 at which time operational funding will be supported by OCE.

Baseline History

NSF first requested construction funding for the *SIKULIAQ* 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. $148.07 million was provided through the American Recovery and Reinvestment Act of 2009. In early 2010, the vessel was officially named the R/V *SIKULIAQ*, which means "First year ice able to be walked on" in a native Inuit dialect.

The project is led by the University of Alaska, Fairbanks (UAF) with engineering support from design through construction provided by UAF's naval architect, The Glosten Associates, Inc. The final project baseline (against which the project is now being monitored) incorporates an up-dated technical scope to meet regulatory and science requirements, proper administrative support by UAF, a realistic construction schedule, and an independent, risk-adjusted cost/contingency estimate for construction. The baseline was finalized in late 2010 following selection of Marinette Marine Corporation as the shipyard for construction.

Total Obligations for the ARRV

(Dollars in Millions)

	Prior Years[1]	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
R&RA Obligations:									
Concept & Development	$2.24	-	-	-	-	-	-	-	-
Management & Operations	-	-	-	-	4.17	8.34	8.50	8.50	8.50
Subtotal, R&RA Obligations	$2.24	-	-	-	$4.17	$8.34	$8.50	$8.50	$8.50
MREFC Obligations:									
Implementation	51.42	-	-	-	-	-	-	-	-
ARRA	148.07	-	-	-	-	-	-	-	-
Subtotal, MREFC Obligations	$199.49	-	-	-	-	-	-	-	-
TOTAL Obligations	**$201.73**	**-**	**-**	**-**	**$4.17**	**$8.34**	**$8.50**	**$8.50**	**$8.50**

Totals may not add due to rounding.

[1] Concept & Development funding and Implementation funding are cumulative of all prior years; Management & Operations funding reflects the FY 2010 Actual only.

Satellite observations have shown that the perennial ice in the Arctic is thinning at a rate of nine 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. The *SIKULIAQ* will provide a sophisticated and significantly larger platform for scientists as well as 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. The *SIKULIAQ* is expected to greatly expand research capabilities in the Arctic with up to 270-300 science days at sea annually. An ice-strengthened hull will allow the vessel to operate in seasonal ice up to one meter thick and an anti-roll tank will permit it to operate effectively in the open waters of the Bering Sea, Gulf of Alaska and North Atlantic as well.

Due to its size and projected operating area, the *SIKULIAQ* will operate as a Global Class vessel within the U.S. academic research vessel fleet.

The increased capabilities of the *SIKULIAQ* are expected to dramatically increase the number of proposals addressed to NSF for Arctic science. UAF conducted an initial science planning workshop in May 2011, with a second planned for February 2012, to alert the US science community to the vessel's capabilities and availability to support science beginning in 2014. 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.

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 the Office of Legislative Public Affairs (OLPA). Additional staff from IPS, LFO, and DACS, as well as external consultants, help provide the Program Officer with routine project management and technical assistance. To ensure effective management and oversight, monthly and annual reports provided by the UAF project office are closely monitored by the SIKULIAQ Program Officer for deviations from the established baseline using Earned Value Management. NSF conducted a Business Systems Review (BSR) and issued a final report in July 2011.
- External Structure: UAF maintains project management offices in both Fairbanks and Seward, AK. UAF management also includes an experienced on-site team in Marinette, Wisconsin that will remain at the shipyard until delivery. The *SIKULIAQ* Oversight Committee (SOC), which includes community experts in research vessel design, construction, and operations, convenes monthly to review project status and provide technical and science support advice to both UAF and NSF.
- Reviews: With construction now well underway, NSF will conduct annual project reviews as follows:
  - July 2012: Construction and Trials Review
  - July 2013: Trials and Operational Readiness Review

Current Project Status

Construction began in January 2011 after Design Verification and Transfer (DVT) uncovered a weight issue that had to be corrected by adding six additional feet to the hull and changing the superstructure to aluminum. Launch is now scheduled for October 2012, with final delivery to UAF in July 2013. There appears to be adequate schedule float in Phase IV (Transition to Operations) to complete science trials and still begin science operations in early 2014 as originally planned. With the contract modifications for the weight mitigation changes now in place, a significant level of project risk has been retired. Panel reviews in July and November 2011 indicate a high level of confidence that the project will now be completed within budget and on schedule.

Cost and Schedule

The total project cost approved by NSF and NSB following FDR is $199.50 million. The majority of this total, $138.0 million, or 70 percent, is the fixed price contract with the shipyard which includes the changes associated with vessel weight. UAF management, including purchase of propulsion units as Owner-Furnished Equipment, is $34.70 million (17 percent). Final outfitting, science trials, and delivery

are $11.20 million (6 percent). Uncommitted project contingency for the shipyard contract is approximately $14.50 million (7 percent).

Delivery of the *SIKULIAQ* to UAF is scheduled for July 2013. This will be followed by a period of science, final outfitting, and transit to the first science operational area. Science operations are projected to begin in early 2014 with transition to the OCE Ship Operation Program for funding support. With the delay in delivery, ice trials and a warranty shipyard will now be conducted in 2014 using MREFC funds; both of which were within the original project scope.

Risks

The project risk register is formally up-dated monthly by UAF and reviewed by NSF on a routine basis. Risks at this stage of the project now include:

- 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. With DVT complete and all weight mitigation changes fully incorporated into the shipyard contract, this risk is now considered low.
- Change Risk: Shipyard cost claim potential associated with design development due to changing regulatory body requirements, Buy American and owner-initiated design changes during design and/or construction (Change Orders). This risk is now considered moderate.
- Schedule Risk: Extension of the construction and delivery schedule which would result in project cost increases due to inflation, shipyard liquidated damages, and UAF standing army costs. This risk is now considered low.

Mitigation strategies have been employed by UAF, and the risk analyses reviewed by the panel in both July 2011 and November 2011 indicate that sufficient contingency is currently in place to handle these remaining project risks. The panel also was satisfied that 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 OCE/IPS. Daily rate estimates for both the ship and technical services will be updated in 2012. It is anticipated that OCE will utilize at least 65 percent of the annual vessel availability based on historical data from other global ships within the academic research vessel fleet. Up to 35 percent of the *SIKULIAQ's* schedule is expected to be available to the Office of Polar Programs (OPP) and other federal agencies. In short, the *SIKULIAQ* will fold into an already well-established framework for operating the academic research vessel fleet.

Arecibo Observatory

$8,200,000
-$500,000 / -5.7%

Arecibo Observatory
(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$9.26	$8.70	$8.20	-$0.50	-5.7%

Totals may not add due to rounding.

The Arecibo Observatory (Arecibo), formerly the National Astronomy and Ionosphere Center, is a center for multidisciplinary research and education enabled by world-class observational facilities. The observatory's principal observing facility is the world's largest single-dish radio/radar telescope, a 305-meter diameter reflector located near the town of Arecibo in western Puerto Rico on 120 acres of U.S. Government-owned land. Arecibo Observatory is currently operated and managed by SRI International and subawardees USRA and Universidad Metropolitana under a cooperative agreement with NSF that began October 1, 2011. It serves over 300 users annually with a wide range of research and observing instrumentation in passive radio astronomy, solar system radar astronomy, and space and atmospheric sciences.

Including the Angel Ramos Foundation Visitor Center, Arecibo has a staff of about 120 full-time-equivalent positions, of which approximately 90 are supported by NSF funds. A permanent staff of 17 scientists and 34 engineers, technicians, and operators is available to help visiting investigators with observing programs. The remainder includes 26 management, administrative, and clerical positions, 37 maintenance staff, and several postdoctoral scholars and students.

Total Obligations for the Arecibo Observatory
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Operations and Maintenance	$9.26	$8.70	$8.20	$8.00	$8.00	$8.20	$8.20	$8.20
Astronomical Sciences (MPS)	*6.19*	*5.50*	*5.00*	*4.50*	*4.00*	*4.10*	*4.10*	*4.10*
Atmospheric & Geospace Sciences (GEO)	*3.07*	*3.20*	*3.20*	*3.50*	*4.00*	*4.10*	*4.10*	*4.10*
Total, Arecibo	**$9.26**	**$8.70**	**$8.20**	**$8.00**	**$8.00**	**$8.20**	**$8.20**	**$8.20**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

Arecibo 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). In 2006 the AST Senior Review recommended a reduction in AST support for Arecibo to $8.0 million (FY 2006 dollars) by 2010. In response, the managing organization, then Cornell University, reduced the Arecibo staff by 30 FTEs, modified the operating mode for astronomy observations, and limited the observing time for astronomy and planetary radar projects.

AST support for Arecibo in FY 2008–2010 reflected a planned ramp down in response to the 2006 Senior Review recommendations. The Review also recommended that sufficient external financial or personnel contributions be found to operate Arecibo with competitive scientific productivity after 2011 with an AST

contribution not to exceed half of the expected operational costs, estimated in FY 2006 at $8.0 million. AST support for FY 2011–2017 is based upon the Review recommendations, guidance from a third-party cost review of AST facilities, and a third-party estimate of Arecibo's non-scientific costs.

As AST has ramped down support for Arecibo, AGS has significantly increased support and, in FY 2011 and beyond, will contribute substantively to general facility operations. In the past, AGS funding has primarily supported a research staff in the space and atmospheric sciences program and contributed only incrementally for basic operations costs. Outyear estimates for planned AGS support of Arecibo ramp up to parity with AST support.

Partnerships and Other Funding Sources: Arecibo leverages NSF support with funding from other federal and non-federal sources. Since FY 2010, the NASA Near Earth Object Observation Program has committed $2.0 million to Arecibo in support of the planetary radar program. NASA support is expected to continue at this level, subject to availability of appropriated funds. In association with the new cooperative agreement for Arecibo management and operation, NSF will negotiate a memorandum of understanding with NASA in early spring 2012 to establish appropriate oversight procedures for multi-agency support of Arecibo. In FY 2010, observatory management finalized an assistance agreement with the Puerto Rico Infrastructure Financing Authority to receive $3.0 million for major infrastructure improvements at Arecibo Observatory. In FY 2009, the observatory contracted with the Puerto Rico Department of Education for up to $2.35 million to provide student enhancement and teacher professional development programs at Arecibo through the site's Angel Ramos Foundation Visitor Center and Learning Center. Recent sources of external funding have also included $942,000 from 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 $500,000 from other non-federal and private sources.

An aerial image of the Arecibo Radio Telescope in Puerto Rico. The platform suspension structure, including the Gregorian dome that houses the main suite of research instruments, is visible over the 305-meter primary reflector dish below. *Credit: Arecibo Observatory/NSF*.

A peer-review telescope allocation committee provides merit-based telescope time to users. NSF does not provide awards targeted specifically for use of Arecibo Observatory, although many users are supported through NSF or NASA grants to pursue scientific programs that require use of the facility.

Education and Public Outreach (EPO): A primary education goal for Arecibo 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 (NRAO), Arecibo holds a summer school on single-dish radio astronomy techniques. Arecibo also sponsors a major outreach program in Puerto Rico via the modern Angel Ramos Foundation Visitor Center and Learning Center, as well as summer workshops for K-12 teachers. This center attracts roughly 100,000 visitors each year; over 1.3 million people have visited since its opening in 1997. With funds from the Puerto Rico Department of Education, Arecibo recently hosted 25,000 K–12 school children through the *Inspiration for Science* program that provided transportation to the Observatory and science enrichment activities at no cost to participants.

Operations and Maintenance, $8.20 million: Arecibo 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 3.5. 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. About 80 percent of astronomy users conduct their observing remotely via networked control software, while radar observations typically employ on-site users.

- Division of Astronomical Sciences, $5.0 million: AST funds basic operations costs and science programs in passive radio astronomy and solar system radar astronomy. Funding for the Astronomy program continues to decrease in FY 2013, in response to recommendations of the AST Senior Review. Operational scope changes are anticipated in response to decreased AST funding, as part of the next five-year award for Arecibo management and operations. Beginning in program year 2011, substantial support for planetary radar astronomy will be supplied by NASA (see below).

  Radio astronomers use the Arecibo facility to study diverse areas such as interstellar gas, galactic structure formation and evolution, pulsars and fundamental physics; topics in solar system astronomy include the physical properties of asteroids, planetary surfaces and moons, and the post-discovery characterization and orbital refinement of near-Earth asteroids. Approximately 50 to 60 percent of the astronomy observing time is dedicated to ongoing survey programs, most of which use the Arecibo L-band Feed Array (ALFA) receiver that was commissioned in 2005–2006. The installation and commissioning of wide-band spectrometers in FY 2008 allow up to three survey programs to be conducted simultaneously on each sky pointing.
- Division of Atmospheric and Geospace Sciences, $3.20 million: AGS supports a research staff in the space and atmospheric sciences program and has historically contributed only incrementally for basic operations costs. As stated above, in FY 2011 and beyond, AGS funding will contribute substantively to general operations. The incoherent scatter radar at Arecibo is part of an NSF-supported network of radars strategically distributed to observe the transport of radiative energy and charged particles, from their origins at the sun to their deposition in Earth's upper atmosphere. The unique sensitivity of the Arecibo incoherent scatter radar system allows it to measure the density, temperature, and motion of plasma in Earth's ionosphere with unrivaled time and spatial resolution. Arecibo is also the only aeronomy observatory located at tropical mid-latitudes, where many important ionospheric processes take place. An ionospheric high-frequency heating facility is currently under construction at Arecibo with completion anticipated in FY 2012.

Facility Report

Management and Oversight

- NSF Structure: Ongoing oversight is provided by an assigned NSF program director in AST, in close cooperation with AGS 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 SRI, as well as attending SRI governance committee meetings as appropriate. 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 director and AGS program manager conduct periodic site visits and frequent teleconferences.
- External Structure: Management is via a cooperative agreement with SRI and its subawardees, USRA and Universidad Metropolitana. The awardees provide management and oversight through their own advisory and visiting committees. The Arecibo Director, resident at the telescope site, is the Principal Investigator of the operations award for the facility. Three deputy directors in the areas

of Atmospheric Sciences, Planetary Radar, and Puerto Rican EPO report to the Arecibo Director. A new a new five-year cooperative agreement is beginning in FY 2012.

- Reviews: Management reviews by external 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 AST Senior Review recommendations was completed in March 2008. AST and AGS jointly conduct annual external reviews of Arecibo program plans; the most recent review was held in December 2010. Future annual reviews will continue after review and recommendation of proposals received in response to the competition for Arecibo management and operations (see below). A Business Systems Review (BSR) is planned for 2013.

Renewal/Competition/Termination

The current cooperative agreement with SRI for the management of Arecibo was awarded on schedule on October 1, 2011, replacing Cornell in a competitive process for a new five-year cooperative agreement, consistent with National Science Board policy. This agreement is in effect through September 30, 2016.

NSF decertified Arecibo as a Federally Funded Research and Development Center (FFRDC) upon award of the new cooperative agreement for its management and operation. This decision was made after careful consideration of the advantages and disadvantages such a designation carries. Without restrictions imposed by the FFRDC designation, the Arecibo managing organization will have greater freedom to establish partnerships beyond those permitted by government regulations applicable to FFRDCs.

Cornell High Energy Synchrotron Source and Cornell Electron Storage Ring **$20,000,000**
+$330,000 / 1.7%

Cornell High Energy Synchrotron Source and Cornell Electron Storage Ring

(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$14.12	$19.67	$20.00	$0.33	1.7%

Totals may not add due to rounding.

The Cornell High Energy Synchrotron Source (CHESS) is a first generation, high-intensity, high-energy X-ray facility supported by NSF with partial interagency 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 the Cornell Electron Storage Ring (CESR). CHESS provides capabilities for X-ray research in physics, chemistry, biology, materials, and environmental sciences. Areas of emphasis include soft matter and thin film studies, solution scattering, nanomaterials, high-pressure science, structural biology, time-resolved studies of materials, and X-ray studies of items of art and archaeology. Stewardship and oversight of CHESS is provided through the NSF Division of Materials Research (DMR) within the Directorate for Mathematical and Physical Sciences (MPS), though the majority of CHESS users come from disciplines outside of materials science..

The FY 2013 Request supports operations of CHESS/CESR as a user facility and is consistent with funding levels in previous years. Funding will allow continued operation of the facilities in support of synchrotron light users.

Total Obligations for CHESS/CESR

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Operations and Maintenance	$14.12	$19.67	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00

[1]Years beyond FY 2013 are shown for planning purposes only. The current cooperative agreement ends in March 2014.

The CHESS user program supports work in cancer research, new materials for electronics, aircraft and biotechnology, batteries, fuel cells, solar cells and other energy applications. X-ray detectors developed at CHESS are now in use at 3rd and 4th Generation X-ray sources around the world, including the world's first hard X-ray laser, the Department of Energy (DOE) Linac Coherent Light Source.

CHESS/CESR staff assists in transferring Superconducting Radio Frequency technology to industry. Several CHESS/CESR users are from industry, including pharmaceutical corporations (such as Rib-x Pharmaceuticals) and the research arms of Xerox, and General Motors. Some medical institutions also make use of CHESS/CESR (Dana Farber Cancer Institute, Boston Biomedical Research Institute, and Memorial Sloan-Kettering Institute). CHESS/CESR also has collaborations with DOE-supported synchrotron facilities such as the Advanced Photon Source and National Synchrotron Light Source.

CHESS/CESR supports and enhances Ph.D. level graduate education, postdoctoral research, and research experiences for undergraduates and for K-12 science teachers. Each year there are about 25 Ph.D.

degrees granted as a result of CHESS research. More than 60 undergraduates participate in research at the facility during the academic year; about 16 undergraduates and 10 pre-college teachers participate during the summer. In this educational role, CHESS plays a key role as a training ground for X-ray science and accelerator physics with CHESS students and postdoctorates going to staff other X-ray facilities in the U.S. and around the world.

Facility Report

Management and Oversight

- NSF Structure: CHESS is supported by DMR and by the National Institutes of Health (NIH). CHESS also hosts MacCHESS, a NIH-funded macromolecular crystallography program at Cornell. NSF and NIH provide oversight of CHESS through regular site visits by external reviewers.
- External structure: Both CESR and CHESS are administered by the Cornell Laboratory of Accelerator-based Sciences and Education (CLASSE), which reports to Cornell's Vice-Provost for Research. CHESS/CESR is operated by Cornell University in accordance with a cooperative agreement with NSF that set goals and objectives for the facility.
- CHESS is a national user facility accessed on the basis of competitive proposal review. The primary function of the CHESS staff is to maintain and operate the facility and to assist users. A policy and advisory board, appointed by the Cornell Vice President for Research, provides advice to the director of CHESS on policies related to the use and development of CHESS facilities and equipment for user experiments. A users committee appointed by the users of CHESS advises the director on matters of facilities operations and priorities for the users. An annual users meeting and several workshops help disseminate results from the facility.
- Reviews:
  - Annual site visit review of CHESS operations, November 2011.
  - Business Systems Review (BSR), final report issued in September 2011.
  - Next operations review, planned for fall 2012.

Renewal/Recompetition/Termination

In FY 2009, NSF completed the review of a proposal for the continued operation of CHESS/CESR in support of X-ray photon science. In December 2009, the National Science Board authorized NSF to make a four-year award. The cooperative agreement between NSF and Cornell University funds operations until March 2014. Future support will be determined through interagency discussions on the stewardship of CHESS as a national multidisciplinary user facility.

EarthScope

$26,170,000
+$1,120,000 / 4.5%

EarthScope
(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$26.02	$25.05	$26.17	$1.12	4.5%

The EarthScope facility is a distributed, multi-purpose geophysical instrument array that is helping researchers make 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 15-year life span of the program. Construction of EarthScope was completed September 30, 2008. FY 2009 was the first year of operation of the full EarthScope facility.

Total Obligations for EarthScope
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
EarthScope	$26.02	$25.05	$26.17	$42.51	$43.28	$44.05	$44.85	$45.65

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only. FY 2013 is the final year of the current cooperative agreement; funding beyond FY 2013 assumes continued operation of the EarthScope infrastructure by IRIS and UNAVCO under new awards which integrate the previous activities of these organizations.

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 Program 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 that 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.

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 experiments proposed by individual scientists, 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 1,200 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 and to collect rocks and fluids from the fault zone for laboratory study.

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 approximately $6.42 million. Increased support for EarthScope will enable the capital acquisition, long-term siting and operation of up to 250 EarthScope Transportable Array (TA) stations to be left in the central and eastern United States after the TA's proposed move to Alaska beginning in 2014.

Beginning in FY 2014, the separate seismic and geodetic facilities operated by the Incorporated Research Institutions for Seismology (IRIS), UNAVCO and EarthScope will be integrated into two facilities: (1) Seismological Facilities for the Advancement of Geosciences and EarthScope (SAGE) operated by IRIS and, (2) Geodesy for the Advancement of Geoscience and EarthScope (GAGE) operated by UNAVCO. SAGE will integrate IRIS core programs with the management and operation of EarthScope's Transportable, Flexible and Magnetotelluric arrays. GAGE will integrate UNAVCO's core activities with the management and operation of EarthScope's Plate Boundary Observatory.

Facility 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 and division director in EAR provide other internal oversight.
- External Structure: The external management structure includes the community-based EarthScope National Office, which recently moved from Oregon State University to Arizona 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 to provide advice for the EarthScope managers and NSF. NSF conducted a Business Systems Review (BSR) and issued a final report in July 2010.

Current Project Status

The EarthScope seismic and geodetic instruments consistently exceed 90 percent uptime, and have provided over 92 terabytes of data to the scientific community. EarthScope's open access data policy is having an impact on how experiments are planned and carried out, and is resulting in more scientists making data available to the community in real-time. As just one example, following the March 2010 magnitude 8.8 Chile earthquake, scientists from the United States, Chile, France, Germany, and elsewhere worked together to record critical data using EarthScope and other equipment, and in an unprecedented international partnership, all agreed to share all data collected through the IRIS Data Management Center, which hosts EarthScope data.

Although it became fully operational only during FY 2009, 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. Analysis of the unique SAFOD core from the San Andreas Fault is well underway, with more than 550 samples being analyzed by more than 20 research groups worldwide; in just the past two years, more than two dozen research papers using SAFOD samples have been published. The planned long-term SAFOD observatory has not been as successful, but an independent engineering panel convened through the Advisory Committee for Geosciences has reviewed the observatory and recommended possible paths forward, which have been incorporated along with community input into a new plan announced to the community in November 2011 through an NSF Dear Colleague Letter.

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 San Andreas Fault 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 disastrous Tohoku, Japan, earthquake and tsunami of March 2011. 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. Seismic data from the EarthScope Transportable Array, coupled with individual research projects using the Flexible Array, have provided images of the structure of the North American continent with unprecedented detail and scope.

New advances are also being made in joint modeling of EarthScope seismic and strain data with other data types such as those used in geochemistry and structural geology. EarthScope data have 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. Finally, EarthScope data are being used for unexpected discoveries with potentially transformative impact. Among these are use of EarthScope GPS measurements to understand the distribution of soil moisture and snow depth, key inputs to climate models across the western U.S., and vegetation greenness, a measure of the health of the environment and response to drought. Another example is the incorporation of atmospheric pressure sensors at the USArray Transportable Array stations, which is providing improved understanding of atmospheric structure and enhanced coverage of severe storms, along with better recordings of the seismic data that are the main focus of USArray. These new results have been incorporated in an updated EarthScope solicitation that was released in March 2011.

EarthScope has engaged a broad and steadily growing community of scientists. More than 150 unique investigators have received NSF funding through the EarthScope science program. Over 300 scientists came together for the May 2011 EarthScope National Meeting in Austin, TX, and during the 2011 American Geophysical Union (AGU) meeting, there were 75 presentations related to EarthScope in 46 special sessions spanning 11 different areas of AGU. Scientific results utilizing data collected by the EarthScope facility have already been presented at numerous national meetings and in professional publications.

Operations costs

Annual operations costs for EarthScope are anticipated to remain approximately steady, with annual adjustments for inflation.

Renewals/Recompetition/Terminations

In FY 2013, NSF will begin the phased integration of IRIS and UNAVCO core facilities with the EarthScope facilities operated by these organizations under two awards, one to IRIS and one to UNAVCO. In 2017 and 2018, NSF will recompete the operation of the two integrated facilities.

Gemini Observatory

$18,150,000
-$3,920,000 / -17.8%

Gemini Observatory
(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$19.50	$22.07	$18.15	-$3.92	-17.8%

Totals may not add due to rounding.

The Gemini Observatory consists of two infrared-optimized 8-meter telescopes, one in the northern hemisphere, in Hawaii, and one in the southern hemisphere, in Chile. The Hawaiian telescope, Gemini North, is situated on Mauna Kea at an altitude of 4,200 meters, while the Chilean telescope, Gemini South, is located at the outstanding photometric site of Cerro Pachon, 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. The Gemini telescopes provide 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)

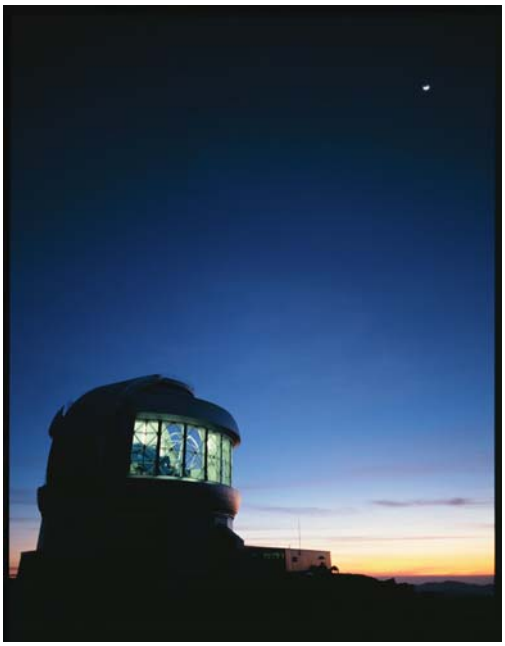
	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Operations and Maintenance	$19.50	$22.07	$18.15	$21.09	$21.61	$21.61	$21.61	$21.61

[1] Outyear funding estimates are for planning purposes only.

Astronomers are working to resolve important questions about the age and rate of expansion of the universe, its overall topology, the amount and nature of non-luminous matter, 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 large aperture (8-meter diameter and above) provides unsurpassed 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, as well as the ability to rapidly reconfigure the attached instrumentation in response to changing atmospheric conditions.

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 members also provide 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 several partner and non-partner countries. These industrial entities have involved firms specializing in large and/or complex optical systems, aerospace, 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.



The Gemini South telescope on Cerro Pachon in Chile prepares for the beginning of observation. The telescope is visible through the three-story-high vents on the rotating dome, which allow a strong air flow across the telescope to provide good image quality. *Credit: Gemini Observatory/Association of Universities for Research in Astronomy.*

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.

Laser guide star systems, which greatly improve the telescopes' ability to correct for atmospheric blurring, are available for both telescopes, with the laser on Gemini North in routine use. In 2011 first light on the sky was achieved and technical commissioning continued for an advanced "multi-conjugate" adaptive optics system, which will yield crisp images over a substantially larger field of view than previous laser systems. Several new instruments are in various states of development. A high-performance infrared spectrometer is now available for science observations; and the Gemini Planet Imager, an advanced camera for the southern telescope designed to directly detect planets around nearby stars, is undergoing subsystem acceptance testing.

The budget request for FY 2013 includes the full contribution to general operations committed in the Gemini international agreement, with a reduced contribution to the instrument development fund. This represents an offset for a contribution in FY 2012 that was above the international commitment. Budget projections for FY 2014 and beyond represent a level of effort adopted by the Gemini Board and NSF for planning purposes.

Facility Report

Management and Oversight

- NSF Structure: NSF has one seat on the Gemini Board and an additional NSF staff member serves as 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 Sciences. 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. 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

In late December 2009, the United Kingdom officially announced its intention to withdraw from the partnership post-2012. Following extensive discussions of the Gemini Board, the remaining partner countries decided to not increase their financial contributions nor to pursue a replacement partner, but rather to adjust the operations model of the Observatory to accommodate the approximately 24 percent reduction in operations budget. All partners with the exception of the U.K. then certified their commitment to this objective by renewing the International Agreement through the end of 2015.

The current NSF cooperative agreement to AURA for management of the Gemini Observatory originally covered calendar years 2006-2010 but was extended through June 30, 2012 to accommodate the partnership decisions described in the previous paragraph. A proposal from AURA to renew the cooperative agreement for the mid-2012-2015 timeframe was received in January 2011 and reviewed in March 2011. The review endorsed the Observatory's plan for the transition to the new operations model, which reduces the instrument complement available at each telescope, reduces the manpower requirements for the scheduling queue, reduces the development and outreach activities of the Observatory, and focuses the operation more on serving the partner user communities and less on internal scientific research activities. The funding recommendation for the renewal proposal was approved by the National Science Board in February 2012.

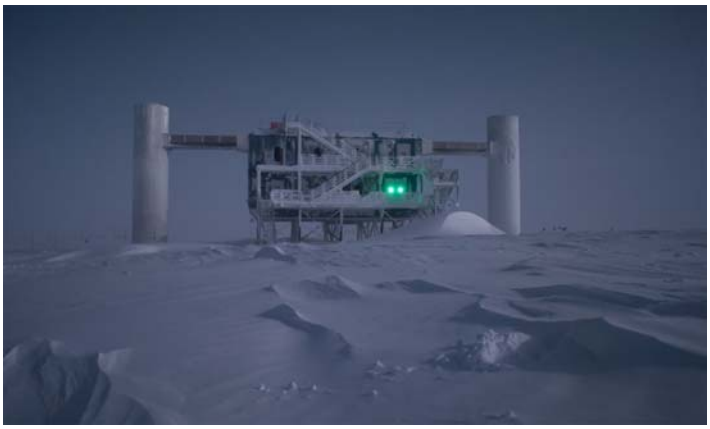
IceCube Neutrino Observatory

$6,900,000
+$0.00 / 0.0%

IceCube Neutrino Observatory
(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$12.19	$6.90	$6.90	-	-

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 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, is 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. 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) are derived from the IceCube data stream.



The IceCube project has transformed one kilometer cubed of natural Antarctic ice into a particle detector. The sensors keep watch for momentary flashes of blue light made by subatomic particles called muons; some are produced in collisions of neutrinos with atomic nuclei inside or near the detector. With the last hole instrumented on December 14, 2010, the IceCube detector has been taking data in its final configuration since May 16, 2011 with an up-time of well over 99 percent. IceCube detects one neutrino every 6 minutes in a background of 2700 cosmic ray muons per second. To handle the high rates, first analysis of the data is performed by a cluster of computers housed in a two-story building placed on top of the array. The filtered data is sent over satellite to the IceCube Research Center at the University of Wisconsin. *Credit: IceCube Collaboration.*

The Observatory includes a Deep Core Array (DCA), situated within the lower part of the center of the overall array. The DCA is composed of eight strings with the DOMs concentrated in the lower-middle part of the array. The tighter spacing of the DOMs allows the Observatory to detect lower energy neutrinos (down to about 10 GeV), thus opening the door to studies of neutrino oscillation measurements and studies of Weakly Interacting Massive Particles (WIMPs) below 250 GeV. In essence, the DCA closes the energy gap between the IceCube Neutrino Observatory and the Super-Kamiokande detector in Japan, and also allows effective observations of high-energy neutrinos entering from the sky of the southern hemisphere.

Total Obligations for IceCube

(Dollars in Millions)

	FY 2011	FY 2012	FY 2013	ESTIMATES[1]				
	Actual	Estimate	Request	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
R&RA Obligations:								
Operations & Maintenance (MPS)	$3.45	$3.45	$3.45	$3.45	$3.45	$3.45	$3.45	$3.45
Operations & Maintenance (OPP)	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45
Subtotal, R&RA Obligations	$6.90	$6.90	$6.90	$6.90	$6.90	$6.90	$6.90	$6.90
MREFC Obligations:								
Implementation	5.29	-	-	-	-	-	-	-
Subtotal, MREFC Obligations	$5.29	-	-	-	-	-	-	-
TOTAL Obligations	**$12.19**	**$6.90**	**$6.90**	**$6.90**	**$6.90**	**$6.90**	**$6.90**	**$6.90**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only. FY 2015 is the final year of the current cooperative agreement. Funding beyond FY 2015 assumes continued operation of the facility.

IceCube is led by the University of Wisconsin (UW) and was constructed with support from four countries (U.S., Belgium, Germany, and Sweden). The science collaboration is much broader, consisting of 16 U.S. institutions and 23 institutions in 10 other countries (Germany, Belgium, Sweden, New Zealand, Australia, Canada, Barbados, Japan, Switzerland, and the UK). NSF's foreign partners contribute a pro rata share of operations and maintenance costs based on the number of PhD-level researchers involved. IceCube construction was successfully completed at the South Pole on December 18, 2010, New Zealand Time.

Facility Report

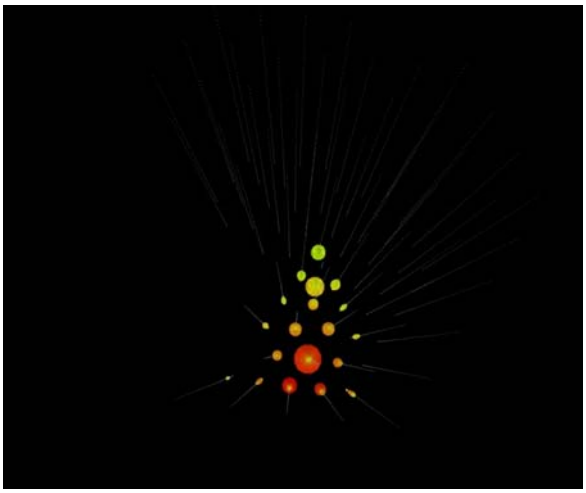
Management and Oversight

- NSF Structure: Oversight responsibility for IceCube is the responsibility of the Office of Polar Programs (OPP). Support for operations and maintenance, research, and education and outreach is shared by OPP and the Directorate for Mathematical and Physical Sciences (MPS), as well as other organizations and international partners. NSF provides oversight of IceCube through regular site visits by external reviewers.
- External Structure: The UW management structure for IceCube 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 and a Software and Computing Advisory Panel that meet annually and provide written advice to the project. UW leadership, including the Chancellor, provides additional awardee-level oversight.
- Reviews: NSF will conduct a review mid-way through the cooperative agreement in approximately October 2013. NSF conducted a Business Systems Review (BSR) and issued a final report in November 2007.

Operations Costs

Full operations and maintenance in support of scientific research began in FY 2011. The associated costs are and will continue to be shared by the partner funding agencies – U.S. (NSF) and non-U.S. – proportional to the number of PhD researchers involved (currently about 55:45). Since total annual costs are $12.50 million, the U.S. share of full science operations and maintenance is $6.90 million.

Support for U.S. institutions working on more refined and specific data analyses, data interpretation (theory support), and instrumentation upgrades is provided through the Research and Related Activities (R&RA) account in response to merit-reviewed proposals.



This image shows IceCube's display of the response of the lattice of light sensors to the shockwave of light produced by a muon passing through IceCube at the speed of light. One can recognize the muon track by its geometry as well as by the trail of sensors recording multiple photons (large colored dots—the smallest dots indicate sensors detecting a single photon). *Credit: IceCube Collaboration.*

The general operations of South Pole Station, reported in the Polar Facilities and Logistics narrative, 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. The expected operational lifespan of the IceCube Neutrino Observatory is 25 years beginning in FY 2011.

Education and Outreach

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 opportunity for involvement of students in international collaborations; 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. NSF supports evaluation and measurement-based education and outreach programs under separate R&RA grants to universities and other organizations that are selected following standard NSF merit review.

Renewal/Recompetition/Termination

The current IceCube Maintenance & Operations award expires in September 2015. Prior to expiration, the award will be re-competed in accordance with NSF policy.

Incorporated Research Institutions for Seismology

$11,250,000
-$1,110,000 / -9.0%

Incorporated Research Institutions for Seismology
(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$12.37	$12.36	$11.25	-$1.11	-9.0%

The Incorporated Research Institutes for Seismology (IRIS) operates a distributed, multi-user, national facility for the development, deployment, and operational support of modern digital seismic instrumentation to serve national goals in basic research and education 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 114 U.S. universities and non-profit institutions with research and teaching programs in seismology, 22 educational affiliates, and 108 foreign affiliates. 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 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Operations and Maintenance	$12.37	$12.36	$11.25	-	-	-	-	-

[1]Outyear funding estimates are for planning purposes only. In FY 2013, NSF will begin the phased integration of IRIS and IRIS-operated EarthScope facilities under a single award. For this reason, separate budget estimates for IRIS are not made beyond FY 2013.

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 under three Service Areas, which include five major core programs, and two Special Emphasis Areas:

- **Instrumentation Services**
  - The Global Seismographic Network (GSN) consists of a global deployment of over 150 permanently-installed broadband digital seismic stations, most of which have real-time data access;
  - The Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL) includes a pool of portable seismometers that are made available to the seismology research community for scheduled regional and local scale studies;
  - USArray is the seismological component of the EarthScope facility, operated by IRIS under separate funding from the NSF EarthScope Program. 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.
- **Data Services**
  - The IRIS Data Management System (DMS) provides the national and international seismic research community with timely access to data from the GSN and PASSCAL (130 terabyte archive);

- **Education and Public Outreach**
  - The IRIS Education and Outreach (E&O) Program enables audiences beyond seismologists to access and use seismological data and research for educational purposes, including teacher workshops, student internships, lectureships, museum exhibits, educational materials, school seismographs, and programs for under-resourced schools.
- **Special Emphasis Areas**
  - IRIS Polar Services, with supplemental funding from the NSF Office of Polar Programs, supports the development of specialized seismic equipment for use in harsh polar environments and provides instrumentation, training and field support for experiments in the Arctic and Antarctic.
  - International Development Seismology leverages the core IRIS Service Areas to provide capacity building and training for earthquake hazard mitigation in developing countries, through technical assistance and research collaborations with scientists at US academic institutions.

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.

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, Department of Energy, and State Department), 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.

A student volunteer prepares to deploy a sensor on a wind farm near Palm Springs, California, that will record high-frequency seismic waves for the Salton Sea Imaging Project. Principal Investigators: John Hole, Virginia Tech, Joann Stock, Caltech, and Gary Fuis, USGS. Credit: IRIS.

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, totaling approximately $15.0

million per year, for NSF-sponsored research making use of the IRIS facilities. Funds permit deployment of PASSCAL instruments and use of GSN data stored at the DMS to solve major Earth science problems. Overall, support of IRIS is reduced $1.11 million, to a total of $11.25 million in FY 2013, reflecting increasing efficiency and streamlining of operations with their new integrated management structure.

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 operational and administrative performance of IRIS.
- External Structure: IRIS is incorporated as a non-profit consortium representing 114 U.S. university and non-profit organizations with research and teaching programs in seismology. Each voting Member Institution of the Consortium appoints a Member Representative. However, all IRIS program and budget decisions are made by a nine-member Board of Directors, elected to three-year terms by the Member Representatives. These decisions are made after consultation with the IRIS advisory committees (seven committees for each of the major IRIS program areas and additional *ad hoc* working groups appointed for special tasks). The Board of Directors appoints a president of IRIS to a renewable two-year term. The president is responsible for IRIS operations, all of which are managed through the IRIS Corporate Office.
- Reviews: 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 a 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. A review of the IRIS Education and Outreach (E&O) Program also took place during 2009. The review panel found the E&O Program to be healthy but made a number of recommendations that are being considered by the seismological community as it prepares a new Strategic Plan for this program. NSF conducted a Business Systems Review (BSR) and issued a final report in January 2010.

Renewal/Recompetition/Termination

A proposal from IRIS for a 27-month renewal of support was submitted in August 2010; this will synchronize the IRIS award with the complementary EarthScope activity. A 27-month cooperative agreement with the IRIS Consortium for the continued management of the IRIS core facilities (2011-2013) was approved by the NSB in May 2011 and finalized in September 2011. In FY 2013, NSF will begin the phased integration of IRIS and IRIS-operated EarthScope facilities under a single award. For this reason, separate budget estimates for IRIS are not made beyond FY 2013.

The Integrated Ocean Drilling Program and the Scientific Ocean Drilling Vessel **$38,900,000**
-$5,500,000 / -12.4%

Integrated Ocean Drilling Program

(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Change over FY 2012 Estimate Percent
$53.35	$44.40	$38.90	-$5.50	-12.4%

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 the scientists, research institutions, and funding organizations of 25 nations 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 sea floor.

SODV Underway for Initial Science Expedition, March 10, 2009. *Credit: NSF*

Total Obligations for IODP

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Operations and Maintenance	$53.35	$44.40	$38.90	$40.00	$40.00	$40.00	$40.00	$40.00

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only. Funding for FY 2014 through FY 2018 is estimated assuming renewal of the program.

Annual operations and maintenance support for IODP includes the costs of operating the *Joides Resolution*, the primary platform of IODP. Maintaining databases, preparing scientific publications emerging from IODP expeditions, and management of the international program are additional IODP science integration costs, made minimal to NSF because of international contributions to the IODP program. In addition, NSF provides support for U.S. scientists to sail on IODP drilling platforms and to participate in the IODP Science Advisory Structure through an associated grants program. The annual costs for the associated science integration and science support (not included in the table above) are estimated to be about $12.0 million. Operations support is reduced in 2013. This reduction may result in fewer expeditions, however, the addition of new international members may mitigate this impact.

The IODP Scientific program includes emphasis on the following research themes:

- Deep Biosphere and the Sub-seafloor Ocean;
- Processes and Effects of Environmental Change; and
- 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 aid in their development as future leaders. 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. During each fiscal year, an estimated 180,000 K-12, 10,000 undergraduate and 10,500 graduate students, and 35,000 teachers are engaged in or supported by IODP education and outreach efforts.

MEXT and NSF are equal partners in IODP and contribute approximately 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, Korea, India, Australia, and New Zealand have also officially joined IODP and provide financial contributions. 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 2,400 scientists from 40 nations have participated on ODP and IODP expeditions since 1985, including approximately 1,080 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 a light drillship (see the SODV discussion below) 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. Reduction in NSF support for operations will be offset with new sources of revenue from international partners and/or industry.

Facility Report

<u>Management and Oversight</u>

- NSF Structure: The Division of Ocean Sciences (OCE) 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 a light drillship through a contract with the U.S. systems integration contractor, an alliance formed by

the Consortium for Ocean Leadership, Inc. (COL) together with subcontractors at 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), recently streamlined and made more efficient in response to independent, contractual management review. The SAS now consists of a Science Implementation and Policy Committee (SIPCOM), a Proposal Evaluation Panel (PEP), and a series of service panels. The CMO is responsible for coordinating the SAS committee and panels, and for integrating the advice from the SAS into drilling and operational guidance for IODP. Representation in the SAS is proportional to IODP member financial contributions.
- Reviews: Both the CMO and SIC contracts call for management reviews every three years by independent, external panels. Both the SIC and CMO contracts underwent external review in FY 2010, and are available at www.iodp-usio.org/Publications/IODP_OA_2010.pdf and www.iodp.org/triennium-review/. Performance under both contracts will be reviewed again in FY 2013. 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 an independent panel every several years.

Renewal/Recompetition/Termination

The current IODP program officially ends in 2013, with IODP international agreements and contracts covering activities through FY 2013. NSF activities regarding a possible IODP renewal, including overall program review, commenced in FY 2010. IODP scientific community planning efforts for a possible post-FY 2013 science program commenced in FY 2009.

Scientific Ocean Drilling Vessel (SODV)

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 $115.0 million, appropriated through the MREFC account over three years, with FY 2007 representing the final year of appropriations. The ship owner and operator, Overseas Drilling Limited (ODL), covered an additional $15.0 million in construction costs in exchange for a higher day-rate charge during operations. This higher day-rate charge will expire at the end of FY 2013, with reversion to the lower base day-rate for a contractually guaranteed ten years if IODP is renewed. Construction activities have been completed and the ship commenced international scientific operations on March 5, 2009. It has since proved highly reliable, with a facility efficiency rating approximating 100 percent. As well, the drillship and crew have broken numerous scientific coring depth records, with recovered core being of extremely high quality. 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.

Assessment of the SODV science facilities, with emphasis on its data management systems, was conducted during summer 2010 by an independent, international group of ocean drilling geoscientists. The ship has completed fifteen IODP expeditions with exceptional reliability and demonstrably superior coring capability (both the single bit rotary coring and global piston coring depth records have been broken).

Notably, the ship recently completed two expeditions assessing the presence and abundance of subseafloor life in both Pacific and Atlantic Ocean crust. Specialized downhole logging tools were deployed to detect microbial presence and abundance, and sophisticated long-term borehole observatories

were left in place to sample and culture subseafloor microbes in an effort to better assess the abundance and diversity of life in this extreme but globally widespread environment.

Large Hadron Collider

$18,000,000
$0.00 / 0.0%

Large Hadron Collider
(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$18.00	$18.00	$18.00	-	-

Totals may not add due to rounding.

The Large Hadron Collider (LHC), an international project at the CERN laboratory in Geneva, Switzerland, is the premier facility in the world for research in elementary particle physics. The facility consists of a superconducting particle accelerator providing two counter-rotating beams of protons, approximately 16.5 miles in circumference, with each beam to have an energy up to 7 TeV ($1TeV=10^{12}$ electron volts). It can also provide colliding beams of heavy ions, such as lead. Because of start-up difficulties encountered with the accelerator in 2008, data-taking with colliding proton beams was delayed until the Spring 2010, beginning at a lower beam energy of 3.5 TeV. Starting in 2013, the LHC will undergo repairs and upgrades that will enable it to operate at the design energy of 7 TeV per beam. During this period the detectors will undergo a series of repairs and maintenance to prepare them for higher-energy operations. The accelerator, the detectors, and the LHC computing grid (described below) performed very well during the 2010 and 2011 running periods, successfully collecting five times more data than originally planned.

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 occur in intersection regions where the two beams are brought together. They are also being used to study the reaction products from heavy ion beam collisions. A total of 44 international funding agencies participate in the ATLAS detector project and 40 in the CMS detector project. NSF and the Department of Energy (DOE) provide U.S. support to both experiments. CERN is responsible for meeting the goals of the international LHC project. The ATLAS and CMS detectors take data approximately 200 days per year. The remaining time is to be used for maintenance and testing.

The U.S. LHC collaboration continues to be a leader in the development of grid-based computing. The grid enables 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 LHC
(Dollars in Millions)

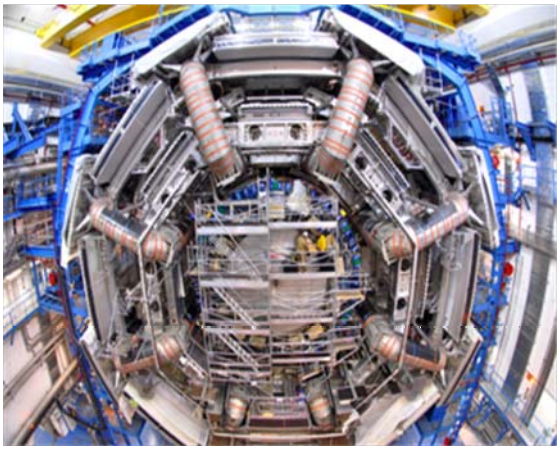
	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Operations and Maintenance	$18.00	$18.00	$18.00	$20.00	$20.00	$20.00	$20.00	$20.00

[1] The current cooperative agreement ends in FY 2016. Funding estimates beyond FY 2016 are for planning purposes only.

The LHC is enabling 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 program also

includes searches for particles predicted by a powerful theoretical framework known as supersymmetry, which may provide clues as to how the known forces, weak, strong, electromagnetic, and gravitational, 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 2013 the estimate for material procurements is approximately $5.0 million, which is included within the $18.0 million detector operating costs.



The ATLAS detector in February 2007. *Credit: CERN.*

Both U.S. LHC collaborations did extensive commissioning of the detectors and the data analysis systems using cosmic rays, while the accelerator was being repaired after the failure of one of the superconducting magnets in 2008. As a result, with the advent of colliding beams in the Spring of 2010, the detectors began immediately collecting data at very near design performance levels, which was unprecedented for the start-up of such complex instruments. Both collaborations continue to operate the detectors smoothly and to analyze the collected data efficiently using world-wide grid resources. The LHC experiments are also adapting quickly to the significant increases in beam intensities. While challenging, these increases in intensity significantly enhance the chances of ground-breaking discoveries at the LHC. During the accelerator shut-down period in 2013, the collaborations will carry out needed maintenance on the detectors while continuing to analyze the many Petabytes of data collected in the previous two years.

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, and International Science and Engineering, as well as the Office of the Assistant Director for the Directorate of Mathematical and Physical Sciences (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 bi-weekly telephone reviews by NSF/DOE program directors to monitor progress. The next major management/technical review is scheduled for March 2012. Two JOG review meetings per year monitor overall program management.

Renewal/Recompetition/Termination

The LHC project is expected to continue at least through the end of the next decade. In December 2011, a new cooperative agreement was negotiated with the ATLAS and CMS collaborations to extend funding for an additional five years to support their role in the international collaborations of which they are members.

Laser Interferometer Gravitational-Wave Observatory

$30,500,000
+$100,000 / 0.3%

Laser Interferomter Gravitational-Wave Observatory

(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$30.30	$30.40	$30.50	$0.10	0.3%

Totals may not add due to rounding.

Einstein's theory of general relativity predicts that cataclysmic processes involving extremely dense objects in the universe, such as the collision and merger of two neutron stars or black holes, will produce gravitational radiation. Detection of these gravitational waves is of great importance for fundamental physics, astrophysics, and astronomy. 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; the Hanford chamber contains a second 2-km interferometer. The interferometers are used to measure minute changes in the distances between mirrors 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 source is on the order of one part in 10^{21}, meaning that the expected change over the apparent 4-km length is only on the order of 4×10^{-18} meters, 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.

An aerial view of the Livingston, LA LIGO site. *Credit: Caltech/MIT LIGO Laboratory.*

In April 2008 construction began on the Advanced LIGO MREFC project (AdvLIGO), which is designed to increase the sensitivity of LIGO tenfold. AdvLIGO is being built within the existing LIGO laboratory. LIGO's current and projected operations and maintenance expenses are designed to sustain operation of the LIGO laboratory during the time that the construction is underway. These include support for the basic infrastructure costs not directly related to the AdvLIGO construction project, support for data analysis for the S5 and S6 science runs, maintenance of computational resources for data storage and analysis, support for R&D for any pre-design costs and risk reduction related to AdvLIGO that are outside the scope of the AdvLIGO project, and support for the education and outreach projects associated with the laboratory.

Total Obligations for LIGO

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Operations and Maintenance	$30.30	$30.40	$30.50	$30.50	$30.50	$30.50	$30.50	$30.50

[1] Outyear funding estimates are for planning purposes only.

The LIGO Science Education Center at the Livingston site is the focal point for augmenting teacher education at Southern University and other student teacher activities state wide through the Louisiana Systematic Initiative Program. The LIGO Science Education Center's programs include funding for an external evaluation firm that provides both assistance in aligning future activities with proposed goals and evaluating outcomes.

Substantial connections with industry have been required for the state-of-the-art construction and measurement involved in LIGO projects, with some innovations leading to new products. Interactions with industry include exploring novel techniques for fabrication of LIGO's vacuum system, seismic isolation techniques, ultrastable laser development (new product), high optical power electrooptic components (new products), new ultra-fine optics polishing techniques, and optical inspection equipment (new product).

Installation of a quantum-mechanical squeezing experiment at LIGO in 2011. The temporary experiment allowed LIGO to increase its sensitivity by more than 20% over most of its frequency range. Such research is conducted by LIGO Laboratory and the LIGO Scientific Collaboration to reduce risk in the Advanced LIGO construction project. *Credit: Caltech/MIT LIGO Laboratory.*

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 77 collaborating institutions in 15 countries with more than 870 participating scientists, and LSC membership is growing at a rate of approximately 10 percent per year. 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, provided through the disciplinary programs.

LIGO concluded its initial phase of existence with the S6 science run, which, in addition to the acquisition of science data, also tested technologies that will become part of AdvLIGO. This run began in July 2009 and ended in October 2010. The detector sensitivity was about 30% higher than that during the previous S5 run, making the S6 science run both a scientific success and a valuable testbed for AdvLIGO. At the end of this run the LIGO instruments were turned over to the AdvLIGO project for decommissioning and for the installation of advanced components. LIGO and the LSC are currently analyzing the data from the S6 run.

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 NSF Offices of General Counsel, Legislative and Public Affairs, International Science and Engineering , as well as the the Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management .
- External Structure: LIGO is managed by the California Institute of Technology under a cooperative agreement. The management plan specifies significant involvement by the user community, represented by the LSC, and collaboration with the other major gravitational-wave detector activities in Asia, Europe, and Australia. External peer-review committees organized by NSF help provide oversight through an annual review.
- Reviews:
  - AdvLIGO Baseline Review, May-June 2006
  - LIGO Annual Review, November 2006
  - AdvLIGO Baseline Update Review, June 2007
  - LIGO Annual Review and LIGO FY 2009-2013 Operations Proposal Review, November 2007
  - LIGO Business Systems Review (BSR), final report issued March 2008.
  - LIGO Annual Review, November 2008
  - AdvLIGO Annual Review, April 2009
  - LIGO Annual Review and AdvLIGO Interim Review, December 2009
  - AdvLIGO Annual Review, April 2010
  - LIGO Annual Review and AdvLIGO Interim Review, December 2010
  - AdvLIGO Annual Review, April 2011
  - LIGO Annual Review and AdvLIGO Interim Review, November 2011
  - LIGO Annual Review and AdvLIGO Interim Review, November 2012

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.

National High Magnetic Field Laboratory

$31,750,000
+$5,950,000 / 23.1%

National High Magnetic Field Laboratory
(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$32.68	$25.80	$31.75	$5.95	23.1%

Totals may not add due to rounding.

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). NHMFL develops and operates high magnetic field facilities that scientists and engineers use for research in core areas of condensed matter and material physics, materials science and engineering, solid state chemistry and various areas of the biological and biochemical sciences, as well as work on energy and the environment. It is the world's premier high magnetic field laboratory with a comprehensive assortment of high-performing magnet systems and extensive support services. The facilities are available to all qualified scientists and engineers through a peer-reviewed proposal process; external users number about 1,100 per year as well as faculty and staff at the three collaborating institutions.

The lab is an internationally recognized leader in magnet design, development, and construction, including the development of conducting and superconducting materials. Many of the unique magnet systems were designed, developed, and built by the Magnet Science and Technology (MS&T) Division of NHMFL. In 2011, the lab set the world's record for the highest nondestructive pulsed magnetic field reaching 97.4 tesla. The 45 tesla hybrid magnet currently provides the highest steady state magnetic fields in the world. Both magnets enable scientists to get new insights on the electronic structure of novel materials such as graphene, topological insulators, high temperature superconductors and more. The 45 tesla magnet supports experiments that require longer time whereas experiments on the 97.4 tesla pulsed magnet can be done in a fraction of a millisecond.) 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.

Two FY 2010 actions -- a $15.0 million award funded by the American Recovery and Reinvestment Act of 2009 (ARRA) and a $2.56 million award funded by regular appropriated dollars -- are supporting design and development of a 21 tesla magnet and world-record-holding advanced mass spectrometer. This equipment will be capable of analyzing chemical samples of unprecedented complexity, such as biological fluids and biofuels, and with unprecedented speed. This new capability will have high impact in several areas including chemistry, molecular biology, and heavy petroleum analysis.

The FY 2013 Request will allow the facility to continue operations, focus on magnet development, and strengthen education, training, user support, and in-house research. It is consistent with prior levels for this activity. The FY 2012 level, by contrast, reflects advanced funding provided from earlier appropriations.

Total Obligations for NHMFL
(Dollars in Millions)

	FY 2011	FY 2012	FY 2013	ESTIMATES[1]				
	Actual	Estimate	Request	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Operations and Maintenance	$32.68	$25.80	$31.75	$31.75	$31.75	$31.75	$31.75	$31.75

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

Current magnet development at NHMFL focuses on new energy-saving, high-field magnet technologies, including the design, development and construction of all-superconducting magnets based on high-temperature superconductor technology. The goal is to develop high-field magnets for the NHMFL user program that double current energy-efficiency. NHMFL collaborates with more than 60 private sector companies, including Cryomagnetics, Pfizer, SuperPower, and Oxford Superconductor Technologies, 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 at Argonne National Laboratory. International collaboration includes magnet development with the Helmholtz-Zentrum Berlin (HZB) (previously known as the Hahn-Meitner-Institute Berlin), the International Thermonuclear Experimental Reactor (ITER) in France, and national magnet labs in France, the Netherlands, Germany, and China.

NHMFL provides a unique interdisciplinary learning environment. The Center for Integrating Research and Learning at NHMFL conducts education and outreach activities, which include a Research Experience for Undergraduates, summer programs for teachers, and a summer camp for young girls in middle schools, including programs to raise the scientific awareness of the general public.

Facility Report

Management and Oversight

- NSF Structure: NHMFL is supported by the Division of Materials Research (DMR) and the Division of Chemistry (CHE) in the Directorate for Mathematical and Physical Sciences (MPS). DMR is the steward supporting the broad mission of the facility, providing 95 percent of the funds. CHE supports the Fourier Transform Ion Cyclotron Resonance Laboratory and provides about 5 percent. 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 Directorate for Biological Sciences. Site visit reviews are conducted annually. In addition to a panel of experts from the community, representatives from other federal agencies such as DOE and the National Institutes of Health (NIH) attend these site visits.
- External Structure: A consortium of the three institutions (FSU, UF, and LANL) operates NHMFL 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. Four senior faculty members are co-principal investigators. The NHMFL director receives guidance and recommendations from an external advisory committee, the NHMFL executive committee, the NHMFL science council, the NHMFL diversity committee, participating institutions, and the users' executive committee.
- Reviews: NSF conducts annual external reviews, 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 and upcoming reviews include:

- Business Systems Review (BSR), final report issued in September 2009.
- Renewal Review by external panel of site visitors, December 2011.
- National Research Council study on the future of high field magnetic science, started in FY 2012.

Renewal/Recompetition/Termination

A comprehensive renewal review was conducted in FY 2007. On August 8, 2007 the National Science Board approved a five-year renewal award not to exceed $162.0 million for FY 2008-2012. A 5-year renewal proposal for the operation of the NHMFL from FY 2013 through FY 2017 was submitted to NSF in summer 2011 and is currently under review, with results expected in summer 2012. NSF has initiated broad-based community input through the National Research Council to plan for the Nation's long-term investment in high magnetic field research.

National Nanotechnology Infrastructure Network

$15,360,000
-$500,000 / -3.2%

National Nanotechnology Infrastructure Network

(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$16.36	$15.86	$15.36	-$0.50	-3.2%

Totals may not add due to rounding.

The National Nanotechnology Infrastructure Network (NNIN) is in the second and final five-year funding period from FY 2009-2013. NNIN 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 expertise 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 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Operations and Maintenance	$16.36	$15.86	$15.36	$15.36	$15.36	$15.36	$15.36	$15.36

[1] Outyear funding estimates are for planning purposes only. FY 2013 is the final year of the current cooperative agreement. Funding beyond FY 2013 assumes continued operation of the facility.

NNIN's broad-based national user facilities enable the Nation's researchers from academia, small and large industry, and government to pursue transformative research, seek new discoveries and applications in a broad range of domains of nanoscale science and engineering, and 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. The NNIN user facilities promote interdisciplinary research by bridging the gap between materials, mechanics, electronics, photonics, biology and diverse fields, and enabling longitudinal pathways from fundamental studies to devices and systems.

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.

Three institutions joined the network in the renewal period, each bringing new capabilities and broadening the user base: the University of Colorado, which focuses on research in energy-related problems and in precision sciences that include measurements, standards, and systems; Arizona State University, which focuses 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, whose research focuses on nanomaterials and nanosciences for environment, health, and safety. NNIN, through lead efforts at the University of Washington and University of Michigan, is also serving as a technology source to facilitate collaboration between the ocean sensing infrastructure geoscienses community and the nanotechnology sensor community.

During its eighth year of operation encompassing the 10 month period from March 2011 through December 2011, 5,626 unique users (an increase of 5 percent over the previous year 10 month period) performed a significant part of their experimental work at NNIN facilities. Of these, 4,700 were academic users, mostly graduate students, 865 industrial users, 29 users from State and Federal laboratories, and 32 users from foreign institutions. Included in the above are 644 users from more than 300 small companies who used NNIN facilities during this period. Over 2,700 publications, several of them significant scientific and engineering highlights of the year, resulted from the work of the user community. A major task of staff of NNIN is in training of this user community, particularly graduate students from across the United States, where there is a continuous and significant turnover. A total of 1,925 new users were trained in the vast instrument set, large and small, at the network's facilities.

Facility Report

Management and Oversight

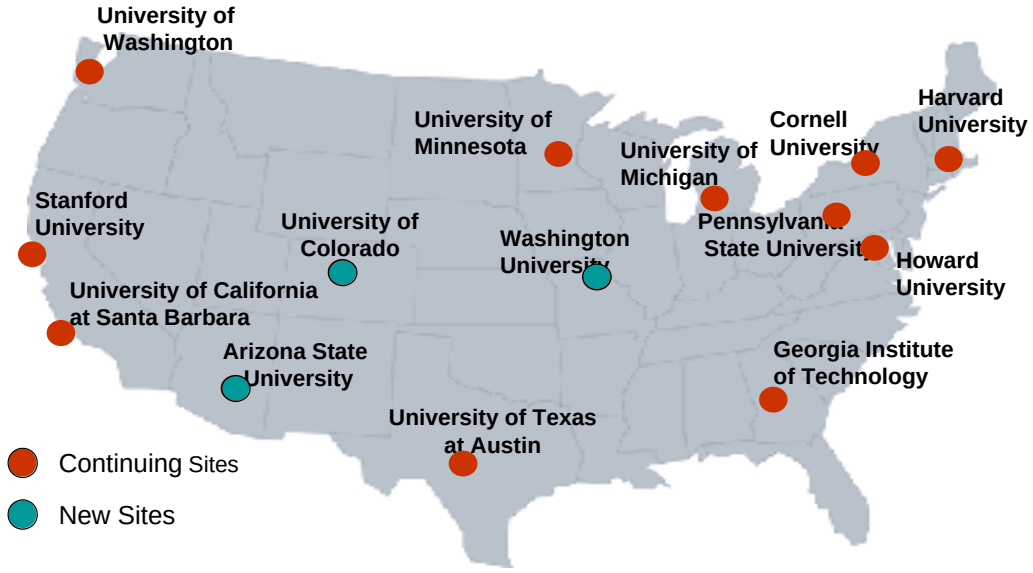
- NSF structure: NSF provides oversight of NNIN under a cooperative agreement with Cornell University, the lead institution. The program officer for the NNIN activity resides in the Division of Electrical, Communications and Cyber Systems (ECCS) in the Directorate for Engineering (ENG). The program officer 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 position of Network Director, which has previously resided with Professor Sandip Tiwari at the lead institution, Cornell University, has at his request and NSF concurrence now been transferred to Professor Roger Howe, director of the Stanford University site. The Network Director provides intellectual leadership for the network and is also 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 the Stanford University site in May 2008. This review also served to evaluate the NNIN renewal proposal for the five-year period FY 2009-2013. A mid-year informational review was held at NSF in October 2009. The sixth annual review was held at the University of Washington site in May 2010. The seventh annual review was held at the University of Colorado-Boulder site in May 2011
  - Upcoming reviews: The eighth annual review will be held at the Georgia Institute of Technology site in May 2012.

Renewal/Recompetition/Termination

The National Science Board approved NSF's review-based recommendation in December 2008 and authorized renewal of the NNIN award for a final five-year period from FY 2009-2013. NSF plans to convene a panel of recognized national experts in 2012 to evaluate the needs of, and appropriate future investments in, the national infrastructure for nanotechnology. This evaluation would be followed by an open recompetition process for the period FY 2014 and beyond.



National Solar Observatory

$8,000,000
-$1,100,000 / -12.1%

National Solar Observatory
(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$9.10	$9.10	$8.00	-$1.10	-12.1%

Totals may not add due to rounding.

The National Solar Observatory (NSO) operates facilities in New Mexico and Arizona as well as a coordinated worldwide network of six telescopes 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 may 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 also provides routine and detailed, synoptic solar data used by many researchers and other agencies through its online archive and data delivery system.

NSO telescopes are open to all astronomers regardless of institutional affiliation on the basis of peer-reviewed observing proposals. In 2011, 84 unique observing programs from 15 U.S. and 17 foreign institutions were carried out using NSO facilities. Students carried out twenty six per cent of these programs, which included 28 Ph.D. thesis programs. Nearly nine terabytes of NSO synoptic data were downloaded from the NSO digital archives.

The Division of Astronomical Sciences (AST) is carrying out a community-based review of its entire portfolio and it is expected that this review will be completed during FY 2012. Its output will inform future budget allocation and planning activities.

Total Obligations for NSO
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
NSO-Operations	$7.25	$7.25	$6.70	$6.70	$6.70	$6.70	$6.70	$6.70
NSO-Development	1.50	1.50	1.00	1.00	1.00	1.00	1.00	1.00
NSO-Research & Education	0.35	0.35	0.30	0.30	0.30	0.30	0.30	0.30
Total, NSO	**$9.10**	**$9.10**	**$8.00**	**$8.00**	**$8.00**	**$8.00**	**$8.00**	**$8.00**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only and do not include ATST operations.

Partnerships and Other Funding Sources: Thirty-seven U.S. member institutions and seven international affiliate members comprise the Association of Universities for Research in Astronomy, Inc. (AURA), the management organization for NSO. Other partners include the U.S. Air Force Office of Scientific Research, U.S. Air Force Weather Agency, NASA, and industrial entities. 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 sub-awards to aerospace, optical fabrication, and information technology

companies. Observing time on NSO telescopes is assigned on the basis of merit-based review. No financial support accompanies telescope time allocation.

Education and Public Outreach: NSO supports U.S. education goals by promoting public understanding and support of science and by providing education and training at all levels. NSO introduces undergraduate students to scientific research by providing stimulating environments for basic astronomical research and related technologies through NSF's Research Experiences for Undergraduate students (REU) program. NSO has diverse education programs, including teacher training and curriculum development, visitor centers, and a web-based information portal at www.nso.edu.

NSO-Operations, $6.70 million: NSO Operations include facility operations at Sacramento Peak Observatory (SPO) in New Mexico, the world-wide Global Oscillations Network Group (GONG), and solar facilities based on Kitt Peak, Arizona. ATST will replace several of the NSO telescopes at SPO and on Kitt Peak.

NSO-Development, $1.0 million: NSO reporting now includes only work apart from ATST, notably for the synoptic program consisting of the GONG array and the SOLIS telescope.

NSO-Research & Education, $300,000: NSO supports public education in solar physics through its education and public outreach office at SPO. This office provides science community outreach, a visitors' center, news and public information, and the activities on Maui in collaboration with University of Hawaii Maui Campus.

ATST infrastructure, $0.0 million in this narrative ($2.0 million in the ATST narrative): In its Record of Decision authorizing ATST construction, NSF agreed to mitigation activities of $2.0 million per year for ten years. This support, which began in FY 2011, is provided through the ATST budget in the Research and Related Activities account, not the MREFC construction project account. Please see the ATST narrative in the MREFC chapter for more information.

Facility Report

Management and Oversight

- NSF Structure: An NSF program director in the Division of Astronomical Sciences (AST) provides continuing 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 NSO as well as attending AURA Solar Observatory Council meetings. The latter committee is formed from the national solar physics community and provides a window into community priorities and concerns. The AST program manager works 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 in the Office of Budget, Finance, and Award Management.
- External Structure: AURA is the managing organization for NSO. The NSO director reports to the president of AURA, who is the principal investigator on the FY 2010 NSF cooperative agreement. AURA receives management advice from its Solar Observatory Council, composed of members of its scientific and management communities. NSO employs visiting and users' committees for the purposes of self-evaluation and prioritization. The visiting committee, composed of nationally prominent individuals in science, management, and broadening participation, reviews for AURA all aspects of the management and operations of NSO. The users committee, composed of scientists with considerable experience with the observatory, reviews for the Director all aspects of NSO that affect user experiences at the 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. The last extensive review for NSO was in FY 2008 that led to the award of a new cooperative agreement at the beginning of FY 2010. Annual reviews are anticipated for both NSO program plans and the ATST project, beginning in spring 2011. A Business Systems Review is scheduled for spring 2012.

Renewal/Recompetition/Termination

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 a new cooperative agreement with AURA for management and operation of NSO for the period October 1, 2009, through March 31, 2014. Since NSO is the home for the ATST project, which is expected to begin operation in 2018, it is anticipated that the current cooperative agreement will be renewed without competition upon its expiration in 2014.

The NSO's SOLIS (Synoptic Optical Long-term Investigations of the Sun) instrument on Kitt Peak, Arizona. SOLIS provides detailed image, spectral, and magnetic data of the sun that is distributed in near real-time by the web. *Credit: NSO/AURA.*

National Superconducting Cyclotron Laboratory

$21,500,000
+$0.00/ 0.0%

National Superconducting Cyclotron Laboratory
(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$21.50	$21.50	$21.50	-	-

The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University (MSU) is a university-based national user facility. With two linked 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 faculty and staff research program.

Total Obligations for NSCL
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Operations and Maintenance	$21.50	$21.50	$21.50	$21.50	$21.50	$20.00	$15.00	$10.00

[1]Outyear funding estimates are for planning purposes only.

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 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. The laboratory is completing construction and commissioning of an MSU-funded reaccelerator facility (ReA3) that will enable experiments at very low energies – a domain of particular interest to nuclear astrophysics.

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. The lab also provides research experiences for undergraduate students, K-12 students, and K-12 teachers.

The coupled cyclotron facility supports a broad experimental program. The mix of experiments is determined by beam use proposals. An external program advisory committee selects the best proposals at a typical success rate of about 50 percent. The science output of NSCL is driven by these experiments – 4,000-4,500 beam hours each year, with most running one to three days.

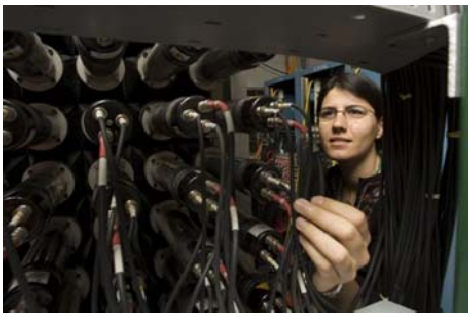
Facility Report

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 Division of Physics and other staff, accompanied by external experts.
- External Structure: NSCL is managed by its 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 expert, 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 proposal submission opportunities each year. About 5,000 beam hours are provided for experiments annually, with a backlog of at least a year.
- Reviews:
  - Total Business Systems Review (TBSR), report issued in January 2008.
  - Latest Review: A 5-year review in FY 2011 covered results and achievements related to intellectual merit and broader impacts for the past five year period (FY 2007 – FY 2011), and future funding for the next five year period (FY 2012 – FY 2016).
  - Next Review: An annual review is planned for May 2012. Review topics include science, operations, and future funding.

Renewal/Recompetition/Termination

In December 2008 the Department of Energy (DOE) announced that it had selected Michigan State University as the site for a new world-class rare isotope Facility for Rare Isotope Beams (FRIB). FRIB will be built on the site of the present NSCL and will make use of much of the NSCL beamlines and general infrastructure. Michigan State University will be the performing institution under a cooperative agreement with DOE for the future FRIB, which is now in the preliminary design stage. A recent National Science Board (NSB) resolution approved a new 5-year renewal of the present Cooperative Agreement, which expires at the close of FY 2016. The FRIB cooperative agreement between DOE and MSU was signed in 2009. To facilitate interagency planning and allow for a smooth transition from the NSF-funded NSCL to the DOE-funded FRIB, a Joint Oversight Group (JOG) of DOE and NSF personnel has been established.



An NSCL research associate adjusts a cabling on a detector. *Credit: NSCL.*

Network for Earthquake Engineering Simulation

$20,500,000
+$0.00 / 0.0%

Network for Earthquake Engineering Simulation

(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$20.10	$20.50	$20.50	-	-

The Network for Earthquake Engineering Simulation (NEES) is a national, networked simulation resource of 14 advanced, geographically distributed, multi-user 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 United States, networked together through a high performance Internet2 cyberinfrastructure system (NEEShub). NEES completed construction on September 30, 2004, and opened for user research and education projects on October 1, 2004. NEES was operated during FY 2005-FY 2009 by NEES Consortium, Inc., located in Davis, CA. During FY 2008 and FY 2009, NSF recompeted NEES operations using program solicitation NSF 08-574, George E. Brown, Jr. Network for Earthquake Engineering Simulation Operations (NEES Ops) FY 2010-FY 2014. The outcome of that competition was an award to Purdue University to operate NEES from FY 2010-FY 2014. Through a five-year cooperative agreement with NSF (FY 2010-FY 2014), Purdue University operates the NEES experimental facilities and cyberinfrastructure; coordinates education, outreach, and training; and develops national and international partnerships.

Total Obligations for NEES

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Operations and Maintenance	$20.10	$20.50	$20.50	$20.50	$20.50	$20.50	$20.50	$20.50

[1] Outyear funding estimates are for planning purposes only. FY 2014 is the final year of the current cooperative agreement. Funding beyond FY 2014 assumes continued operation of the facility.

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. Purdue University operates NEES under a strategic plan and develops 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. Purdue also organizes an annual meeting for NEES users/researchers and facility operators.

Through the National Earthquake Hazards Reduction Program (NEHRP), which includes the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), and NSF, NEES supports research and outreach 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 leverages and complements its capabilities through connections and collaborations with large testing facilities at foreign earthquake-related centers, laboratories, and institutions. NSF has developed a partnership to utilize the NEES infrastructure with the 3-D Full-Scale Earthquake Testing Shake Table Facility (E-Defense), located in Miki City, Japan, 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 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. The annual planning meeting was held at the E-Defense facility in August 2011 to continue to develop research topics and experiments for NEES/E-Defense collaboration. Two NSF-supported research projects conducted tests at the E-Defense facility during FY 2009 to investigate new seismic design methodologies for mid-rise wood frame buildings and steel frame structures, and collaborative testing on reinforced concrete structures was conducted during December 2010. In August 2011, two NSF-supported research projects used a full-scale, five-story steel frame structure at the E-Defense facility to test new seismic base isolation concepts and the response of non-structural systems during strong seismic motion.

Using a unique landslide tsunami generator, researchers at the Georgia Institute of Technology in cooperation with faculty at University of Alaska at Fairbanks are investigating a methodology for improved assessment and mitigation of landslide and tsunami hazards. Field data from landslide-generated tsunamis events are limited to very few cases with marginal data that are generally missing the most important information related to tsunami generation characteristics. Researchers are compensating for this lack of field data by creating physical models of three-dimensional tsunami generation by deformable landslides and source run-up in the NEES Tsunami Wave Basin at Oregon State University. *Credit: Devin K. Daniel, California Polytechnic State University, San Luis Obispo, NEES summer 2010 REU student.*

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 NEEShub 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 $9.0 million in FY 2013. These awards support basic research in multi-hazard engineering involving experimental and computational simulations at the NEES facilities, addressing important challenges in earthquake and tsunami engineering research. ENG support for NEES Operations in FY 2013 will continue to support core research conducted at the 14 network sites through FY 2014.

Facility Report

Management and Oversight

- NSF structure: NSF provides oversight to NEES operations through a cooperative agreement with Purdue University during FY 2010-FY 2014. NEES operations are reviewed through annual site

visits and through periodic site visits to the individual NEES facilities. The annual site reviews are held at either the headquarters or at one of the network facilities. All reviews involve an external team of experts selected by NSF staff. The NSF program manager for NEES is located in the Division of Civil, Mechanical and Manufacturing Innovation (CMMI) in the Directorate for Engineering (ENG). The Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management (BFA) provides advice and assistance.

- External structure: Purdue University provides the headquarters and staffing to coordinate network-wide operation of the NEES experimental facilities, cyberinfrastructure, and education, outreach, and training activities as well as develop national and international partnerships. Day-to-day operations of the network are overseen by the headquarters staff led by a director. A governance board meets several times a year and provides independent advice and guidance to the director concerning the network's programs, activities, vision, funding allocations, and new directions. The governance board shares its major recommendations with the NSF. Each of the 14 experimental facilities has an on-site director responsible for local day-to-day equipment management, operations, and interface with Purdue, other NEES facilities, users, and the NEEShub for network coordination. The NEEShub provides telepresence, the NEES Project Warehouse data repository, and 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
  - Transition review: April 2010
  - Management reviews: NSF BFA Business Systems Review: March 2011
  - Mid-award operations reviews: NSF Annual Merit Reviews: FY 2010-FY 2013
  - Experimental facility reviews: Up to three annually: FY 2010-FY 2013

Renewal/Recompetition/Termination

In FY 2008, NSF recompeted NEES operations for a second five-year period from FY 2010-FY 2014. The competition was announced in program solicitation NSF 08-574, George E. Brown, Jr. Network for Earthquake Engineering Simulation Operations (NEES Ops) FY 2010-FY 2014. As an outcome of that competition, the National Science Board, at its August 5-6, 2009 meeting, approved NSF's recommendation for a five-year cooperative agreement (FY 2010-FY 2014) to Purdue University. Annual funding to Purdue University for NEES operations is based upon satisfactory progress and availability of funding. During FY 2010, the prior NEES operations awardee, NEES Consortium, Inc., was supported by NSF to provide continuity of operations and to help transition software, documents, and other inventory to Purdue University. During FY 2010, NEES Consortium, Inc., also closed out its support for NEES operations. In FY 2010, NSF supported two studies for the assessment of the need for earthquake engineering experimental and cyberinfrastructure facilities beyond 2014, as described in the Dear Colleague Letter NSF 10-071 (http://nsf.gov/pubs/2010/nsf10071/nsf10071.jsp). One study, a workshop held by the National Research Council on the Grand Challenges in Earthquake Engineering Research, was completed in FY 2011 and the second study will be completed in FY 2012. These studies will provide input to NSF for the determination of support for future earthquake engineering research infrastructure beyond 2014.

Polar Facilities and Logistics

$297,510,000
+$1,720,000 / 0.9%

Polar Facilities and Logistics
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
Polar Facilities[1]	$185.72	$184.73	$186.45	$1.72	0.9%
Polar Logistics	111.82	111.06	111.06	-	-
Total, Polar Facilities and Logistics	**$297.54**	**$295.79**	**$297.51**	**$1.72**	**0.6%**

Totals may not add due to rounding.

[1]Funding for Polar Facilities for FY 2011 excludes a one-time appropriation transfer of $53.892 million ($54.0 million less the 0.2% rescission) to U.S. Coast Guard, per P.L.112-10.

Polar Facilities

The Office of Polar Programs (OPP) within NSF provides the infrastructure needed to support U.S. research conducted in Antarctica, including research 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. One example of support to other agencies includes mission-essential satellite communications support at McMurdo Station for the Joint Polar Satellite System (JPSS), the National Aeronautics and Space Administration's (NASA) Ground Networks for the relay of data. In addition, OPP enables important climate monitoring activities for the National Oceanic and Atmospheric Administration (NOAA) at the Clean Air Facility at South Pole Station, one of only five such sites around the globe. OPP also provides support for NASA's Long Duration Balloon program that enables research in fields ranging from astrophysics to cosmic radiation to solar astronomy. OPP also provides support to the U.S. Geological Survey's (USGS) South Pole Remote Earth Science and Seismological Observatory (SPRESSO), the most seismically-quiet station on earth, and access to its Global Navigation Satellite System (GNSS).

All support for these activities is provided by OPP, including transportation, facilities, communications, utilities (water and power), health and safety infrastructure, and environmental stewardship. The U.S. Antarctic Program (USAP) maintains the U.S. presence in Antarctica in accordance with U.S. policy, and supports Antarctic Treaty administration under State Department leadership.

Total Obligations for Polar Facilities
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Antarctic Infrastructure & Logistics	$185.72	$184.73	$186.45	$191.53	$191.53	$191.53	$191.53	$191.53
U.S. Coast Guard Icebreaker Support	[53.892]	-	-					
Total, Polar Facilities	**$185.72**	**$184.73**	**$186.45**	**$191.53**	**$191.53**	**$191.53**	**$191.53**	**$191.53**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

NOTE: FY 2011 funding for U.S. Coast Guard Icebreaker Support excludes a one-time appropriation transfer of $53.892 million, $54.0 million less the 0.2% rescission, to USCG, per P.L. 112-10.

OPP contracts with a prime contractor for science support, operations, the leasing of research vessels, and the maintenance of the Antarctic stations and related infrastructure in New Zealand and Chile. The contractor is selected through a competitive bidding process. Rotary- and fixed-wing aircraft used in support of research are also provided through separate competitively awarded contracts. Other agencies and contractors provide technical support in areas of expertise such as engineering, construction, and communications.

Project Report

Management and Oversight

- NSF Structure: OPP has overall responsibility for funding and managing Polar Facilities. This includes planning all activities, and overseeing contractors.
- External Structure: A new Antarctic support contract was competed and awarded to Lockheed Martin Corporation in December 2011. There are many separate subcontractors for supplies and technical services, and other services are procured through separate competitively bid contracts.
- Reviews: OPP evaluates the performance of the Antarctic support contractor annually via an Award Fee Plan, which involves multiple tiers of review, including a Performance Evaluation Board (PEB) composed of 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.

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), including the newly-constructed South Pole Station, are currently operating normally.
- South Pole Station Modernization (SPSM) project was funded through NSF's Major Research Equipment and Facilities Construction (MREFC) account. The new station was dedicated in January 2008 and construction was completed in January 2011. The new station replaces 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 provides 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 MREFC appropriations for SPSM. Operations and maintenance of South Pole Station is consolidated within the requested budget funding for polar facilities.

Recompetition

- NSF recently concluded an effort to recompete the Antarctic support contract. Lockheed Martin Corporation was awarded a 13.5 year contract, consisting of a five-year base period and four option periods exercised on the basis of performance and totaling an additional 8.5 years.
- 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. The research emphases at the three stations change as the scientific forefronts addressed there evolve with time, as does the infrastructure needed to support it.

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 2011	FY 2012	FY 2013	ESTIMATES[1]				
	Actual	Estimate	Request	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
U.S. Antarctic Logistical Support	$67.52	$67.52	$67.52	$67.52	$67.52	$67.52	$67.52	$67.52
Research Support and Logistics	44.29	43.54	43.54	44.85	44.85	44.85	44.85	44.85
Total, Polar Logistics	**$111.82**	**$111.06**	**$111.06**	**$112.37**	**$112.37**	**$112.37**	**$112.37**	**$112.37**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

The U.S. Antarctic Logistical Support program funds support activities provided by the U.S. Department of Defense (DoD). DoD operates as a logistical support provider on a cost-reimbursable basis. Major funding elements of DoD support include: military personnel, LC-130 flight operations and maintenance support through 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. A contractor provides research support and logistics services for NSF-sponsored activities in the Arctic. 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.

Project Report

Management and Oversight

- NSF Structure: OPP has overall responsibility for U.S. Antarctic Logistical Support and Arctic Research Support & Logistics. DoD operates as a 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: The current Arctic support contract was recompeted and recently awarded to the incumbent, CH2M Hill, in September 2011. There are many separate subcontractors for supplies and technical services, and other services are procured through separate competitively bid contracts.
- Reviews: OPP evaluates the performance of the Arctic support contractor using feedback from the research community they support, and by conducting site visits that include representatives from OPP and BFA. OPP's performance is externally reviewed by Committees of Visitors and the OPP Advisory Committee.

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. As discussed above, the research emphases at the three stations and at Arctic research sites change as the scientific forefronts addressed there evolve with time, as does the logistics support for these activities. NSF recently recompeted the Arctic support contract and made an award to the incumbent contractor, CH2M Hill, in September 2011. The contract has an initial term of four years and the possibility of two, two-year extensions exercised on the basis of performance.

FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS (FFRDCs)

National Center For Atmospheric Research

$92,290,000
-$6,310,000/ -6.4%

National Center for Atmospheric Research
(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$98.10	$98.60	$92.29	-$6.31	-6.4%

The Mesa Laboratory, designed by architect I.M. Pei, in Boulder, CO. *Credit: NCAR.*

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 77 Ph.D. granting academic institutions.

As of November 2011, NCAR employed a total of 964 FTEs, of which 392 are funded under the NSF primary award to UCAR.

Number of FTEs Supported at NCAR

FTEs	Primary Award[1]	All Funding
Career Scientists	98	127
Scientific Support[2]	276	673
Other Staff[3]	18	164
Total	**392**	**964**

[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.

In addition to performing fundamental research, NCAR provides facilities, including world-class supercomputing services, research aircraft, airborne and portable ground-based radar systems, atmospheric sounding, and other surface sensing systems for atmospheric research, to university, NCAR, and other atmospheric researchers. 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 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Aircraft Support	$9.93	$9.93	$9.00	$9.20	$9.41	$9.62	$9.84	$10.06
Computational Infrastructure	22.00	22.59	25.59	$26.17	$26.75	$27.36	$27.97	$28.60
Other Facility Support	23.42	23.42	19.00	$19.43	$19.86	$20.31	$20.77	$21.24
Research & Education Support	42.75	42.66	38.70	$39.57	$40.46	$41.37	$42.30	$43.25
Total, NCAR	**$98.10**	**$98.60**	**$92.29**	**$94.37**	**$96.48**	**$98.66**	**$100.88**	**$103.15**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

Partnerships and Other Funding Sources: NCAR leverages NSF support with funding provided by other federal agencies and non-federal sources. In FY 2011, NCAR received approximately $45.30 million in support from other federal agencies such as the National Oceanographic and Atmospheric Administration (NOAA) and the Federal Aviation Administration, and $15.90 million from non-federal sources.

Major Investments in FY 2013: In FY 2013, investments at NCAR will focus on issues of societal importance in the areas of atmospheric chemistry, climate, including climate models, cloud physics, severe storms, 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, responding to severe weather occurrences, and to better understand the characteristics of the Sun and Sun-Earth connections. Example investments are an increased emphasis on research efforts that combine ecological, hydrological, biogeochemical and social science expertise with core atmospheric disciplines to address challenging and multifaceted Earth system science problems. This includes the continued development and improvement of community climate and weather numerical models.

Aircraft Support: NCAR operates a C-130 and a Gulfstream-V (G-V, also known as the High Altitude Instrumented Airborne Platform for Experimental Research, or HIAPER), both of which are highly modified and equipped with specialized instrumentation, to enable the support of research activities designed to understand complex environmental processes. These aircraft will continue to support several community-originated projects deemed by peer review to be of exceptional scientific merit. These campaigns occur not only in the United States but overseas as well.

Computational Infrastructure: NCAR's computational facility supports high-end modeling and simulation of climate, weather and other Earth Systems processes. Additionally, this facility supports the development and application Interagency U.S. Global Changes Research Program (USGCRP) Community Climate System Model (CCSM), which uses mathematical formulas to simulate and better understand the chemical and physical processes that drive Earth's climate system. CCSM results are to be used as a major US contribution to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report scheduled for release in 2013.

In FY 2013, NCAR will oversee the transition to operations of a new computational facility near Cheyenne, Wyoming. This new facility is a joint effort between NCAR and the University of Wyoming and other Wyoming partners. The NCAR/Wyoming Supercomputing Center will provide physical infrastructure needed to expand NCAR's computational capability to better meet the high-end computational needs of the atmospheric and related sciences and to allow the development of

supercomputing research and educational activities of specific interest to the University of Wyoming and the state.

Other Facility Support: In addition to the C-130 and G-V aircraft, NCAR also provides support for a number of other atmospheric observing platforms through its Earth Observing Laboratory (EOL), including a large transportable Doppler radar, a unique aircraft mounted radar, upper atmosphere observing capabilities, and other unique experimental systems. NCAR operates a coronagraph as a community resource, and supports community weather and climate models as well as other infrastructure. NCAR collaborates with universities in development and operation of instrumentation for use by the broad community. These facilities are used by both NCAR and community researchers to undertake cutting edge research projects.

Research and Education Support: Funding for research and education support at NCAR totals $41.0 million in FY 2013. 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 local and regional weather; and
- the examination of human society's impact on and response to global environmental change.

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.

Educational activities at NCAR are noteworthy, 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.

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 education and outreach is $3.44 million.

Management and Oversight

- NSF Structure: NSF's Division of Atmospheric and Geospace Sciences (AGS), 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 cooperative agreement between UCAR and NSF encourages interactions between NCAR scientists and AGS staff and ensures close coordination between AGS and NCAR

management. The agreement contains requirements necessary for AGS's oversight of the NCAR program and UCAR management activities that affect NCAR. These include a provision that UCAR submit an annual program plan for AGS 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. Over the course of a year, several strategic planning sessions are held between AGS, UCAR, and NCAR to ensure that scientific and facility priorities remain consistent with those of NSF. Previous Committee of Visitors (COV) reports offered positive and constructive comments on NSF's oversight of UCAR/NCAR.

- 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 the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), the Department of Energy (DOE), the Department of Defense (DOD), the Environmental Protection Agency (EPA), and the Federal Aviation Administration (FAA) support research collaboration wherever it enhances NCAR's basic NSF-supported research goals or facilities missions.
- Reviews:
  - As required by the cooperative agreement between NSF and UCAR, a major review of the science, facilities and management of NCAR was conducted between mid-FY 2011 and early FY 2012. Review results were very positive with NCAR receiving high marks in all areas. Some issues were identified and appropriate actions to these issues are being pursued with UCAR and NCAR management.
  - NSF conducted a Business Systems Review (BSR) and issued a final report in March 2011.

Renewal/Recompetition/Termination:

In May 2008, UCAR competed successfully for the management and operation of NCAR. The term of the award is for a period of five years, extensible for an additional five years subject to appropriate and successful review. After satisfactory resolution of the minor issues identified in the review process, AGS will formulate a recommendation to the National Science Board to either recompete or renew the current cooperative agreement.

National Optical Astronomy Observatory

$25,500,000
+$0.00 / 0.0%

National Optical Astronomy Observatory
(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$29.50	$25.50	$25.50	-	-

Totals may not add due to rounding.

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 (OIR) astronomy. NOAO also is the gateway for the U.S. astronomical community to the International Gemini Observatory and to the "System" of federally-funded and non-federally-funded OIR telescopes through the Telescope System Instrumentation Program (TSIP) and the Renewing Small Telescopes for Astronomical Research (ReSTAR) program. For all NOAO and "System" telescopes, peer-review telescope allocation committees provide merit-based telescope time but no financial support. NOAO manages national community involvement in the development of potential future infrastructure projects and is closely involved in the design, development, and potential construction and operations of the Large Synoptic Survey Telescope (LSST). This project was the highest priority recommendation for "New Ground-Based Activities – Large Projects" of the 2010 Decadal Survey (*Astro2010*) conducted by the National Research Council's Astronomy and Astrophysics Survey Committee.

NOAO telescopes are open to all astronomers regardless of institutional affiliation on the basis of peer-reviewed observing proposals. They serve nearly 1,400 U.S. and foreign scientists annually. In FY 2011, 80 thesis students and an additional 106 non-thesis graduate students from U.S. institutions used NOAO telescopes for their research. In FY 2011 NOAO employed nearly 380 personnel in Arizona and Chile, including 46 support scientists and 12 postdoctoral fellows.

The NSF Directorate for Mathematical and Physical Sciences Division of Astronomical Sciences (MPS/AST) is carrying out a community-based review of its entire portfolio and it is expected that this review will be completed during FY 2012. Its output will inform future budget allocation and planning activities.

Partnerships and Other Funding Sources: Thirty-seven 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. Other partners include NASA and industrial entities. A large number of U.S. universities support their own astronomical facilities at KPNO and CTIO with reimbursed services provided by NOAO. Development of new telescopes, instrumentation, and sensor techniques is done in partnership with universities and with industry through subawards to aerospace, optical fabrication, and information technology companies. NOAO leverages NSF support with funding from other federal agencies and non-federal sources. In FY 2011, NOAO received $15.77 million for reimbursed services from partnerships and tenant observatory support, from the Kitt Peak Visitors' Center, grants from other federal agencies, and NSF supplemental funding for LSST and for the Research Experiences for Undergraduates (REU) program.

Education and Public Outreach: NOAO supports U.S. education goals by promoting public understanding and support of science and by providing education and training at all levels. Over 200 graduate students observe on NOAO telescopes yearly and a significant fraction of the observations contribute to PhD dissertations. The observatories introduce undergraduate students to scientific research by providing stimulating environments for basic astronomical research and related technologies through NSF's Research Experiences for Undergraduate Students (REU) program. NOAO has a diverse education program, visitor centers, and a web-based information portal at www.noao.edu.

Total Obligations for NOAO

(Dollars in Millions)

	FY 2011	FY 2012	FY 2013	ESTIMATES[1]				
	Actual	Estimate	Request	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
NOAO-Operations	$21.40	$20.10	$20.10	$20.50	$20.50	$20.50	$20.50	$20.50
NOAO-Development	5.60	4.90	4.90	5.00	5.00	5.00	5.00	5.00
NOAO-Research & Education	0.50	0.50	0.50	0.51	0.51	0.51	0.51	0.51
TSIP[2]	2.00	-	-	-	-	-	-	-
Total, NOAO	**$29.50**	**$25.50**	**$25.50**	**$26.01**	**$26.01**	**$26.01**	**$26.01**	**$26.01**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

[2] TSIP is the Telescope System Instrumentation Program.

NOAO-Operations: $20.10 million: NOAO-Operations support covers the operation of facilities at KPNO, CTIO, and the headquarters, offices, laboratories, and workshops in Tucson, Arizona and La Serena, Chile.

NOAO-Development: $4.90 million: Development support includes $1.50 million for the share of LSST design and development funded from NOAO's base budget, as well as 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 began a multi-year effort to introduce new capabilities to the U.S. community.

NOAO-Research and Education: $500,000: NOAO links the research conducted at its facilities to education of the public through its education and public outreach office in Tucson.

Telescope System Instrumentation Program (TSIP): $0.0 million: The TSIP program has been used to enhance instrumentation at non-federal observatories in exchange for open-access time for the U.S. community at those observatories. The TSIP competition and this open-access time have been administered by NOAO and have resulted in U.S. community access to unique assets such as the Keck and Magellan telescopes. The FY 2012 Budget Request proposed to eliminate TSIP as a standalone program and reallocate funding to a broader, more competitive activity outside NOAO. In FY 2013, proposals for TSIP-like activities will be considered within the Disciplinary and Interdisciplinary Research portfolio of the MPS Division of Astronomical Sciences.

Facility Report

Management and Oversight

- NSF Structure: An NSF program director in the Division of Astronomical Sciences (AST) provides continuing oversight, including consultation with an annual NSF program review panel. The program

director reviews detailed annual program plans, annual long range plans, quarterly technical and financial reports, and annual reports submitted by NOAO, and attends AURA governance committee meetings. Governance committees are formed from the national astronomical community and provide additional windows into community priorities and concerns. The AST program manager works closely with other offices at NSF, particularly the Office of General Counsel, the Division of Acquisition and Cooperative Support, and the Large Facilities Office in the Office of Budget, Finance, and Award Management.

- External Structure: AURA is the managing organization for NOAO. The NOAO director reports to the president of AURA, who is the principal investigator on the FY 2010 NSF cooperative agreement. AURA receives management advice from an observatory council composed of members of its scientific and management communities. NOAO employs 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 NOAO Director all aspects of user experiences at the observatory.
- Reviews: In addition to reviews held mid-way through all cooperative agreements, NSF conducts both periodic and ad hoc external reviews of AURA management. A Business Systems Review (BSR) to evaluate the restructuring of NOAO's business services began in FY 2012. A mid-term management review is scheduled for FY 2012. A full BSR will be conducted in FY 2013.

Renewal/Recompetition/Termination

A management review of AURA's performance was carried out in August 2006. In response to the review, the National Science Board extended the previous 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 a new cooperative agreement with AURA for the management and operation of NOAO for the period October 1, 2009, through March 31, 2014. A solicitation is being developed and will be promulgated in late 2012 for the management of NOAO under a new cooperative agreement to begin April 1, 2014.

The Cerro Tololo Inter-American Observatory 4-meter telescope dome. *Credit: M. Urzua Zuniga/Gemini Observatory.*

National Radio Astronomy Observatory

$73,920,000
+$2,170,000 / 3.0%

National Radio Astronomy Observatory
(Dollars in Millions)

FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate Amount	Percent
$67.65	$71.75	$73.92	$2.17	3.0%

Totals may not add due to rounding.

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. Headquartered in Charlottesville, Virginia, NRAO is 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 facilities.

In FY 2011, NRAO concluded an organizational realignment across its multiple observatory sites. Including the ALMA operations staff located at NRAO, Observatory staff consists of 495 FTEs in the operations and maintenance components of the Observatory: 80 in Observatory Science Operations, 302 in Observatory Telescope Operations, 26 in Observatory Development Programs, 52 in Observatory Administrative Services, and 35 in the Director's Office.

The Division of Astronomical Sciences (AST) is carrying out a community-based review of its entire portfolio and expects that this review will be completed during FY 2012. Findings from this review will inform future budget allocation and planning activities.

In FY 2013 the Karl G. Jansky Very Large Array (VLA) will begin full science operations. Transformed by upgrades in the hardware, electronics and computing of the existing VLA infrastructure, the Jansky VLA will provide order-of-magnitude improvements in observing sensitivity, spectral coverage, and resolution. *Credit:NRAO/AUI*

Total Obligations for NRAO

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES[1] FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Operations and Maintenance	$43.14	$43.14	$41.00	$41.82	$42.66	$42.66	$42.66	$42.66
Observatory Management	*6.03*	*6.03*	*5.73*	*5.85*	*5.97*	*5.97*	*5.97*	*5.97*
Observatory Operations	*31.77*	*31.77*	*30.20*	*30.80*	*31.41*	*31.41*	*31.41*	*31.41*
Science, Academic Affairs, EPO	*3.62*	*3.62*	*3.44*	*3.51*	*3.58*	*3.58*	*3.58*	*3.58*
Central Development Lab	*1.72*	*1.72*	*1.63*	*1.66*	*1.70*	*1.70*	*1.70*	*1.70*
Implementation of EVLA	1.13	-	-	-	-	-	-	-
ALMA Operations	23.38	28.61	32.92	36.41	39.17	39.17	39.17	39.17
Total, NRAO	**$67.65**	**$71.75**	**$73.92**	**$78.23**	**$81.83**	**$81.83**	**$81.83**	**$81.83**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

The primary area of increased funding in FY 2013 is in ALMA operations. Base funding for NRAO operations decreases in FY 2013 as part of the budget realignment plan to support increases in ALMA operations. The amounts presented here may be adjusted based on the outcome of the astronomy portfolio review currently in progress. Funding for the implementation of the Expanded Very Large Array (EVLA), recently renamed the Karl G. Jansky Very Large Array (Jansky VLA), concluded in FY 2011.

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 2011, NRAO received approximately $1.10 million from non-AST sources at NSF, $1.30 million from other federal agencies, and $530,000 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 conducted 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.

Education and Public Outreach: NRAO supports a comprehensive outreach program that makes information about radio astronomy available to the public (see www.nrao.edu/index.php/learn). With over 150 students involved per year, NRAO facilities are also used by graduate students carrying out dissertation research and work experience programs and by undergraduate students participating in the Research Experiences for Undergraduates (REU) program. NRAO sites also support visitor and education centers and conduct active educational and public outreach programs. The Green Bank Science Center and the visitor center at the Jansky VLA together attract about 62,000 public visitors each year.

Observatory Management, $5.73 million: Observatory Management includes the director's office, administrative services, and the New Initiatives Office.

Observatory Operations, $30.20 million: The Observatory Operations programmatic area includes 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, $3.44 million: 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), $1.63 million: 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, $0.00: As planned, support for the construction phase of EVLA was last obligated in FY 2011.

ALMA Operations, $32.92 million: NRAO is engaged in construction of the international ALMA, which in FY 2013 will be in the final stages of construction, funded through the Major Research Equipment and Facilities Construction (MREFC) account. Early operations funding for ALMA began in FY 2005 and ramps up sharply from FY 2008 to FY 2015. A funding profile through FY 2015 was authorized by the National Science Board in February 2011. Please see the MREFC chapter for additional information on ALMA construction.

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 increasing its activity in conjunction with the ramp up in ALMA operations. The NAASC serves two key functions: (1) supporting basic ALMA operations as an ALMA Regional Center (ARC), providing day-to-day support for ALMA operations carried out in Chile, and (2) providing easy access and strong support to the broad astronomical community that will be using ALMA. The NAASC organizes summer schools, workshops, and courses in the techniques of millimeter and submillimeter astronomy.

Facility Report

Management and Oversight

- NSF Structure: Continuing oversight and assessment is carried out for NRAO and ALMA by dedicated AST program officers 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, as well as by attendance by the AST program officers and AST management at triannual governance committee meetings of the managing organization, Associated Universities, Inc., (AUI). To address issues as they arise, AST works closely with other NSF offices, such as the Office of General Counsel and the Division of Acquisition and Cooperative Support and the Large Facilities Office in the Office of Budget, Finance, and Award Management.
- 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: NSF conducts annual reviews of the NRAO Program Operating Plan, the Long Range Plan, and the AUI Management Report. A Business Systems Review and mid-term Management Review are scheduled to be conducted in FY 2012.

Renewal/Recompetition/Termination

The current cooperative agreement is in place for the years FY 2010 through FY 2015. Preparations are underway for a solicitation for the management and operation of NRAO that will be promulgated in FY 2013 for a new cooperative agreement to begin October 1, 2015.

OTHER FACILITIES FUNDING

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, refer to the MREFC chapter of this Budget Request.

Preconstruction Planning

Within the R&RA account, funds are provided for preconstruction planning activities for prospective large facility projects. This funding generally supports such activities as design, cost estimates, and other actions that prepare potential projects for oversight review, agency decisions milestones, and potential implementation.