MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

$117,290,000
-$34,720,000 / -22.8%

Major Research Equipment and Facilities Construction Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Major Research Equipment and Facilities Construction	$166.85	$152.01	$400.00	$117.29	$34.72	-22.8%

The MREFC account supports the acquisition, construction, and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Initial planning and design, and follow on operations and maintenance costs of the facilities are provided through the Research and Related Activities (R&RA) account.

MREFC Account Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate
Ongoing Projects									
AdvLIGO	$32.75	$51.43	-	$46.30	$20.96	$23.58	$15.17	$14.68	$0.24
ATST	-	7.00	146.00	10.00	20.00	15.20	8.30	12.70	17.00
ARRV	1.48	-	148.07	-					
ALMA	102.07	82.25	-	42.76	13.91	3.00	-		
EarthScope[1]	4.21	-	-	-					
IceCube	18.74	11.33	-	0.95	-				
NEON	-	-	-	-					
OOI	-	-	105.93	14.28	110.70	82.80	46.80	20.00	-
SODV[1]	0.02	-	-	-					
SPSM[1]	7.57	-	-	-					
Judgment Fund	-	-	-	3.00					
MREFC Account Total	$166.85	$152.01	$400.00	$117.29	$165.57	$124.58	$70.27	$47.38	$17.24

Totals may not add due to rounding.

[1]EarthScope and SODV received the final year of MREFC funding in FY 2007, and SPSM received final appropriations in FY 2008. Information on these projects can be found in the Facilities chapter of this document.

A modern and effective research infrastructure is critical to maintaining U.S. leadership in science and engineering (S&E). The future success of entire fields of research depends upon access to new generations of powerful research tools. Increasingly, these tools are large and complex, and have a significant information technology component.

In accordance with the plan outlined in *A Joint National Science Board-National Science Foundation Management report on Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation,* NSF developed guiding documentation for the MREFC process. NSF is releasing its

Facility Plan in conjunction with this Budget Request. These documents can be found on the NSF website[1].

In order for a project to be considered for MREFC funding, NSF requires that it represent an exceptional opportunity that enables research and education. In addition, the project should be transformative in nature in that it should have the potential to shift the paradigm in scientific understanding and/or infrastructure technology. The projects included in this budget request meet these criteria based on NSF and NSB review.

Projects under consideration for MREFC funding must undergo a multi-phase review and approval process that is described in detail in the *Large Facilities Manual*. As a general framework for priority setting, NSF assigns highest priority to ongoing projects, which are those that have received funding for implementation and where outyear funding for the full project has already been included in a Budget Request to Congress.

All of the projects in the MREFC account are undergoing or have undergone major cost and schedule reviews, as required by guidelines instituted by NSF over the last few years. In FY 2010, NSF requests continued funding for five ongoing projects: Advanced LIGO (AdvLIGO), the Atacama Large Millimeter Array (ALMA), the Advanced Technology Solar Telescope (ATST), the final year of funding for the IceCube Neutrino Observatory (IceCube), and the Ocean Observatories Initiative (OOI). In addition, NSF requests $3.0 million to reimburse the Department of Justice's Judgment Fund to cover a settlement associated with an adjustment to the contract for the upgrades to the LC-130s, a project funded through the MREFC account from FY 1999 through FY 2001.

NSF has implemented a "no cost overrun" policy, which will require that cost estimate developed at the Preliminary Design Stage have adequate contingency to cover all foreseeable risks, and that any cost increases not covered by contingency be accommodated by reductions in scope. NSF senior management is developing procedures to assure that the cost tracking and management processes are robust and that the project management oversight has sufficient authority to meet this objective. As project estimates for the current slate of projects are revised, NSF will identify potential mechanisms for offsetting any cost increases in accordance with this policy.

Appropriation Language

For necessary expenses for the acquisition, construction, commissioning, and upgrading of major research equipment, facilities, and other such capital assets pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including authorized travel, ~~$152,010,000,~~*$117,290,000*, to remain available until expended..

[1]*A Joint National Science Board-National Science Foundation Management report on Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*: www.nsf.gov/pubs/2005/nsb0577/nsb0577_1.pdf
NSF 2009 Facility Plan: http://www.nsf.gov/pubs/2009/nsf0939/nsf0939.pdf

Major Research Equipment and Facilities Construction
FY 2010 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Carryover/ Recoveries	Transfers	Rescission	Total Resources	Obligations Incurred/Est.
FY 2008 Appropriation	$220.74	$27.81	-	-$15.27	$233.28	$166.85
FY 2009 Current Plan (CP)	152.01	66.43	-	-	218.44	218.44
FY 2009 ARRA	400.00	-	-	-	400.00	400.00
FY 2010 Request	117.29	-	-	-	117.29	117.29
$ Change from FY 2009 CP						-$101.15
% Change from FY 2009 CP						-46.3%

Totals may not add due to rounding.

Explanation of Carryover:

Within the Major Research Equipment and Facilities Construction (MREFC) appropriation, a total of $66.43 million was carried forward into FY 2009 and will be applied to ongoing projects.

South Pole Station Modernization carried forward a total of $2.26 million into FY 2009. The carryover will be applied toward the logistics and warehousing facility at South Pole, completion of exterior activities for the elevated station, and demolition of the existing station and other construction as the project approaches its scheduled completion in 2010.

A total of $3.0 million was carried forward into FY 2009 for the National Ecological Observatory Network (NEON) in anticipation of two upcoming reviews for NEON.

A total of $5.91 million was carried forward into FY 2009 for the Ocean Observatories Initiative (OOI). These funds are expected to be obligated in summer 2009, upon the initiation of the cooperative agreement for the project.

A total of $7.90 million was carried forward into FY 2009 for the IceCube Neutrino Observatory (IceCube). The carryover will be applied toward data warehousing, systems upgrade, labor and materials, logistics support, and remaining construction costs.

A total of $47.36 million was carried forward into FY 2009 for the Alaska Region Research Vessel (ARRV). The carryover will be applied to planning, shipyard contract award, design verification, and ordering long lead equipment items.

The MREFC Account in FY 2010:

NSF's ongoing projects in FY 2010 include:

- Advanced LIGO,
- the Atacama Large Millimeter Array,
- the Advanced Technology Solar Telescope
- the IceCube Neutrino Observatory, and
- the Ocean Observatories Initiative.

Information on these projects follows. Information on the Alaska Region Research Vessel (ARRV), which received appropriations in FY 2009 necessary to complete the project, the National Ecological Observatory Network (NEON), and the request to reimburse the Department of Treasury's Judgment Fund, is also provided below.

Advanced Laser Interferometer Gravitational-Wave Observatory $46,300,000

The FY 2010 Budget Request for the Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO) is $46.30 million, which represents the third year of a seven-year project totaling an estimated $205.12 million.

Appropriated and Requested MREFC Funds for the Advanced Laser Interferometer Gravitational-wave Observatory
(Dollars in Millions)

FY 2008	FY 2009	FY 2010 Request	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	Total
$32.75	$51.43	$46.30	$23.58	$20.96	$15.17	$14.92	$205.12

Totals may not add due to rounding

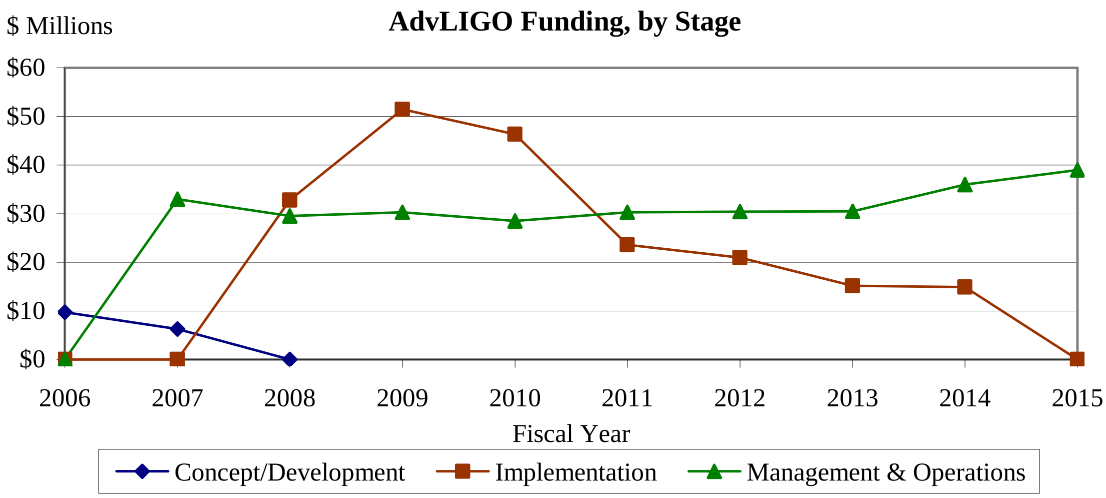
Baseline History: NSF first requested FY 2008 construction funds for AdvLIGO through the MREFC account in the FY 2006 Budget Request to Congress. The original proposal received in 2003 estimated a total construction cost of $184.35 million. A baseline review in June 2006 established the project cost at $205.12 million, based upon known budget inflators at the time and a presumed start date of January 1, 2008. A second baseline review, held in June 2007, confirmed this cost, subject to changes in budget inflators. Final Design Review in November 2007 recommended that construction begin in FY 2008. The National Science Board approved the project at a cost of $205.12 million in March 2008, and the project began in April 2008.

AdvLIGO is the planned upgrade of the Laser Interferometer Gravitational-Wave Observatory (LIGO) that will allow LIGO to approach the ground-based limit of gravitational-wave detection. LIGO consists of the world's most sophisticated optical interferometers, operating at two sites (Hanford, WA and Livingston, LA) 3,000 km apart. These interferometers measure changes in arm-lengths resulting from the passing wave-like distortions of spacetime called gravitational waves, caused by cataclysmic processes in the universe such as the coalescence of two black holes or neutron stars. LIGO is sensitive to changes as small as one-one thousandth the diameter of a proton over the 4-km arm-length; AdvLIGO is expected to be at least 10 times more sensitive. The LIGO program has stimulated strong interest in gravitational-wave research around the world, producing vigorous programs in other countries that provide strong competition as well as highly beneficial collaborations. LIGO has pioneered the field of gravitational-wave detection, and a timely upgrade is necessary to sustain progress in this area.

Total Obligations for AdvLIGO
(Dollars in Millions)

	Prior	FY 2008	FY 2009	FY 2010	ESTIMATES				
	Years	Actual	Plan	Request	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	$40.74	-	-	-	-	-	-	-	-
Management & Operations	33.00	29.50	30.30	28.50	30.30	30.40	30.50	36.00	39.00
Subtotal, R&RA Obligations	$73.74	$29.50	$30.30	$28.50	$30.30	$30.40	$30.50	$36.00	$39.00
MREFC Obligations:									
Implementation	-	32.75	51.43	46.30	23.58	20.96	15.17	14.92	-
Subtotal, MREFC Obligations	-	$32.75	$51.43	$46.30	$23.58	$20.96	$15.17	$14.92	-
Total: AdvLIGO Obligations	**$73.74**	**$62.25**	**$81.73**	**$74.80**	**$53.88**	**$51.36**	**$45.67**	**$50.92**	**$39.00**

Totals may not add due to rounding.



Note: Management & Operations refers to the continued operations of LIGO during the construction phase and the onset of operations for the newly constructed AdvLIGO in FY 2015.

Active outreach programs have been developed at both the Livingston and Hanford sites. Teams at both sites have provided visual displays, hands-on science exhibits, and fun activities for visiting students and members of the public. In the last three years an average of over 2,000 students per year have taken advantage of this opportunity. More formal programs at the sites include participation in the Research Experiences for Teachers (RET) Program, a set of "scientist-teacher-student" research projects in support of LIGO, and participation in the Summer Undergraduates Research Fellowships/Research Experiences for Undergraduates (SURF/REU) programs for college students. Both sites have developed web-based resources for teachers that include information on research opportunities for schools and a set of standards-based classroom activities, lessons, and projects related to LIGO science. The LIGO Science Education Center at the Livingston site contains many Exploratorium exhibits and is the focal point for augmenting teacher education at Southern University and other student-teacher activities state-wide through the Louisiana Systematic Initiative Program.

Substantial connections with industry have been required for the state-of-the-art construction and measurements involved in the LIGO projects. Some have led to new products. Areas of involvement include novel techniques for fabrication of LIGO’s vacuum system, seismic isolation techniques, ultrastable laser development (new product introduced), high-power active optical components (new products introduced) development of new ultra-fine optics polishing techniques, optical inspection equipment (new product), and high-power active optical components (new products).

LIGO has extensive international ties. The LIGO Scientific Collaboration, which sets the scientific agenda for LIGO, is an open collaboration that has established formal ties with institutions from 11 foreign countries. Close collaboration is maintained with two other gravitational-wave observatories: GEO, a UK-German collaboration, and Virgo, a French-Italian collaboration. LIGO has signed an agreement with Virgo under which all data will be shared and analyzed cooperatively and all discoveries will be jointly credited. New technologies critical to AdvLIGO are being contributed by foreign institutions: the pre-stabilized laser source, funded and developed by the Max Planck Gesellschaft, and the mirror/test mass suspension systems, funded and developed by the GEO collaboration. The laser has essentially attained its design specifications; the suspension systems are being tested in European gravitational-wave facilities.

Project Report:

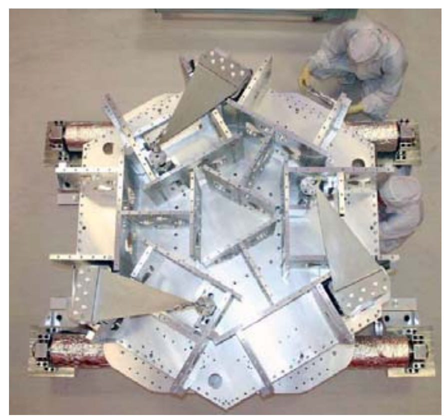
Management and Oversight:

- NSF Structure: NSF oversight is coordinated internally by a dedicated LIGO program director in the Division of Physics (PHY) in the Directorate for Mathematics and Physical Sciences (MPS), who also participates in the LIGO Advisory Team (LIGO PAT). The LIGO PAT includes staff from the Offices of Budget Finance and Award Management (BFA), General Counsel (OGC), and Legislative and Public Affairs (OLPA). Formal reporting consists of submitted quarterly and annual reports and brief monthly status reports to the LIGO program officer, who in turn reviews, edits, comments and submits the reports to the Deputy Director–Large Facility Projects. LIGO also submits periodic progress indicators within the provisions of the Government Performance and Results Act (GPRA) of 1993.

- External Structure: LIGO is managed by California Institute of Technology under a Cooperative Agreement. The project has a detailed management structure in place.

- Reviews:

  - Technical Reviews: NSF conducts annual scientific and technical reviews involving external reviewers and participates in meetings of the LIGO Scientific Collaboration (LSC) as well as making site visits to the Hanford, WA and Livingston, LA interferometers.
  - Management, Cost, and Schedule Reviews: (1) AdvLIGO construction proposal review in 2003; (2) first baseline review in June, 2006; (2) second baseline review in June, 2007; (3) final readiness review in November, 2007.
  - The first Advanced LIGO review of the active project was held in November 2008.
  - Advanced LIGO annual review in April 2009.
  - Continuing annual reviews by external panels throughout construction.



Top view of a seismic isolation system being constructed for use in Advanced LIGO. *Credit: LIGO Laboratory.*

Current Project Status:

The National Science Board approved funding for the Advanced LIGO in March 2008, and the project began in April 2008. Major initial activities include the placing of long lead-time orders and the preparation of the sites for the upgrade. The current performance is consistent with ending on budget. Total project contingency usage to date is $1.90 million of an initial $39.10 million, or 4.9 percent of contingency for 7 percent of the project completed.

Cost and Schedule:

The projected length of the project is seven years, with an 11-month schedule contingency. The risk-adjusted cost of $205.12 million includes a contingency budget of 23.7 percent.

Advanced Technology Solar Telescope $10,000,000

The FY 2010 Budget Request for the Advanced Technology Solar Telescope (ATST) is $10.0 million. FY 2010 represents the first year of a seven-year construction project. The total project cost (currently estimated at $250 to $260 million) will be finalized after a Final Design Review in May 2009.

Appropriated and Requested MREFC Funds for the Advanced Technology Solar Telescope
(Dollars in Millions)

	FY 2009	FY 2010 Request	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	FY 2016 Estimate	FY 2017 Estimate
Regular Appropriations	$7.00	$10.00	$20.00	$15.20	$8.30	$12.70	$17.00	$11.00	$8.40
ARRA Estimate	146.00	-	-	-	-	-	-	-	-
Total, ATST	**$153.00**	**$10.00**	**$20.00**	**$15.20**	**$8.30**	**$12.70**	**$17.00**	**$11.00**	**$8.40**

Baseline History: Beginning in 2001, NSF provided funds to the National Solar Observatory (NSO) for an eight-year design and development program for ATST and its initial complement of instruments through the Division of Astronomical Sciences (AST) and the Division of Atmospheric and Geospace Sciences (AGS). The current ATST design, cost, schedule, and risk were scrutinized in an NSF-conducted Preliminary Design Review (PDR) in October-November 2006. In addition to the $7.0 million provided for the ATST in FY 2009 to initiate construction through the MREFC account, NSF’s FY 2009 funding includes $6.27 million provided through the Research and Related Activities (R&RA) account to support design activities to complete a construction-ready design. $3.10 million of these funds were provided through the American Recovery and Reinvestment Act of 2009 (ARRA) and will be used for risk reduction, prototyping, and design feasibility and for cost analyses in areas identified at preliminary and systems design reviews. The funds will also support several new positions to complete preparation for the start of construction. Funding of $146.0 million is also provided in FY 2009 through ARRA via the MREFC account to initiate construction, which will commence in FY 2010 contingent on approval of the NSF Director and the National Science Board in late summer 2009. The project will hold a Final Design Review (FDR) in May 2009, at which time a baseline “not-to-exceed” cost and schedule will be established. Requirements for environmental and cultural compliance should be completed by the end of FY 2009.

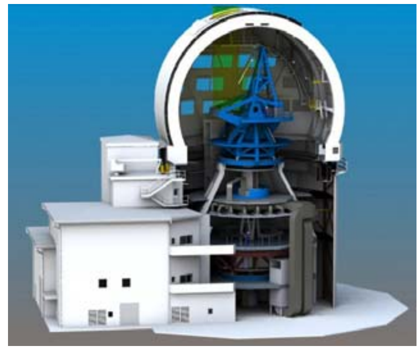
Total Obligations for ATST
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	$14.40	$2.44	$3.17	-	-				
Management and Operations	-	-	-	-	-				
ARRA Estimate			3.10	-	-				
Subtotal, R&RA Obligations	$14.40	$2.44	$6.27	-	-	-	-	-	-
MREFC Obligations:									
Implementation	-	-	7.00	10.00	20.00	15.20	8.30	12.70	17.00
ARRA Estimate	-	-	146.00	-	-				
Subtotal, MREFC Obligations	-	-	$153.00	$10.00	$20.00	$15.20	$8.30	$12.70	$17.00
Total: ATST Obligations	**$14.40**	**$2.44**	**$159.27**	**$10.00**	**$20.00**	**$15.20**	**$8.30**	**$12.70**	**$17.00**

Totals may not add due to rounding.

ATST will enable the study of magneto-hydrodynamic phenomena in the solar photosphere, chromosphere, and corona. Determining the role of magnetic fields in the outer regions of the Sun is crucial to understanding the solar dynamo, solar variability, and solar activity, including flares and mass ejections which can affect civil life on Earth and may have impact on the terrestrial climate.

The ATST project is a collaboration of scientists and engineers at more than 20 U.S. and international organizations. Potential additional partners include the Air Force Office of Scientific Research and international agencies and groups in Germany, the United Kingdom, Spain, and Italy.



Cutaway view of the ATST Facility.
Credit: National Solar Observatory.

Project Report

Management and Oversight

- NSF Structure: Oversight from NSF is handled by a program manager in the AST Division in MPS working with staff from the Offices of Budget, Finance and Award Management (BFA), General Counsel, and Legislative and Public Affairs, and AGS in GEO. The Deputy Director for Large Facilities in BFA also provides advice and assistance.

- External Structure: The ATST Project is managed by NSO. NSO operation and maintenance and ATST design and development are funded by NSF via a cooperative agreement with the Association of Universities for Research in Astronomy, Inc (AURA). The NSO Director serves as the Director of the ATST project; a senior NSO scientist is the Project Scientist; and an experienced full-time Project Manager coordinates the Project activities. Several councils and working groups provide input from the solar and space physics communities.

- Reviews:
  - Technical Reviews: Reviews have been conducted throughout the design and development phase. The preliminary design was found to be robust in an NSF-conducted Preliminary Design Review in October-November 2006. The Project has completed a comprehensive set of system-level design reviews for all major sub-systems.
  - Management, Cost, and Schedule Reviews: The ATST cost, schedule, and risk were scrutinized and validated at the Preliminary Design Review.
  - Upcoming Reviews: The Final Design Review will be held on May 18-21, 2009 in Tucson, Arizona.

Current Project Status

Current activities include finalizing the design and retiring the remaining areas of risk. The project has chosen the Haleakala High Altitude Observatory on the island of Maui as the ATST site. Preparation of the environmental impact statement is in its final stages. Consultation with Native Hawaiian stakeholders is ongoing. Application for final construction permits required for the ATST site will follow the publication of a record of decision. It is anticipated that the federal environmental and cultural compliance activities will be completed in FY 2009 and construction will begin in early FY 2010.

Costs and Schedule

The estimate of total project cost established at PDR in FY 2006 was approximately $250.0 million assuming an FY 2008 start. The baseline not-to-exceed cost will be established following the FDR. The technically-paced funding profile is front-loaded and extends for eight years. Assuming a construction start in FY 2010, operation will begin in FY 2016.

$3.10 million of ARRA funding within the R&RA Account will be used to fund the PDR and Systems Design Review committee recommended risk- reduction work, prototyping and design feasibility, and cost analyses. The completion with industry of the site architectural and engineering work and the foundation design is the highest priority item within this additional risk-reduction and vendor-contracting package. These studies drive the schedule for work on site and therefore drive the construction critical path. Other recommended work includes adaptive optics deformable mirror prototyping ($400,000) and wavefront sensor camera development ($400,000), and software and controls development. These risk-reduction efforts with industry flow directly from recommendations made by design and cost-review committees. This funding will also allow staff additions to the project team, including a contracts officer and mechanical engineer, to complete preparation and planning for construction.

$146.0 million of MREFC funding provided through the ARRA will initiate construction.

Risks

All major technical risks have been retired. Remaining technical risks will be addressed by the prototyping activities supported by ARRA funding. The remaining risk with respect to the environmental assessment is an unresolved discussion with the Federal Aviation Administration (FAA) regarding the potential obscuration of ground-air communication with commercial aircraft caused by the ATST building. Negotiations between the project, NSF, FAA, and consultants are ongoing to evaluate the impact and design mitigation systems should they be needed. A solution is anticipated by the time of publication of the final environmental impact statement this summer.

Future Operations Costs

Estimates for annual ATST operations cost are $12.0 to $14.0 million. A revised operations plan will be presented at FDR. Since ATST will become the flagship solar telescope of NSO and will render several telescopes obsolete, approximately $5.0 million per year of NSO operations cost will be recovered from the closure or divestment of redundant facilities.

Alaska Region Research Vessel **$0.00**

The FY 2010 Budget Request does not request funds for the Alaska Region Research Vessel (ARRV). The remaining project balance was provided through the American Recovery and Reinvestment Act of 2009 (ARRA) as shown in the table below. The estimated project cost is $199.50 million.

Appropriated and Requested MREFC Funds for the Alaska Region Research Vessel
(Dollars in Millions)

	FY 2007	FY 2008	FY 2009	FY 2010 Request	Total
Regular Appropriations	$9.43	$42.00	-	-	$51.43
ARRA Estimate	-	-	148.07	-	148.07
Total, ARRV	**$9.43**	**$42.00**	**$148.07**	**-**	**$199.50**

Totals may not add due to rounding.

<u>Baseline History</u>: NSF first requested construction funding for the ARRV through the MREFC account in FY 2007. The project received an initial appropriation of $9.43 million in that year followed by an additional appropriation of $42.0 million in FY 2008. In FY 2009, NSF delayed acquisition of the ARRV to incorporate updated pricing information into the construction plan. Rapid inflation in the shipbuilding industry made it difficult to accurately project the final construction cost for the ARRV. A revised project estimate was provided during the Final Design Review (FDR) held in October 2008. The new baseline incorporates an updated technical scope for the ship in order to meet current regulatory requirements, proper administrative support by the awardee, a realistic construction schedule, and independent, risk-adjusted cost estimates for construction. The final construction baseline against which progress will be monitored will be established once the construction contract is awarded to the shipyard in late FY 2009.

Total Obligations for the ARRV
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	$2.24	-	-	-					
Management and Operations	-	-	-	-	-	-	-	4.17	8.34
Subtotal, R&RA Obligations	$2.24	-	-	-	-	-	-	$4.17	$8.34
MREFC Obligations:									
Implementation	2.58	1.48	7.36	40.00	-				
ARRA Estimate	-	-	148.07	-	-				
Subtotal, MREFC Obligations	$2.58	$1.48	$155.43	$40.00	-	-	-	-	-
Total: ARRV Obligations	**$4.82**	**$1.48**	**$155.43**	**$40.00**	**-**	**-**	**-**	**$4.17**	**$8.34**

Totals may not add due to rounding.

The total estimated project cost from FDR and subsequent NSF evaluation of Panel recommendations is $199.50 million. $51.43 million was provided between FY 2007 and FY 2009; the full remaining project balance of $148.07 million was provided through the American Recovery and Reinvestment Act of 2009 (ARRA).

The ARRV will replace the R/V *Alpha Helix*, which, at 40 years of age prior to its decommissioning, was the oldest ship in the national Academic Research Fleet. Science activities in the Arctic have been limited by the capabilities of the *Alpha Helix*, which was restrictively small and could not operate in ice or in severe winter weather in the open seas. With its ice-strengthened hull, the ARRV has been designed to operate year round in the challenging waters of the Chukchi, Beaufort, and Bering Seas, as well as the open Gulf of Alaska, coastal Southeast Alaska, and Prince William Sound, including operations in seasonal ice up to 3.9 feet thick.

Satellite observations have shown that the perennial ice in the Arctic is thinning at a rate of 9 percent per decade, which is beginning to have major regional and global consequences. Research is urgently needed on topics ranging from climate change, ocean circulation, ecosystem studies, and fisheries research to natural hazards and cultural anthropology. Furthermore, the ARRV will provide a sophisticated and significantly larger platform for scientists, graduate, and undergraduate students to participate in complex multidisciplinary research activities and will enable the training of the next generation of scientists with the latest equipment and technology. Broadband satellite communications capable of relaying data, including high definition video from tools such as remotely operated vehicles that explore under the ice and the ocean depths, will bring research into the K-12 classroom and to the general public.

This image is an artist's rendition of the ARRV, proposed to replace the R/V *Alpha Helix*, which, at 39 years is the oldest ship in the national academic research fleet.

The construction phase of the project is being led by the University of Alaska, Fairbanks (UAF). A complete contract level design package has been completed by UAF's naval architect, The Glosten Associates, Inc. It is anticipated that the ARRV will greatly expand research capabilities in the region, going from a maximum of 160 ship operating days with the R/V *Alpha Helix*, up to 270-300 days with the ARRV. The vastly increased capability of the ARRV, both with regard to its ability to accommodate much larger interdisciplinary research teams and greatly enlarged geographical and seasonal ranges, will dramatically increase the number of proposals addressed to NSF for its utilization. Individual projects vary greatly in cost, as do the number of projects supported onboard at any given time. Assuming two simultaneous projects onboard for 3-4 weeks at a time and the average grant size in the Division of Ocean Sciences (OCE) in the Directorate for Geosciences (GEO), over $17.0 million in research would be supported annually.

Project Report

Management and Oversight:

- NSF Structure: NSF oversight is described in the Program's Internal Management Plan (IMP). The NSF Program Officer for Ship Acquisition and Upgrades has primary responsibility for oversight of the project and resides within the Integrative Programs Section (IPS) of the Division of Ocean Sciences (OCE), Directorate for Geosciences (GEO). Periodic oversight is provided by a Project Advisory Team (PAT) which includes staff from GEO and OPP, the Division of Acquisition and Cooperative Support (DACS), the Large Facilities Office (LFO), the Office of the General Counsel (OGC), and Office of Legislative Public Affairs (OLPA). Additional staff from IPS, the LFO, and DACS, as well as external consultants, help provide the Program Officer with routine project management and technical assistance.

- External Structure: UAF has established a project management office in Fairbanks, AK, a component of which will eventually include an on-site team that will remain in the shipyard throughout the construction process. The ARRV Oversight Committee (AOC), which includes community experts in research vessel design, construction, and operations, has been commissioned and convenes monthly to review project status and provide technical and science support advice to both UAF and NSF.

- Reviews:

  1. Final Design Review (FDR): FDR was completed in October 2008. The Panel advised that both the design and Project Execution Plan were "sound" and ready to proceed with construction. UAF presented a risk adjusted project baseline that was considered realistic based on market conditions just prior to FDR. NSF used Panel recommendations to increase confidence levels and account for recent global market volatilities to arrive at the final estimated project cost of $199.50 million.
  2. Acquisition Strategy Review: NSF conducted a final review of UAF's vessel and propulsion acquisition strategies in January 2009 based on Panel comments from FDR. Final NSF guidance was given to UAF and revised documents have been received and approved by NSF.
  3. Upcoming Reviews: NSF will conduct two internal reviews during Phase II to review UAF's shipyard selection process. If executed properly, NSF will provide concurrence with UAF's contractor selection prior to contract signing.

Current Project Status:

Following a successful final review of the acquisition strategies and the high likelihood of receiving funding in FY 2009, shipyard selection was authorized to begin with release of the Request for Information in early March, 2009. This will be followed quickly by a Request for Proposals (RFP) from those shipyards responding to the RFI and will culminate in a technical and financial evaluation of the shipyards. The Request for Cost Proposals will be released in July 2009.

A phased approach for project execution has been established within the cooperative agreement with UAF, where award of subsequent phases is contingent upon successful completion of the prior phases. Phase I (Project Refresh), which has primarily been an update of engineering drawings and specifications and preparing the Project Execution Plan, was awarded in FY 2007 at a cost $4.10 million, funded through the R&RA account. Phase II (Shipyard Selection) includes technical and financial evaluations, shipyard visits, and a "best value" selection process following receipt of cost proposals and will end with an award of a construction contract in late FY 2009. Phase III (Construction) is contingent upon successful completion of Phase II and will last thirty to thirty-six months. Phase IV (Transition to Operations) will include preliminary acceptance of the vessel by UAF, deep water science and ice trials, final outfitting, and transit to Alaska.

Cost and Schedule:

The total estimated project cost following FDR is approximately $199.50 million. The majority of this total is the fixed price contract with the shipyard which is estimated at $110.0 million, or 55 percent. UAF management, including purchase of propulsion units as Owner-Furnished Equipment, is $21.40 million, or 11 percent. Final outfitting, science trials, and delivery are $23.60 million, or 12 percent. Due to extreme global market volatility, the total required project contingency is $44.50 million, or 22 percent.

Construction is anticipated to take thirty to thirty six months, but the precise schedule will not be known until shipyard proposals are received. Delivery schedule will be an evaluation criteria during shipyard selection. Preliminary acceptance from the shipyard is anticipated for mid-FY 2013 followed by a year of science trials, final outfit, and transit to Alaska. The transition to operations is anticipated to take place in conjunction with a partial operating year in FY 2014 with the first full year of operations occurring in FY 2015.

Risks:

A formal risk assessment and management plan was developed by UAF in accordance with NSF guidelines and presented at FDR. Following FDR, the Risk Management Plan and Risk Register will be formally updated monthly by UAF and reviewed by NSF on a routine basis. Significant risks at this stage of the project include:

- Bid Risk: higher than anticipated shipyard bids due to market volatility and other contract requirements.
- Technical Risk: Any component of the vessel not meeting technical requirements of the specifications resulting in loss of capability or increased costs to correct after installation or delivery.
- Change Risk: shipyard contract disputes and claim potential associated with design development due to changing regulatory body requirements and owner initiated design changes.
- Schedule Risk: Extension of the construction and delivery schedule which would result in project cost increases due to inflation and UAF standing army costs.

Mitigation strategies have been employed by UAF and the risk analysis indicates that ample contingency is currently in place to handle these project risks. Bid risk will be retired in early FY 2010 following shipyard selection. Proper change and contingency management control processes are in place to facilitate the project coming on time and within budget.

Future Operations Costs:

Vessel operations will be governed by the terms of a separate cooperative agreement with UAF through the Ship Operations Program within IPS. Daily rate estimates for both the ship and technical services were provided by UAF at FDR. It is anticipated that OCE will pay for approximately 65 percent of the annual vessel operating costs ($8.40 million per year) based on historical data from other global ships within the academic research vessel fleet. 35 percent of the funding support for the ARRV will likely come from the Office of Polar Programs (OPP) and other federal agencies. In short, the ARRV will fold into an already well established framework for operating the academic research vessel fleet.

Atacama Large Millimeter Array $42,760,000

The FY 2010 Budget Request for the Atacama Large Millimeter Array (ALMA) is $42.76 million, which represents the ninth year of an eleven year project totaling an estimated $499.26 million.

Appropriated and Requested MREFC Funds for the Atacama Large Millimeter Array

(Dollars in Millions)

FY 2006[1] & Earlier	FY 2007	FY 2008	FY 2009	FY 2010 Request	FY 2011 Estimate	FY 2012 Estimate	Total
$190.97	$64.30	$102.07	$82.25	$42.76	$13.91	$3.00	$499.26

[1]An additional $31.99 million was appropriated through the MREFC account prior to FY 2005 for concept and development.

Baseline History: A $26.0 million, three-year Design and Development Phase was originally planned for a U.S.-only project, the Millimeter Array. NSF first requested funds for the design and development for this project in FY 1998. In June 1999, the U.S. entered into a partnership via a Memorandum of Understanding (MOU) with the European Southern Observatory (ESO), a consortium of European funding agencies and institutions. The MOU committed the partners to construct a 64 element array of 12 meter antennas. NSF received $26.0 million in appropriations between FY 1998 and FY 2000. Because of the expanded managerial and technical complexity of the joint U.S./ESO project, now called ALMA, an additional year of Design and Development was provided by Congress in FY 2001 at a level of $5.99 million. In FY 2002, $12.50 million was appropriated to initiate construction of ALMA; the U.S. share of the cost was estimated to be $344.0 million. The National Research Council (NRC) of Canada joined ALMA as a partner in 2003. In 2004, Japan entered under the provisions of a MOU between NSF, ESO, and the National Institute of Natural Sciences of Japan.

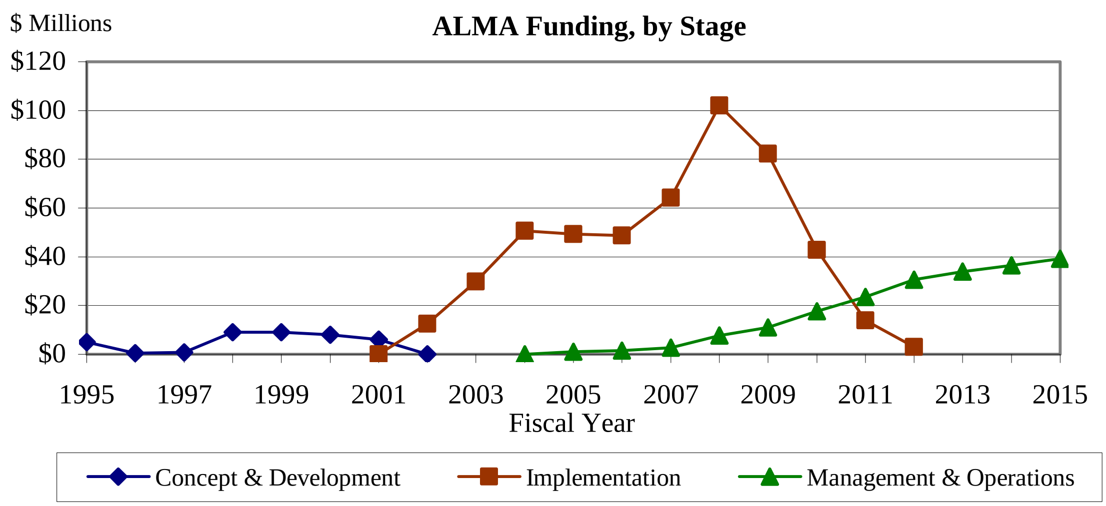
The ALMA Board initiated rebaselining in the fall of 2004 under the direction and oversight of the Joint ALMA Office (JAO) Project Manager. The project was at that point sufficiently mature that the baseline budget and schedule established in 2002, prior to the formation of the partnership, could be refined based on experience. The rebaselining process took approximately one year, scrutinizing cost and schedule throughout the project, assessing technical and managerial risk, and ultimately revising the assumptions on the scope of the project. The new baseline plan developed by the JAO assumed a 50-antenna array as opposed to the original number of 64, extended the project schedule by 24 months, and established a new U.S. total project cost of $499.26 million. The FY 2009 Request was increased by $7.50 million relative to the re-baselined profile in order to allow more strategic use of project contingency to buy down near-term risk, as recommended by the 2007 annual external review. The increase in FY 2009 was offset by a matching decrease in FY 2011.

The global ALMA project will be an aperture-synthesis radio telescope operating in the wavelength range from 3 to 0.4 mm. ALMA will be the world's most sensitive, highest resolution, millimeter-wavelength telescope, combining sub-arcsecond angular resolution with the sensitivity of a single antenna nearly 100 meters in diameter. The array will provide a testing ground for theories of planet formation, star birth and stellar evolution, galaxy formation and evolution, and the evolution of the universe itself. The interferometer is under construction at 5,000 meter altitude near San Pedro de Atacama in the Second Region of Chile, the ALMA host country.

Total Obligations for ALMA
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	6.50	-	-	-	-	-	-	-	-
Management & Operations	6.21	7.64	11.00	17.57	23.50	30.65	33.92	36.41	39.17
Subtotal, R&RA Obligations	$12.71	$7.64	$11.00	$17.57	$23.50	$30.65	$33.92	$36.41	$39.17
MREFC Obligations:									
Concept & Development	31.99	-	-	-	-	-	-	-	-
Implementation	255.27	102.07	82.25	42.76	13.91	3.00	-	-	-
Subtotal, MREFC Obligations	$287.26	$102.07	$82.25	$42.76	$13.91	$3.00	-	-	-
Total: ALMA Obligations	**$299.97**	**$109.71**	**$93.25**	**$60.33**	**$37.41**	**$33.65**	**$33.92**	**$36.41**	**$39.17**

Totals may not add due to rounding.



Once completed, ALMA will function as the most capable imaging radio telescope ever built and will bring to millimeter and submillimeter astronomy the high-resolution aperture synthesis techniques of radio astronomy. ALMA will image at 1 millimeter wavelength with the same 0.1 arcsecond resolution achieved by the Hubble Space Telescope at visible wavelengths, and will form a critical complement to the leading-edge optical, infrared, ultraviolet, and x-ray astronomical instruments of the twenty-first century.

ALMA will help educate and train U.S. astronomy and engineering students; at least 15 percent of ALMA's approximately 1,000 yearly users are expected to be students. There is already substantial involvement by graduate students in applied physics and engineering at universities participating in the ALMA Design and Development program, providing an opportunity to broaden participation in science and engineering by members of under-represented groups.

Extensive public and student ALMA outreach programs will be implemented in North America, Europe, and Chile as ALMA approaches operational status. A visitors' center will be constructed at the 2,800 meter-altitude Operations Support Facility gateway to the ALMA site near San Pedro de Atacama in northern Chile. The project also supports a fund for the Antofagasta (II) Region of Chile that is used for economic, scientific, technical, social, and cultural development, particularly within the nearby towns of San Pedro de Atacama and Toconao.

The first Vertex antenna formally accepted by the ALMA Observatory at the site in Chile. *Credit ALMA/ESO/NAOJ/NRAO*

North America and Europe are equal partners in the core ALMA instrument. Japan joined ALMA as a third major partner in 2004, and will deliver a number of enhancements to the baseline instrument. The North American side of the project, consisting of the U.S., Canada and Taiwan, is led by Associated Universities Incorporated/National Radio Astronomy Observatory (AUI/NRAO). Funding and execution of the project in Europe is carried out through the European Southern Observatory (ESO). Funding of the project in Japan is carried out through the National Institutes of Natural Sciences of Japan and project execution is the responsibility of the National Astronomical Observatory of Japan.

From an industrial perspective, ALMA instrumentation will push gallium arsenide and indium phosphide transistor amplifier technology to high frequencies, will challenge production of high-density, high-speed integrated circuits for computational uses, and is expected to stimulate commercial device and communication technologies development.

Peer-review telescope allocation committees will provide merit-based telescope time but no financial support. NSF will not provide awards targeted specifically for use of ALMA. Most U.S. users will be supported through NSF or NASA grants to pursue research programs that require use of ALMA.

Construction progress continues in FY 2009, both at the site in Chile and within the ALMA partner countries. The most significant events for the project in FY 2008 were delivery of six production antennas to Chile, delivery of the two antenna transporters and installation of the first receiver system in an antenna. In FY 2010 the first antennas will be delivered to the final, high-altitude site and science commissioning will begin. Early science operations are expected to commence in FY 2011 and completion of the construction project and the start of full science operations are planned to occur around the end of FY 2012.

Project Report:

Management and Oversight:

- NSF Structure: Programmatic management is the responsibility of the ALMA Program Manager in the Division of Astronomical Sciences (AST) in the Directorate for Mathematical and Physical Sciences (MPS). An NSF advisory group consisting of representatives from the Office of General Counsel, the Office of Budget, Finance, and Award Management, the Office of International Science and Engineering, and the Office of Legislative and Public Affairs, serves as a standing ALMA Project Advisory Team (PAT). The NSF Deputy Director for Large Facility Projects (DDLFP) is a member of the PAT and provides advice and assistance.

- External Structure: An international ALMA Management Advisory Committee (AMAC) advises AST and the ALMA Board. Management of the NRAO effort on ALMA is carried out under a cooperative agreement with AUI. Oversight of the full international project is vested in the ALMA Board, whose membership includes an NSF member; coordination and management of the merged international efforts is the responsibility of the Joint ALMA Office (JAO), whose staff includes the ALMA Director, Project Manager, and Project Engineer.

- Reviews:

  - Technical reviews: The JAO holds frequent technical and schedule reviews at appropriate design and fabrication milestones. For example, a series of reviews to assess the robustness and risks to the schedule was held in November 2008 through January 2009. Reviews of the regional centers that assemble and test receiver electronics are planned for FY 2009 and FY 2010. A function of the AMAC is to conduct project-wide external reviews and to audit internal reviews on behalf of the ALMA Board.
  - Management, Cost, and Schedule reviews: NSF, through the ALMA Board, holds external reviews of the broad Project and in targeted areas. A review of the Operations Plan was conducted in February 2007. A project-wide annual review, held in December 2008, assessed management, cost and schedule performance, status, issues, and risks. NSF also directly charges external assessments, both broad-based e.g. through its review of the performance of the managing organization (AUI), and of specific areas as warranted. For example, an external review of safety was held in October 2008. The project-wide annual reviews will continue and a science operations readiness review will be held in FY 2010.
  - Upcoming reviews: Receiver integration center operational readiness review in April 2009. Review of Chilean labor management performance in June 2009. Review of schedule and schedule drivers in July 2009. Annual External Reviews in November 2009 and late 2010. Operations review in 2010.

<u>Current Project Status:</u>

- Major project milestones attained in FY 2008 included:

  - Full acceptance and occupation of the technical building at the high-altitude site
  - Installation of the first quadrant of the digital correlator at the high site
  - Acceptance of the mid-level facilities including offices, warehouse, test and maintenance laboratories and control room
  - Delivery of the second through sixth North American antennas to Chile
  - Delivery of the two antenna transporters
  - Delivery of the first North American and East Asian receivers to Chile
  - Astronomical spectra obtained with the prototype antennas and test receivers at the antenna test facility in Socorro, New Mexico

- Major milestones for FY 2009 are expected to include:

  - Acceptance of the first North American and Japanese antennas
  - Continued delivery of North American antennas at a rate of one every two months.
  - Delivery of the first three European antennas to Chile
  - Delivery of the second quadrant of the correlator
  - Delivery of the third and fourth North American and East Asian receivers
  - Test interferometry at the mid-level facility in Chile using two antennas

- Major milestones for FY 2010 are expected to include:

  - Acceptance of the first European antennas
  - Continued delivery of North American antennas at a rate of one every two months.
  - Acceptance of the eighth through fourteenth North American antennas and the remaining three Japanese antennas
  - Transport of several antennas to the final, high-altitude site in Chile (may be very end of FY 2009)
  - Start of commissioning

<u>Cost and Schedule:</u>

The current schedule performance is slightly behind plan due to equipment delivery delays, in particular delivery of the first antennas and receivers. Consequently, the major milestones of early-science and full-science are forecast to be delayed by six to nine months although schedule recovery is possible. Cost performance is very good at this stage in the project – cost variance is -1 percent and schedule variance is -6 percent relative to the 2005 baseline – with approximately 40 percent contingency remaining in the uncommitted budget.

<u>Risks:</u>

- Full handover of the first North American and Japanese antennas will enable the other delivered antennas to be tested and accepted swiftly. The schedule for production of the European antennas should begin to stabilize once the first few antennas are delivered to Chile.
- While fabrication of the individual receiver components is making good progress, their integration into complete receiver systems and subsequent testing are the pacing items for the schedule and will be one of the key challenges for the project in the coming 12 months.
- The supply of 5MW of electricity to operate the full array has not been finalized due to the unstable power economy in Chile and South America. The original plan for gas-fed generators was eliminated following the cessation of gas exports from Bolivia and Argentina. Consequently, project management is pursuing alternative options of electricity supply via a 160km-long overhead line to the nearest grid access point or multi-fuel on-site power generation.
- For operations, the principal challenge is to ramp-up the staffing to 200 technically qualified personnel over the next two years.

<u>Future Operations Costs:</u>

Operations and maintenance funds phase in as initial site construction is completed and antennas begin to be delivered. Funds will be used to manage and support site and instrument maintenance, array operations in Chile, early science (FY 2011) and eventually full science operations, and in support of ALMA observations by the U.S. science community. Full ALMA science operations are anticipated to begin around the end of FY 2012. An Operations Plan and a proposal for North American operations were externally reviewed in FY 2007 and a funding profile through FY 2011 was authorized by the National Science Board in December 2007. The operations estimates for FY 2012 and beyond are based on current cost projections. The anticipated operational lifespan of this project is at least 30 years.

IceCube Neutrino Observatory $950,000

The FY 2010 Budget Request for the IceCube Neutrino Observatory is $950,000, which represents the final year of a nine-year project totaling an estimated $276.63 million. $242.07 million of the total project cost has been funded through NSF's MREFC account, and the balance of $34.56 million has been provided by foreign partners in the project.

Appropriated and Requested MREFC Funds for the IceCube Neutrino Observatory
(Dollars in Millions)

FY 2004 & Earlier	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010 Request	Total
$81.29	$47.62	$49.85	$28.65	$22.38	$11.33	$0.95	$242.07

Total may not add due to rounding.

Baseline History: Congress provided an initial appropriation for IceCube of $15.0 million in FY 2002 and $24.54 in FY 2003 for "Start-up Activities", including development of an Enhanced Hot Water Drill. NSF requested construction funding for IceCube in the FY 2004 Budget Request, and the total cost of the project (including start-up activities) was estimated to be $271.77 million at that time ($242.07 from NSF and the balance from the international partners). NSF carried out a comprehensive external baseline review of the entire project, including cost, schedule, technical and management review, in February 2004; this rebaselining effort confirmed the U.S. total project cost of $242.07 million.

The total project cost is now $276.63 million, $4.86 million more than the initial estimate. This change is due to an increase in the value of the contributions made by foreign partners, which is now at $34.56 million. NSF's cost, however, remains constant at $242.07 million.

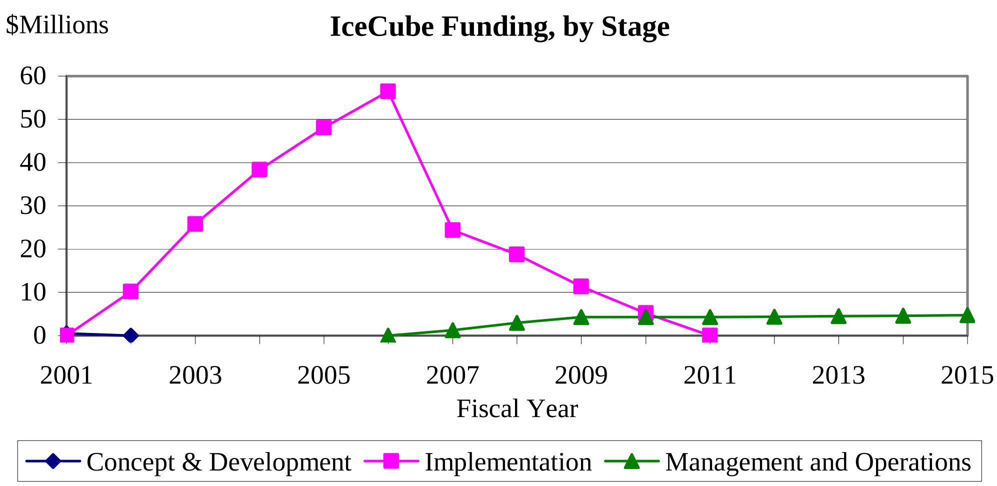
IceCube is the world's first high-energy neutrino observatory, located deep within the ice cap under the South Pole in Antarctica. It represents a new window on the universe, providing unique data on the engines that power active galactic nuclei, the origin of high energy cosmic rays, the nature of gamma ray bursters, the activities surrounding supermassive black holes, and other violent and energetic astrophysical processes. Approximately one cubic kilometer of ice is being instrumented with photomultiplier (PM) tubes to detect neutrino-induced, charged reaction products produced when a high energy neutrino interacts in the ice within or near the cubic kilometer fiducial volume. An array of Digital Optical Modules (DOMs), each containing a PM and associated electronics, will be distributed uniformly from 1.5 km to 2.5 km beneath the surface of the South Pole ice cap, a depth where the ice is highly transparent and bubble-free. When completed, IceCube will record the energy and arrival direction of high-energy neutrinos ranging in energy from 100 GeV (10^{11} electron Volts [eV]) to 10 PeV (10^{16} eV).

IceCube post-doctoral researcher Dr. Ryan Bay of UC-Berkeley takes a depth measurement during deployment of an IceCube string of digital optical modules. *Credit: John Jacobsen, University of Wisconsin-Madison, 2009*

Total Obligations for IceCube
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	$0.50	-	-	-					
Operations & Maintenance (OPP)	1.00	1.50	2.15	2.15	2.15	2.20	2.25	2.30	2.35
Operations & Maintenance (PHY)	0.25	1.50	2.15	2.15	2.15	2.20	2.25	2.30	2.35
Subtotal, R&RA Obligations	$1.75	$3.00	$4.30	$4.30	$4.30	$4.40	$4.50	$4.60	$4.71
MREFC Obligations:									
Implementation	203.16	18.74	11.33	5.20	-				
Subtotal, MREFC Obligations	$203.16	$18.74	$11.33	$5.20	-	-	-	-	-
Total: IceCube Obligations	**$204.91**	**$21.74**	**$15.63**	**$9.50**	**$4.30**	**$4.40**	**$4.50**	**$4.60**	**$4.71**

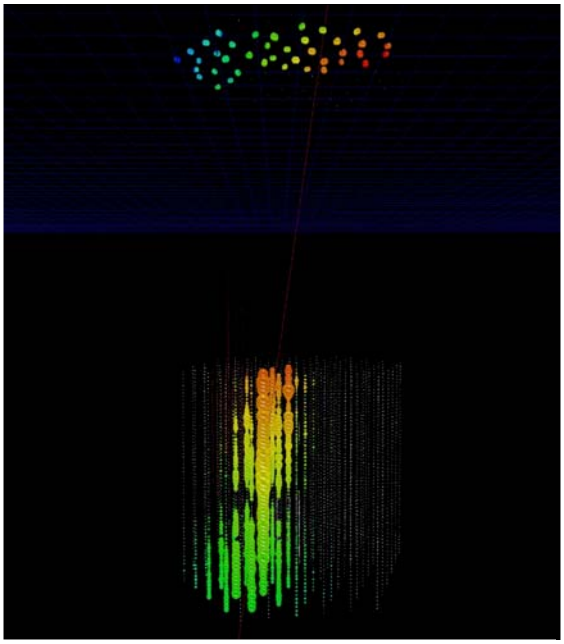
Totals may not add due to rounding.



The principal tasks in the IceCube project are: production of the needed DOMs and associated electronics and cables; production of an enhanced hot water drill and a DOM deployment system capable of drilling holes for and deploying DOM strings in the ice at the Pole; refurbishment and outfitting of the IceCube Laboratory (ICL) at the South Pole; the actual drilling of the deep-ice holes, deployment of the needed DOMs, and their commissioning and verification; installation of a surface array of air shower detectors ('IceTop') to both calibrate and eliminate background events from the IceCube DOM array; construction of data acquisition, handling, archiving, and analysis systems; and associated personnel and logistics support.

IceCube construction is being carried out by the IceCube Collaboration, led by the University of Wisconsin (UW). The IceCube Collaboration consists of 12 U.S. institutions and institutions in three other countries: Belgium, Germany, and Sweden. NSF's foreign partners are contributing approximately $34.56 million to the project, as well as a pro rata share of IceCube Operations & Maintenance costs based on the number of PhD-level researchers involved. NSF's share of the Operations & Maintenance costs is estimated at approximately $4.30 million. The Department of Energy, through its Lawrence Berkeley National Laboratory, is also participating.

NSF will support activities at U.S. institutions working on more refined and specific data analyses, data interpretation (theory support), and instrumentation upgrades through ongoing research programs. The annual support for these research activities will be provided through the R&RA account and is currently estimated at approximately $4.0 million once the facility reaches full operation.



High-energy muons in showers can penetrate deep into the ice, passing through both IceTop and the deep detectors of IceCube. The picture here shows the reconstruction of such a coincident event. Two color time intervals are illustrated, one for the surface array and one for the deep ice detectors. *Credit: IceCube Collaboratory*

IceCube provides a vehicle for helping to achieve national and NSF education and outreach goals. Specific outcomes include the education and training of next-generation leaders in astrophysics, including undergraduate students, graduate students, and postdoctoral research associates; K-12 teacher scientific/professional development, including development of new inquiry-based learning materials and using the South Pole environment to convey the excitement of astrophysics, and science generally, to K-12 students; increased diversity in science through partnerships with minority institutions; and enhanced public understanding of science through broadcast media and museum exhibits (such as the Adler Planetarium) based on IceCube science and the South Pole environment. Education and outreach activities so far have been supported principally by participating institutions, leveraged by the IceCube construction and research activities. NSF expects to support education and outreach under separate R&RA grants to universities and other organizations that are selected following standard NSF merit review.

Project Report:

Management and Oversight:

- NSF Structure: Oversight responsibility for IceCube construction is the responsibility of OPP, and a project coordinator manages and oversees the NSF award. Support for operations, research, education, and outreach will be shared by OPP and MPS as well as other organizations and international partners. Besides annual progress reviews and other specialized reviews (e.g., a safety review), the project provides monthly progress reports and quarterly reports. NSF conducts site visits, weekly teleconferences with the project managers, and internal NSF project oversight and management meetings.

- External Structure: The UW management structure for the IceCube project includes leadership by a project director and a project manager. At lower levels, project management includes international participation as well as participation by staff at collaborating U.S. institutions. This framework was put in place during the start-up phase of IceCube and provided a sound basis for initiation of full construction with FY 2004 funding as soon as the project was baselined. UW has in place an external Scientific Advisory Committee, an external Project Advisory Panel, and a high-level Board of Directors (including the UW Chancellor) providing awardee-level oversight of the project.

- Reviews: NSF carried out a comprehensive external baseline review of the entire project (including cost, schedule, technical, and management) in February 2004. There was a follow-up external cost review in Fall 2004. Comprehensive external reviews are held each spring following the annual deployment season; such reviews were held in May of 2005, 2006, 2007, and 2008. The next review is scheduled for May 2009.

Current Project Status:

- In FY 2008, the high end of the season's goal of deploying 14-18 new DOM strings was met with deployment of the 18th string, bringing the total number of operational strings to 40 – half of the 80 originally envisioned for the project. In FY 2009, the project exceeded planning goals by successfully installing 19 additional strings, including one "deep ice" prototype string. This string is at the same depth as other strings in the array, but the DOMs are concentrated lower on the string, allowing measurements to lower energy. If this string performs as expected, the project may seek to similarly situate five of the remaining strings.

Cost and Schedule:

- IceCube is 88.9 percent complete in terms of earned value, well within the originally proposed budget and approximately on schedule. Contingency is $7.80 million, or approximately 26.3 percent of the value of the remaining work. Contingency continues to be carefully managed to ensure the successful completion of the project.

- Projected out-year milestones (FY 2010-2011) are based on current project planning and represent a general outline of anticipated activities. These activities are also dependent on weather conditions and the Antarctic logistics schedule. These include:
  - Continue DOM and IceTop module production and testing, and continue to drill, deploy, test, and commission strings (up to 21 more strings) and the corresponding IceTop modules, including installation and testing of the associated data acquisition (DAQ) elements; and,
  - Ramp up to full operation and scientific exploitation of IceCube in FY 2011.

Risks:

- The enhanced hot water drill used to melt the 2.5 km water columns, into which the strings of DOMs are deployed, continues to perform well, with fuel efficiency better than planned and with a penetration rate that meets specifications. Of the DOMs deployed thus far, 98.5 percent are now working at or better than design specifications. Based on performance thus far, a mean-time-to-failure analysis predicts a survival fraction of just over 97 percent after 15 years, better than the original 95 percent reliability specification for the project and slightly higher than the assessment a year ago. Installation of the IceTop surface array is proceeding according to schedule, with elements deployed on the surface at each string location. DOM production and cold-testing facilities in the U.S. and Europe continue to work with high efficiency, producing reliable DOMs that continue to meet or exceed requirements.

- Based on the above achievements, the project has retired major technical risks. A key factor to the success of IceCube, and a remaining risk, is the logistics support chain required to transport all material and personnel to the South Pole, and this, too, continues to perform at a very high level.

Future Operations Costs:

Operations and maintenance in support of scientific research began in FY 2007, and will ramp up in subsequent years to full science operations in FY 2011 following completion of drilling and DOM deployment in that year. The associated costs are and will continue to be shared by the partner funding agencies – U.S. (NSF) and non-U.S. – on a pro rata basis according to the number of PhD researchers involved (currently about 55:45). In FY 2010, the U.S. share of operations and maintenance is $4.30 million.

The annual cost of the data analysis that will be carried out by the collaborating U.S. and foreign institutions is estimated at $8.0 million, of which $4.0 million will come from NSF for the U.S. groups, and which is outside of support for operations and maintenance (e.g., the data acquisition and data handling systems, data quality monitoring, information technology (IT) upgrades).

The general operations of South Pole Station, reported in a separate section, also contribute to supporting IceCube. The cost of IceCube operations shown in the table herein includes only those that are project-specific and incremental to general South Pole Station operations. Progress in IceCube operations will be reviewed annually, as it is for the MREFC construction project. The expected operational lifespan of this project is 25 years beginning FY 2011.

The National Ecological Observatory Network $0.00

The FY 2010 Budget Request does not request MREFC funds for the construction of the National Ecological Observatory Network (NEON).

Appropriated and Requested MREFC Funds for the National Ecological Observatory Network
(Dollars in Millions)

	FY 2007	FY 2008	FY 2009	FY 2010 Request	Total
Regular Appropriations	$4.00	$3.00	-	-	$7.00
Rescission[1]	-$4.00	-	-	-	-$4.00
ARRA	-	-	-	-	-
Total, NEON	**-**	**$3.00**	**-**	**-**	**$3.00**

[1/]$4.0 million of the FY 2007 appropriated funds for NEON were rescinded per PL 110-161.

Baseline History: In 2004 the National Research Council (NRC) evaluated the original NEON design of loosely confederated observatories and recommended that it be reshaped into a single integrated platform for regional to continental scale ecological research. Congress appropriated MREFC funding for NEON in FY 2007 and FY 2008. Project planning will continue through FY 2010; a Preliminary Design Review (PDR) is expected in June 2009 and Final Design Review (FDR) in early FY 2010. Confirmed baseline estimates for construction are anticipated during FY 2010. A formal baseline review will occur in FY 2010 as part of a Final Design Review (FDR). Assuming a successful FDR, NSF will request additional MREFC construction funding for NEON in a future budget submission.

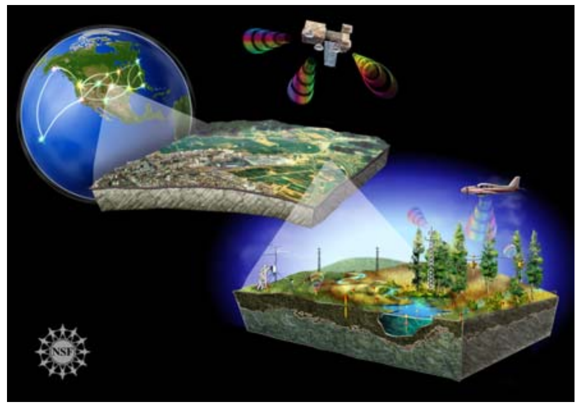
NEON would consist of geographically distributed field and lab infrastructure networked via cybertechnology into an integrated research platform for regional to continental scale ecological research. Cutting-edge sensor networks, instrumentation, experimental infrastructure, natural history archive facilities, and remote sensing would be linked via the internet to computational, analytical, and modeling capabilities to create NEON's integrated infrastructure.

Total Obligations for NEON
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	$17.75	$13.83	$13.30	$13.50	$13.73	$7.00	$3.00	-	-
Management and Operations	-	-	-	-	-				
Subtotal, R&RA Obligations	$17.75	$13.83	$13.30	$13.50	$13.73	$7.00	$3.00	-	-
MREFC Obligations:									
Implementation	-	-	-	-					
Subtotal, MREFC Obligations	-	-	-	-	-	-	-	-	-
Total: NEON Obligations	**$17.75**	**$13.83**	**$13.30**	**$13.50**	**$13.73**	**$7.00**	**$3.00**	**-**	**-**

Totals may not add due to rounding.

Since NSF supports 63 percent of the fundamental environmental biology research at U.S. academic institutions, advances in the field of ecology and the infrastructure to enable those advances depend largely on support from NSF. Current research infrastructure is inadequate to enable studies to address the complex phenomena driving ecological change in real time and at the scales appropriate for studying many grand challenge questions in ecology. As a continent-wide research instrument, NEON will support a large and diverse group of organizations and individuals; foremost are the scientists, educators, and engineers who will use NEON infrastructure in their research and educational programs. A NEON cyberinfrastructure gateway will provide resources to support formal and informal public education and provide opportunities for citizens to participate in scientific investigations. Data from standard measurements made using NEON will be publicly available.



NEON will be a collaborative research platform of geographically distributed infrastructure connected via the latest information technology. By combining in-situ sensing with remote sensing observations, NEON will address pressing environmental questions on regional to continental scales. *Credit: NSF.*

Coordination with other federal agencies occurs through the NEON Federal Agency Coordinating Committee. A Memorandum of Understanding (MOU) between NSF and the U.S. Geological Survey (USGS) will facilitate the sharing of satellite remotely sensed data, in-situ verification, and archival storage of NEON aerial remote sensing data by USGS. NEON infrastructure deployment sites are located on USDA Forest Service, USDA Agricultural Research Site, Bureau of Land Management, and National Park Service lands. These agencies are cooperating agencies on the NSF (Lead Agency) environmental assessment. Discussions about collaboration have also taken place between NSF and several other federal agencies, including: Department of Energy (DOE), National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA). In addition, the Jet Propulsion Laboratory (JPL) is designing the hyperspectral sensor for the NEON airborne observation platform.

Private organizations, e.g., the Heinz Center, Nature Serve, and the Science and Engineering Alliance, participated in the NEON design and development activities. While the bulk of NEON's infrastructure and instrumentation will be "commercial off the shelf", NEON's scientific and networking design requires certain technological innovations. Consequently, BIO is providing funds for advanced R&D activities in the areas of sensors and cyberinfrastructure.

Project Report:

Management and Oversight:

- NSF Structure: The NEON Program is managed in the Office of the Assistant Director (OAD) as part of Emerging Frontiers. OAD/BIO provides overall policy guidance and oversight, and the location of the NEON program in Emerging Frontiers fosters its interdisciplinary science connections. The NEON program is managed by a dedicated program officer. A business oversight team chaired by the NEON program officer advises and assists with the business framework of the project. A BIO-NEON committee, which includes the Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management (BFA), and a cross-NSF Program Advisory Team (PAT) formulates program planning for NEON. The NEON program officer is the COTR for the NEON environmental assessment and is assisted by the NEON Environmental Assessment Team (EA) that provides technical advice on environmental assessment, NEPA compliance, and NSF environmental policy.

- External Structure: The NEON Project is funded through cooperative agreements with NEON, Inc. The NEON, Inc.'s CEO provides overall leadership and management. A project manager at NEON, Inc. oversees all aspects of the project design, review, construction, and deployment. The NEON, Inc.'s director of computing is responsible for oversight of the cyberinfrastructure and embedded sensor development. The NEON, Inc. Board of Directors, a Science, Technology, and Education Advisory Committee (STEAC) and a Program Advisory Committee (PAC), composed of members of the NEON user community, help ensure that NEON will enable frontier research and education.

- Reviews:

  - Technical reviews: The NEON Observatory Design (including site selection and deployment design) Review was successfully completed in February 2009.
  - Management, Cost, and Schedule reviews:
    - The Conceptual Design Review (CDR) was held in November 2006.
    - A combined PDR/ FDR of the airborne observation platform was successfully completed in February 2009.
    - A PDR for entire project will be held in June 2009.
    - An FDR is scheduled for the first quarter of FY 2010.

<u>Current Project Status:</u>

The NEON, Inc. Project Office is currently completing the final design, NEON project execution plan (PEP), and maintenance and operations plan. The site selection and associated deployment plan is complete and has been merit reviewed. The NEPA environmental assessment is underway through an NSF contract with CH2 M Hill. In FY 2010 the final design and baseline, scope, schedule, and the risk-adjusted cost will be reviewed. Sufficient contingency will be built into the project design and budget to cover known risks.

<u>Cost and Schedule:</u>

Prior to certification of construction-readiness following a final baseline review, support is requested through the R&RA account for the NEON Project Office, for the NEON, Inc. Consortium that is the implementing organization for the project, and for ongoing R&D projects. The appropriated FY 2008 MREFC funds will continue to be carried over. In FY 2010, based on the outcome of the FDR and approval of a construction award by the NSB, these MREFC funds will be used to begin construction of a Fundamental Instrumentation Unit and embedded cyberinfrastructure in one NEON domain core site. Additional MREFC construction funding will be requested in a future budget submission.

<u>Risks:</u>

- Technical: Dependence on commercial off-the-shelf technology will be mitigated by long-lead purchase orders and alternative vendors. Production quality, embedded and system-level cyberinfrastructure (CI) will be addressed by a combination of "In-house" design, commercial, contracts, and targeted research (e.g., cyber-dashboard).

- Deployment: Environmental assessment and permitting may impact schedule and costs. These risks are being addressed through the direct contracting of the environmental assessment by NSF. In addition two national firms have been hired by NEON, Inc. for engineering and permitting, NEON, Inc. has alternative sites if the primary sites have significant risk, the US Forest Service allocated two FTEs to assist with environmental compliance issues on Forest Service lands, and local scientists are involved in site selection and analysis.

- Remote Sensing: A potential risk is the long-term availability of satellite (e.g., LANDSAT and MODIS) borne sensors. This risk is mitigated through a partnership with the USGS EROS Data Center that has the federal responsibility for curation and management of LANDSAT and MODIS images and having alternative satellite sensor sources to purchase images (e.g., SPOT - France, AWIFS – India, Terra and Aqua - US). The proposed NEON airborne observatory platform sensor system design and aircraft availability provide technical and implementation risk. To minimize this risk the design is being developed by JPL; similar instrument packages are being prototyped by NASA and Carnegie Mellon Institute at Berkley University. The designed sensor system fits multiple aircraft, including commercial aircraft. Experienced flight design engineers from Conklin & de Decker Aviation Company are contracted by NEON, Inc. to provide the baseline operations plans, aircraft analysis, and assessment of commercial companies that could support NEON flight operations and experienced research aircraft pilots serve on the design team.

Future Operations Costs

Management and operations costs are being finalized and will be reviewed at the PDR and subsequent FDR. NEON is reliant on sensors and cyberinfrastructure that have a defined lifecycle. Operations costs include scheduled replacement and refreshing of sensor, instrumentation and cyberinfrastructure technology.

Ocean Observatories Initiative $14,280,000

The FY 2010 Budget Request for the Ocean Observatories Initiative (OOI) is $14.28 million, which is a six year construction project totaling an estimated $386.42 million.

Appropriated and Requested MREFC Funds for the Ocean Observatories Initiative
(Dollars in Millions)

	FY 2007	FY 2008	FY 2009	FY 2010 Request	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	Total
OOI Regular Appropriations and Requests	$5.12	$5.91	-	$14.28	$110.70	$82.80	$46.80	$20.00	$285.61
Rescission	-5.12								-$5.12
ARRA			105.93						$105.93
Total, OOI	-	$5.91	$105.93	$14.28	$110.70	$82.80	$46.80	$20.00	$386.42

$5.12 million of the FY 2007 appropriated funds for OOI were rescinded per PL 110-161.

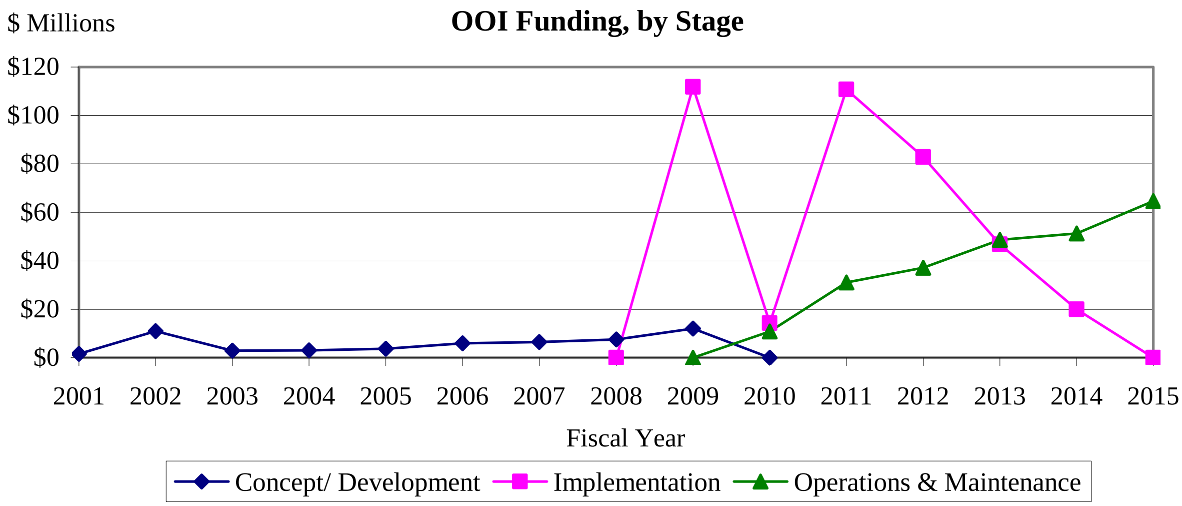
The proposed OOI will consist of an integrated observatory network that will provide the oceanographic research and education communities with continuous, interactive access to the ocean. The OOI will have three elements: 1) deep-sea buoys with designs capable of deployment in harsh environments such as the Southern Ocean; 2) regional cabled nodes on the seafloor spanning several geological and oceanographic features and processes; and 3) an expanded network of coastal observatories. A cutting edge, user-enabling cyberinfrastructure will link the three components of the OOI and facilitate experimentation using assets from the entire OOI network.

Baseline History: NSF first requested construction funding for OOI through the MREFC account in FY 2007 and received initial appropriations of $5.12 million in that year. The OOI has undergone a series of technical reviews, with the Final Design Review (FDR) conducted on November 6-7 and 12-14, 2008. The FDR panel determined that OOI was ready to move to construction assuming some adjustments to the baseline with respect to schedule and overall project contingency. Following the FDR, in an effort to focus OOI more specifically on high priority science issues related to climate change, ocean acidification, carbon cycling and ecosystem health, NSF initiated a rapid turn-around process to develop a modified network design in January 2009, referred to as the Variant Design. NSF convened an additional Science Review Panel and a Cost/Schedule Review Panel in March 2009 to consider the revised scope to ensure it continued to support the science goals of OOI. It is this Variant Design that is being recommended for construction. The Science Review Panel determined that the science motivating OOI continues to be important, vital, and transformative, and it supported proceeding with the Variant Design. The Cost-Schedule Panel expressed high confidence that the modified project scope, as expressed in the Variant Design, can be completed within the proposed total project cost, which includes ~30 percent contingency, and by the project completion date.

Total Obligations for OOI
(Dollars in Millions)

	Prior Years	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	ESTIMATES FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
R&RA Obligations:									
Concept & Development	$49.56	$7.50	$12.00	-					
Management and Operations				10.90	31.10	37.20	48.70	51.30	64.70
Subtotal, R&RA Obligations	$49.56	$7.50	$12.00	$10.90	$31.10	$37.20	$48.70	$51.30	$64.70
MREFC Obligations:									
Implementation	-	-	5.91	14.28	110.70	82.80	46.80	20.00	
ARRA	-	-	105.93	-					
Subtotal, MREFC Obligations	-	-	$111.84	$14.28	$110.70	$82.80	$46.80	$20.00	-
Total: OOI Obligations	**$49.56**	**$7.50**	**$123.84**	**$25.18**	**$141.80**	**$120.00**	**$95.50**	**$71.30**	**$64.70**

Totals may not add due to rounding.



NOTE: FY 2009 implementation funding includes $105.93 million provided through the American Recovery and Reinvestment Act.

Deployed in critical parts of the global and U.S. coastal ocean, OOI's 24/7 telepresence will capture climate, carbon, ecosystem, and geodynamic changes on the time scales on which they occur, rather than when research vessels are able to be in the area. Data streams from the air-sea interface through the water column to the seafloor will be openly available to educators and researchers in any discipline, making oceanography available to citizens and scholars who might never go to sea. Science themes for OOI include the ocean carbon cycle and its response to global change, ocean acidification, the impact of climate variability on ocean circulation, coastal ocean dynamics and ecosystem response, and the impact of tectonically driven fluid flow on the carbon cycle, deep ocean ecosystems and earthquakes.

The education and public engagement infrastructure of OOI will complement and leverage existing ocean education efforts, and build off of the cyberinfrastructure to provide an interactive digital presence to educators and the public alike. Educational links will be made with the Division of Ocean Sciences (OCE) Centers for Ocean Science Education Excellence (COSEE). In addition, with the establishment of the National Integrated Ocean Observing System (IOOS), there will be an unprecedented need for a

STEM workforce and oceanographers skilled in the use and manipulation of large, oceanographic, time-series datasets. The facilities comprising OOI will provide the ideal platforms to train this new generation of oceanographers.

Some of the component technologies that are part of OOI are currently in use or in development as part of the telecommunication and exploration industries. These groups have been engaged in drafting components of the OOI Network Design as well as in reviews of OOI planning. Industry will also be important participants in the construction and implementation phase of OOI, as well as in the future development of sensors critical to the evolution of the OOI network. Most recently, industry input has been solicited in a sensor workshop, which brought together industry representatives with the OOI Project Team to discuss OOI sensor requirements.

OOI will be coordinated with the IOOS to support operational mission objectives of agencies such as the National Oceanic and Atmospheric Administration (NOAA), the U.S. Navy, the National Aeronautics and Space Administration (NASA), and the U.S. Coast Guard.

Science proposals using the OOI network will be solicited as part of the normal competition for funds in OCE. The research envisioned for OOI encompasses a broad range of disciplines, and therefore no special research program will be established. Instead, proposals will be reviewed and competed with other research proposals submitted to OCE.

Project Report:

Management and oversight:

- NSF Structure: The project is managed and overseen by a Program Manager in OCE in the Directorate for Geosciences (GEO). The Program Manager receives advice and oversight support from an NSF Project Advisory Team (PAT) that includes representatives from GEO, the Directorates for Biological Sciences (BIO) and Engineering (ENG); the Office of Budget, Finance and Award Management (BFA); the Office of International Science and Engineering (OISE); the Office of General Counsel (OGC); and the Office of Legislative and Public Affairs (OLPA). The Deputy Director for Large Facility Projects (DDLFP) in BFA is also a member of the PAT and provides advice and assistance.

- External Structure: For the construction phase of OOI, management, coordination, and oversight of OOI is the responsibility of the OOI Project Director operating from the Ocean Observatory Project Office (systems integrator) at the Consortium for Ocean Leadership (Ocean Leadership), established through a cooperative agreement with NSF in 2004. This Project Director is accountable to NSF, the Ocean Leadership Board of Trustees, and an external scientific and technical advisory committee. The OOI Project Advisory Committee membership is drawn from individuals with expertise in ocean observing science and engineering. Subawards have been issued by Ocean Leadership to establish three Implementing Organizations (IOs). These IOs provide the detailed management and oversight for implementation of the regional cabled observatory (led by the University of Washington), cyberinfrastructure (led by the University of California-San Diego/Scripps Institute of Oceanography), and coastal/global observatories (led by Woods Hole Oceanographic Institution). These IOs report directly to the Project Office, which ensures cooperation and coordination between the IOs.

- Reviews:

  - Technical reviews: NSF organized a series of external science reviews for OOI, including the Blue Ribbon Review in July 2006, which assessed whether the ocean observing network proposed in the OOI Conceptual Network Design (CND) would provide the capabilities for the ocean researchers to answer high priority science questions that require *in situ*, real-time measurements across the three scales of OOI. A second Blue Ribbon Review in October 2007 assessed whether the OOI Preliminary Network Design provided the experimental capabilities needed to address the scientific scope outlined for OOI. These science reviews provided a general endorsement of OOI, supplemented by a series of recommendations for improvement. These reviews also served as input to the paired design reviews (Conceptual and Preliminary). NSF convened a Blue Ribbon Review in March 2009 to assess a modified OOI network design and its ability to provide transformative research capabilities for the ocean science community. This OOI Variant Design is a modification to the existing network design that more closely focuses OOI infrastructure on climate processes, carbon cycling, ocean acidification, and ecosystem health. The Blue Ribbon Review panel noted that the OOI, as described by the Variant Network Design, remains a worthy investment, providing a transformative capability for the ocean science community.

  - Management, Cost, and Schedule reviews:
    - The OOI Conceptual Design Review (CDR), held August 2006, reviewed the scope and system level implementation plans for OOI, including management plans and budgeting. It discussed whether all major risks with this project have been identified and whether appropriate initial system development specifications (performance requirements, major system components, and interfaces) have been established for each sub-element of OOI.
    - The Preliminary Design Review (PDR) in December 2007 assessed the robustness of the technical design and completeness of the budget and construction planning for the OOI. The PDR panel also reviewed progress made by the OOI Project Team on the findings of the CDR.
    - The FDR in November 2008 assessed whether OOI's project plans were fully ready for construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.
    - A Cost-Schedule Review Panel in March 2009 assessed whether the OOI Variant Design project plans were fully ready for construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.

  - Upcoming reviews:
    - Semi-annual external reviews of the OOI will be scheduled and conducted when construction begins.

<u>Current Project Status:</u>

The OOI project addressed key high priority recommendations from the FDR and is continuing planning efforts in anticipation of a 4th quarter 2009 construction start, pending NSB approval.

<u>Cost and Schedule:</u>

In FY 2009, OOI receives ARRA funding in the amount of $105.93 million to initiate construction. These funds will support a suite of efforts across the OOI project in the first two years of construction, including production engineering and prototyping of key coastal and global components (moorings, buoys, sensors), award of the primary cable contract, completion of the shore station, data sensing and acquisition digital capabilities, and instrument agent development. Initiation of such activities during FY 2009 and FY 2010 will provide risk reduction and cost savings (inflation) for the project.

Requests in FY 2010 and beyond, totaling $274.58 million, as well as funding appropriated in prior years, will enable the acquisition of OOI instruments and sensors, production of key infrastructure elements such as the coastal and open ocean moorings, and the deployment of these assets.

Risks:

- Oversight risk: The complexity of the OOI and the need for the Project Office and Implementing Organizations to coordinate and integrate construction activities and network implementation under the schedule, cost, and scope constraints of the project presents a project risk. OOI relies heavily on open lines of communication and effective cooperation between the managing entities (Project Office and IOs) and NSF. Both the PDR and the FDR panels were very supportive of the management structure. To ensure effective management and oversight, monthly and annual reports provided by the Project Office and IOs will be closely monitored by the OOI Program Manager and Contracts Officer for deviations from established baselines (using Earned Value Management) and annual site visits and reviews will be used to gain a more detailed impression of the integrative nature of the project teams. In addition, weekly teleconferences with the program staff from both the Project Office and IOs will help ensure that all groups are up to date with current activities. OOI semi-annual to annual programmatic reviews will be conducted by NSF, in addition to assessments by an external scientific oversight committee. Lastly, NSF's OOI Program Director will attend the Project Office's own internal reviews to ensure that OOI implementation is proceeding according to established principles as outlined in the Cooperative Agreement.

- Scope contingency: The Project Team has been directed to develop an appropriate level of contingency for OOI as dictated by a comprehensive (top-down and bottom-up) risk analysis. Should this contingency be exhausted, reductions in the scope of the OOI network plan will be required. These potential reductions, or scope contingency, must be implemented based on clearly articulated scientific priorities. Any changes to scope (as well as cost or schedule) will follow the OOI Change Control Process, which has a tiered evaluation process for evaluating and determining any change to the project.

- Risks Related to the OOI Cyberinfrastructure - The OOI Cyberinfrastructure will not only provide the network integration needed to achieve the scientific goals of OOI, but a robust, user-friendly cyberinfrastructure will be essential to develop a vigorous OOI user community. Ensuring the "usability" of the cyberinfrastructure was a key topic of discussion at the preliminary and final design reviews. Addressing recommendations from the FDR, the CI Implementing Organization was required by NSF to incorporate continued engagement of the user community during development and testing of the cyberinfrastructure. Additionally, continued involvement of Office of Cyberinfrastructure (OCI) Program Managers, via the PAT, and participation in reviews of the OOI network, will help mitigate risks associated with development and construction of the OOI cyberinfrastructure.

Future Operations Costs:

A steady state of $65.0 million in operations support (2015 dollars) is anticipated, and the expected operational lifespan of this project is 25 years.

Judgment Fund **$3,000,000**

Background: In 1998, a project was initiated both to modify and to upgrade and maintain three NSF-owned LC-130s to meet Air Force safety and operability standards that differ from those of the previous U.S. Navy operators. Modifications specified by the Air Force included avionics, airframe, safety, propulsion, and record data; storage and project administration costs were also included. Ski-equipped LC-130 aircraft are the backbone of the U.S. Antarctic Program's (USAP) air transport system and also support NSF's research in the Arctic. In FY 1998 $4.30 million from the Research and Related Activities (R&RA) account was provided for early engineering design, and between FY 1999 and FY 2002 $32.90 million from the Major Research Equipment and Facilities Construction (MREFC) account was expended for the modifications. The work included scheduled maintenance requirements.

Project Management: The contract for the modifications was awarded and administered by the Air Force C-130 Systems Program Office at Warner Robins Air Logistics Center (Warner Robins, GA; WRALC), which is the C-130 engineering authority for the Air Force. The solicitation also sought Programmed Depot Maintenance services in accordance with Air Force standard operating procedures. In March 1999, the Air Force awarded the contract for the work to Raytheon Services E-Systems. The contract was subsequently transferred to L-3 Communications, Inc. (L3) when it acquired Raytheon Services E-Systems.

The Warner Robins Air Logistics Center served as the procurement office with oversight and contract administration responsibilities. The contract was assigned for administration in accordance with FAR 42.202 to the Defense Contract Management Command, Dallas. NSF, responsible for the management of the USAP, served as the funding agency for the contract. To date, NSF has reimbursed WRALC for all its fees and costs relating to the performance and administration of the contract. The Defense Contracts Management Agency (DCMA) accepted the three aircraft on behalf of the Government.

Request for Equitable Adjustment: In June 2002, L3 Communications informed WRALC that it was experiencing substantial financial loss on the contract. In September 2002, L3 Communications indicated they would be submitting a request for equitable adjustment (REA) in the amount of $14.9 million. In January 2004 the contractor submitted a proposal to settle the REA in the amount of $2,999,941. In support of its proposal, the contractor submitted certified cost and pricing data for the proposed settlement amount.

Settlement Funding: In response to the contractor's settlement proposal, WRALC conducted a legal review and litigation risk assessment for the contractor's REA. It concluded that the Government was partly liable for L3 Communications' $14.9 million of uncompensated incurred costs based on the legal theories of defective specifications, mistake in bid caused by the Government providing late, defective, or unsuitable property, data and information, superior knowledge, constructive change, estoppel, detrimental reliance, and quantum meruit (i.e., "reasonable value of services"). The WRALC further concluded that the Government's litigation exposure came to about $7.5 million, including various fees and costs to litigate the matter. The WRALC recommended that the Government settle the matter for $3.0 million, as proposed by L3 Communications.

As a result of the WRALC legal review and litigation risk assessment, the Air Force and NSF discussed how the agencies would fund the costs to settle the REA submitted by L3 Communications or satisfy a judgment against the Government. Based on the facts provided by WRALC, NSF did not disagree with the Air Force's legal review and litigation risk assessment. Based on the review and assessment presented by WRALC, NSF agreed in principal that a settlement for $3.0 million in this case would best serve the interest of the Government.

In light of the Air Force's stated willingness to bear partial responsibility for the additional costs, NSF and WRALC officials, over the course of several months, endeavored to find a legal basis that would allow the Air Force to contribute funds to settle the contractor's REA. Based on an opinion issued by the Office of Legal Counsel in the Department of Justice, NSF advised the Air Force that a performing agency has the discretion to pay for actual costs, without seeking reimbursement from the ordering agency if the interagency agreement was based on authority other than the Economy Act.

On July 16, 2004, the Air Force informed NSF that under the Economy Act it was unable to use its appropriated funds to settle the REA even though NSF had relied on authorities other than the Economy Act when agreeing to fund the contract that Air Force would administer. It also notified NSF that "under the circumstances, we believe that referring the matter to the Department of Justice for an opinion would not be helpful." The Air Force did not articulate a policy, budgetary, or operational rationale for its decision.

Because the NSF lacked the necessary funding in its budget and the agencies had reached an impasse on whether the Air Force could contribute funds to the settlement, the Air Force denied the contractor's claim. L3 Communications appealed the agency's decision to the Armed Services Board of Contract Appeals (ASBCA). Pursuant to a settlement agreement, the Air Force agreed to pay the contractor $2,999,941 in return for L3 Communications agreeing to settle all present and future disputes, claims, and appeals, arising under or related to the contract. The ASBCA issued an opinion awarding the contractor $2,999,941 to be paid from the Judgment Fund, established under 31 U.S.C. § 1304.

On March 15, 2005, the Judgment Fund Branch, Department of the Treasury, requested that the NSF reimburse the Judgment Fund for the settlement amount. In response, NSF requested funds for this reimbursement in the FY 2007 Budget Request, but funding was not provided in the final appropriations action for that year (P.L. 110-5). NSF's FY 2008 Budget Request did not include a request for this activity since action on the FY 2007 Budget Request had not yet been taken by Congress at the time the FY 2008 Request was submitted.

<u>Current Status:</u> During FY 2008, the Financial Management Service of the Department of Treasury requested that NSF reimburse the Judgment Fund for the settlement amount. The FY 2010 Budget Request of $3.0 million funds the necessary reimbursement to the Judgment Fund.

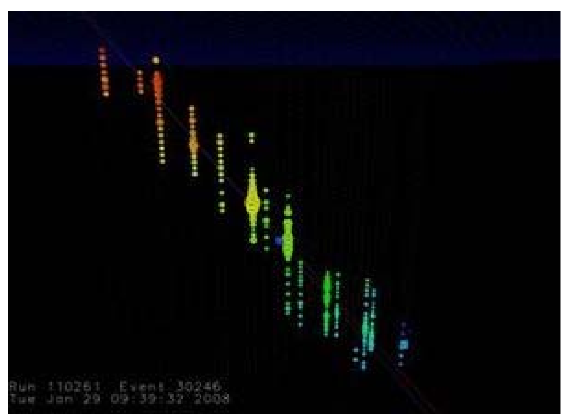
Recent Research Highlights

► **NSF Dedicates New Research Station at the South Pole:** The United States has dedicated a new scientific station at the geographic South Pole, the third since 1957, officially ushering in a new support system for sophisticated large-scale experiments in disciplines ranging from astrophysics to environmental chemistry and seismology. The elevated station is the most imposing structure ever built at the pole. The 12-year effort for planning and construction required extraordinary effort to complete in such an inhospitable environment. The project required 925 flights by ski-equipped LC-130 aircraft flown by the New York Air National Guard. At 26,000 pounds of cargo per flight, a total of 24 million pounds of cargo were transported. The elevated station consists of a series of interconnected modules mounted on steel support beams above the snow surface. The new station reasserts NSF's vital role in managing the U.S. Antarctic Program to meet the needs of the U.S. research community.

The Amundsen-Scott South Pole Station was dedicated on January 12, 2008. *Credit: National Science Foundation.*

► **Construction of the IceCube Neutrino Telescope Reaches Halfway Point:** Construction of the IceCube Neutrino Telescope by the University of Wisconsin-Madison at the U.S. Amundsen Scott South Pole Station has reached the halfway point. The telescope opens a new window for extragalactic astronomy and astrophysics, exploring a range of neutrino energies that are not available from any terrestrial source built by nuclear and particle physicists. IceCube discoveries have the potential to improve scientists' understanding of the universe's content and evolution (for instance, discovering the nature of Dark Matter). The engineering and science associated with the IceCube project represents an exciting opportunity to engage learners of all ages in the discovery process. IceCube scientists and staff eagerly shared their experiences at the South Pole Station via Web sites and blogs, in interviews with their hometown newspapers, and by visiting schoolrooms and participating in science fairs and exhibitions after the field season.

Steam rising from the IceCube heating plant. *Credit: Jim Haugen, University of Wisconsin-Madison, 2008.*



Down-going event detected on January 29, 2008, by 36 of the 40 strings of Ice Cube's in-ice Digital Optical Modules. The colors indicate the time of detection: the red indicates earlier time, the blue - later time. *Credit: Troy Straszheim and Eric Blaufuss, University of Maryland, 2008.*

► **McMurdo Station's Crary Lab and South Pole Station Exceed Energy Efficiency Guidelines:** A new ruling requires federal facilities to comply with strictly defined energy efficiency standards and exceed them by 30 percent. NSF undertook a professional assessment of its main facilities. The South Pole Elevated Station has an efficiency factor of 42 percent better than the new regulations, even in the harsh environment of Antarctica. The Cray Lab efficiency factor was computed as 3 percent better than the base requirement, impressive considering its inherently older technologies. Improvement initiatives underway are expected to boost performance up to 30 percent better than goal. Environmental stewardship is a critical goal of the U.S. Antarctic Program, and ensuring that its structures are energy efficient is critical to meeting this goal.

South Pole Elevated Station, which exceeded new federal standards for energy efficiency even in the harsh environment of Antarctica. *Credit: Jerry Marty.*