Advanced Scientific Computing Research

Program Mission

In the past two decades leadership in scientific computation has become a cornerstone of the Department's strategy to ensure the security of the nation and succeed in its science, energy, environmental quality, and national security missions. This scientific leadership is critical to the economic health of the nation. The mission of the Advanced Scientific Computing Research (ASCR) program is to underpin DOE's world leadership in scientific computation by supporting research in applied mathematics, computer science and high-performance networks and providing the high-performance computational and networking resources that are required for world leadership in science.

Overview:

Computational modeling and simulation are among the most significant developments in the practice of scientific inquiry in the 20th Century. Scientific computing is particularly important for the solution of research problems that are insoluble by traditional theoretical and experimental approaches, hazardous to study in the laboratory, or time-consuming or expensive to solve by traditional means. All of the research programs in the U.S. Department of Energy's Office of Science—in Basic Energy Sciences, Biological and Environmental Research, Fusion Energy Sciences, and High Energy and Nuclear Physics—have identified major scientific challenges that can only be addressed through advances in scientific computing.

ASCR research underpins the efforts of the other programs in the Office of Science. The applied mathematics research activity produces the fundamental mathematical methods to model complex physical and biological systems. The computer science research efforts enable scientists to efficiently perform scientific computations on the highest performance computers available and to store, manage, analyze, and visualize the massive amounts of data that result. The networking research activity provides the techniques to link the data producers, e.g., supercomputers and large experimental facilities with scientists who need access to the data.

ASCR's other principal responsibility is to provide the high-performance computational and networking resources that are required for world leadership in science. Recent dramatic advances in scientific computation by researchers and computer companies underscore the importance of strengthening our position in computational sciences in strategic areas. In March 2002, Japan's NEC Earth Simulator became operational. With a peak speed of 40 teraflops and a demonstrated sustained capability of over 25 teraflops, it is faster by approximately a factor of 50 than the most advanced supercomputer for civilian science in the United States. The potential long-term implications of the Earth Simulator on DOE's computational sciences capability was the principal message of the report on this subject delivered to the Director of the Office of Science by the Advanced Scientific Computing Advisory Committee. To strengthen the program's position in this area, the ASCR program is proposing a new effort in Next Generation Computer Architecture (NGA) to identify and address major bottlenecks in the performance of existing and planned DOE science applications.

The ASCR program supports the Office of Science Strategic Plan's goal of providing extraordinary tools for extraordinary science as well as building the foundation for the research in support of the other goals of the strategic plan. The research programs of ASCR have played a critical role in the evolution of high performance computing and networks. The ASCR program actively contributes to the goals of the *Five Year Strategic Plan* of the Interagency Working Group on Information Technology R&D. In particular, ASCR plays a key role in Large Scale Networking and High End Computing and Computation.

The ASCR program is also responsible for the Laboratory Technology Research subprogram, whose mission is to foster and support high-risk research in the natural sciences and engineering in partnership with the private sector leading to innovative applications relevant to the Nation's energy sector.

The quality of the research supported by the ASCR program is continuously evaluated through the use of merit-based peer review, scientific advisory committees, and interagency coordinating bodies.

How We Work:

The ASCR program uses a variety of mechanisms for conducting, coordinating, and funding research in applied mathematics, network and computer sciences, and in advanced computing software tools. The program is responsible for planning and prioritizing all aspects of supported research, conducting ongoing assessments to ensure a comprehensive and balanced portfolio, regularly seeking advice from stakeholders, supporting core university and national laboratory programs, and maintaining a strong infrastructure to support research in applied mathematics, network and computer science, and advanced computing software tools.

Advisory and Consultative Activities:

The ***Advanced Scientific Computing Advisory Committee (ASCAC),*** established on August 12, 1999, provides valuable, independent advice to the Department of Energy on a variety of complex scientific and technical issues related to the ASCR program. The ASCAC is charged with providing advice on: promising future directions for advanced scientific computing research; strategies to couple advanced scientific computing research to other disciplines; and the relationship of the DOE program to other Federal investments in information technology research. ASCAC's recommendations include advice on long-range plans, priorities, and strategies to address more effectively the scientific aspects of advanced scientific computing including the relationship of advanced scientific computing to other scientific disciplines, and maintaining appropriate balance among elements of the program. This advisory committee plays a key role in assessing the scientific and programmatic merit of presently funded activities and in evaluating plans for the future. The Committee formally reports to the Director, Office of Science and includes representatives from universities, national laboratories, and industries who are involved in advanced computing research. Particular attention is paid to obtaining a diverse membership with a balance among scientific disciplines, institutions, and geographic regions. ASCAC operates in accordance with the Federal Advisory Committee Act (FACA, Public Law 92-463; 92nd Congress, H.R. 4383; October 6, 1972) and all applicable FACA Amendments, Federal Regulations and Executive Orders.

The activities funded by the ASCR program are coordinated with other Federal efforts through the ***Interagency Principals Group***, chaired by the President's Science Advisor, and the ***Information Technology Working Group (ITWG).*** The ITWG evolved through an interagency coordination process that began under the 1991 High Performance Computing Act as the High Performance Computing, Communications, and Information Technology (HPCCIT) Committee. The Federal IT R&D agencies have established a 10-year record of highly successful collaborative accomplishments in multiagency projects and in partnerships with industry and academic researchers. The multiagency approach leverages the expertise and perspectives of scientists and technology users from many agencies who are working on a broad range of IT research questions across the spectrum of human uses of information technology. DOE has been an active participant in these coordination groups and committees since their inception and the ASCR program will continue to coordinate its activities through these mechanisms including an active role in implementing the federal IT R&D FY 2002-2006 Strategic Plan under the auspices of the National Science and Technology Council and the President's Science Advisor.

ASCR is a participant in the Interagency Committee for Extramural Mathematics Programs (ICEMAP), a coordinating committee with representatives from federal agencies that manage programs in mathematical research, including the National Science Foundation, DOE (through ASCR), the National Aeronautics and Space Administration, the National Institute for Standards and Technology, the Air Force Office of Scientific Research, the Army Research Office, and the Office of Naval Research. Meetings are held to coordinate activities across mathematical research programs, ensuring that the federal agencies coordinate their investments in basic mathematical research. The ASCR program regards ICEMAP as an important component in their efforts to maintain coordination with other federal agencies.

Facility Operations Reviews:

The ASCR program has undertaken a series of operations reviews of the National Energy Research Scientific Computing center (NERSC), the Energy Sciences Network (ESnet), and the Advanced Computing Research Testbeds (ACRTs).

NERSC, operated by the Lawrence Berkeley National Laboratory, annually serves about 2,400 scientists throughout the United States. These researchers work at DOE laboratories, universities, industrial laboratories and other Federal agencies. Allocations of computer time and archival storage at NERSC are awarded to research groups based on a review of submitted proposals. As proposals are submitted, they are subjected to peer review to evaluate the quality of science, the relevance of the proposed research to Office of Science goals and objectives and the readiness of the proposed application to fully utilize the computing resources being requested.

The ESnet, managed and operated by the Lawrence Berkeley National Laboratory, is a high-speed network serving thousands of Department of Energy scientists and collaborators worldwide. A pioneer in providing high-bandwidth, reliable connections, ESnet enables researchers at national laboratories, universities and other institutions to communicate with each other using the collaborative capabilities needed to address some of the world's most important scientific challenges. The ESnet Steering Committee (ESSC) was established in 1985 to ensure that ESnet meets the needs of the Office of Science programs. All program offices in the Office of Science appoint members, who represent their scientific communities, to serve on the ESSC. The ESSC is responsible for reviewing and prioritizing network requirements, for establishing performance objectives, and for proposing innovative techniques for enhancing ESnet capabilities. In addition to the ongoing oversight from the ESSC, ASCR conducts external peer reviews of ESnet performance on a three year interval. The last such review was chaired by a member of ASCAC and took place in September 2001.

Advanced Computing Research Testbeds (ACRTs) play a critical role in testing and evaluating new computing hardware and software. Current testbeds are located at Oak Ridge National Laboratory (IBM Power-4 Technology and CRAY X1 technology). In FY 2002, ASCAC conducted a review of the NERSC and ACRTs. The charge to ASCAC, posed the following questions:

- What is the overall quality of these activities relative to the best-in-class in the U.S. and internationally?
- How do these activities relate and contribute to Departmental mission needs?
- How might the roles of these activities evolve to serve the missions of the Office of Science over the next three to five years?

The essential finding of the Subcommittee is that NERSC and the ACRTs are among the best worldwide in their respective categories. It is the opinion of the Subcommittee that these ASCR activities and the related spin-off research efforts contribute signigicantly to the mission needs of the DOE, and profoundly and positively impact high performance computing activities worldwide. The complete report is available on the web at: http://www.sc.doe.gov/ascr/ASCAC-sub.doc

In FY 2001, ASCR conducted a peer review of the Center for Computational Sciences (CCS) at the Oak Ridge National Laboratory. The findings from this review validated the contributions that the CCS made to the Advanced Computing Research Testbed activity within the ASCR program.

Program Reviews:

The ASCR program conducts frequent and comprehensive evaluations of every component of the program. Results of these evaluations are used to modify program management as appropriate. In FY 2002, ASCAC conducted a review of NERSC and the ACRTs.

In FY 2003, ASCR conducted a peer review of the Numerical Linear Algebra, Optimization, and Predictability Analysis areas within the Applied Mathematics activity. These areas represent 33 percent of this activity. In FY 2004, ASCR will conduct a peer review of the Differential Equations and Advanced Numerical Methods for High Performance Computing areas within the Applied Mathematics activity, representing an additional 33 percent of this activity. In FY 2005, ASCR will conduct a peer review of the remaining 34 percent of the Applied Mathematics activity, which consists of Computational Fluid Dynamics and Meshing Techniques. In FY 2004, ASCR will initiate a comprehensive review of the Computer Science research activity.

In FY 2002, following a comprehensive peer review, the ASCR program approved a proposal from the Lawrence Berkeley National Laboratory (LBNL) to manage and operate the National Energy Research Scientific Computing Center for FY 2002 – FY 2006.

Planning and Priority Setting:

The ASCR program must coordinate and prioritize a large number of goals from agency and interagency strategic plans. One of the most important activities of ASCAC is the development of a framework for the coordinated advance and application of network and computer science and applied mathematics. This framework must be sufficiently flexible to rapidly respond to developments in a fast paced area of research. The key planning elements for this program are:

- The Department and Office of Science Strategic Plan, as updated through program collaborations and joint advisory committee meetings. http://www.science.doe.gov/production/bes/strat_pln.htm
- Scientific Discovery through Advanced Computing (SciDAC) plan delivered to Congress in March 2000. http://www.science.doe.gov/scidac/
- The Interagency Working group for Information Technology Five Year Plan – FY 2002-FY 2006 (with key appendixes)
- ASCAC report on the Japanese Earth Simulator. http://www.sc.doe.gov/ascr/ascac.reports.htm

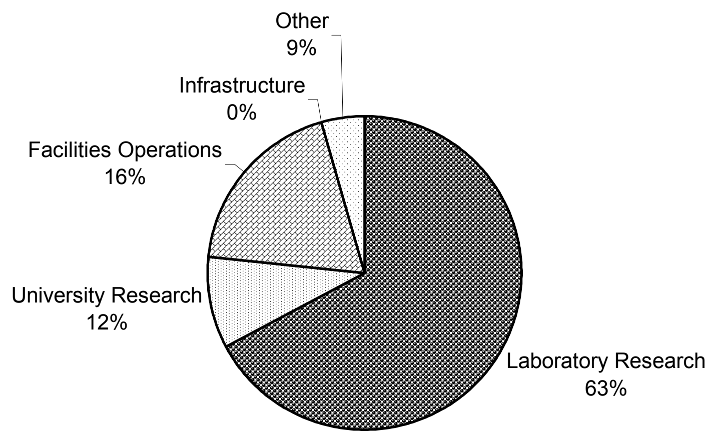
How We Spend Our Budget:

The ASCR program budget has two major components: research and facility testbed and network operations. The FY 2004 budget request continues the core and SciDAC research efforts and strengthens the research partnerships with other SC offices. The testbed and network operations expenditures account for 37 percent of the National Lab Research, or 24 percent of the total ASCR budget.

Research:

Over 76 percent of the program's FY 2004 funding will be provided to scientists at universities and laboratories to conceive and carry out the research or to fund advanced computing testbeds and network operations. National laboratory research scientists work together with the other programs of the Office of Science to develop the tools and techniques that allow those programs to take advantage of terascale computing for scientific research. The laboratories provide state-of-the-art resources for testbeds and novel applications. The division of support between national laboratories and universities is adjusted to maximize scientific productivity.

ADVANCED SCIENTIFIC COMPUTING RESEARCH
FY 2004



- ***University Research***: University researchers play a critical role in the nation's research effort and in the training of graduate students. During FY 2002, the ASCR program supported over 150 grants to the nation's university researchers and graduate students engaged in civilian applied mathematics, large-scale network and computer science research. These grants included support for graduate students. In addition, ASCR supports a Computational Science Graduate Fellowship and an Early Career Principal Investigator Program in Applied Mathematics, Computer Science and High-Performance Networks. In FY 2002, ASCR selected 24 new graduate fellows representing 17 universities and 13 states and expects to make up to forty awards to early career principal investigators. ASCR also provides support to other Office of Science research programs. Approximately one-half of those who received Ph.D.'s in the Computational Sciences Graduate Fellowship program between 1991 and 2001 are pursuing careers outside universities or national labs.

  The university grants program is proposal driven, similar to the computer science and applied mathematics programs at NSF. However, ASCR grant solicitation notices are focused on topics that have been identified as important for DOE missions. ASCR funds the best among the ideas submitted in response to grant solicitation notices (see: www.er.doe.gov/production/grants/grants.html). Proposals are reviewed by external scientific peers and competitively awarded according to the guidelines published in 10 CFR 605 (www.science.doe.gov/production/grants/605index.html).

- *National Laboratory Research*: ASCR supports national laboratory-based research groups at Ames, Argonne, Brookhaven, Los Alamos, Lawrence Berkeley, Lawrence Livermore, Oak Ridge, Pacific Northwest, and Sandia National Laboratories. The directions of laboratory research programs are driven by the needs of the Department and the unique capabilities of the laboratories to support large scale, multidisciplinary, collaborative research activities. In addition, laboratory-based research groups are highly tailored to the major scientific programs at the individual laboratories and the computational research needs of the Office of Science. Laboratory researchers collaborate with laboratory and academic researchers, and are important for developing and maintaining testbeds and novel applications of high performance computing and networking in Office of Science research. At Los Alamos, Livermore and Sandia, ASCR funding plays an important role in supporting basic research that can improve the applied programs, such as the Accelerated Strategic Computing Initiative (ASCI) and the Science Stockpile Stewardship program.

ASCR funds field work proposals from the national laboratories. Proposals are reviewed by external scientific peers and awarded using procedures that are equivalent to the 10 CFR 605 guidelines used for the grants program. Performance of the laboratory groups is reviewed by ASCR staff annually to examine the quality of their research and identify needed changes, corrective actions or redirection of effort. Individual laboratory groups have special capabilities or access to laboratory resources that can be profitably utilized in the development of the research program.

Program Strategic Performance Goals

SC5-1: Build leading research programs in focused disciplines of applied mathematics, computer science, and network and collaboratory research important to national and energy security to spur revolutionary advances in the use of high performance computers and networks. (Mathematical, Information and Computational Sciences subprogram)

Performance Indicator

Eighty percent of all new research projects will be peer reviewed and deemed excellent and relevant, and annually 30 percent of all ongoing projects will be subject to peer review with merit evaluation; all research areas and facilities will be periodically reviewed by subcommittees of the Advanced Scientific Computing Advisory Committee and determined to be world class.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Completed the development of the Cougar lightweight kernel for clusters of Alpha processor-based computers and begin the assessment of scalability and performance for selected applications. (SC5-1) [Met Goal]	Complete the definitive analysis of the advantages and issues associated with lightweight kernel operating systems rather than full kernels for the compute nodes of extreme-scale scientific computers, resolving a critical issue for the future of high performance computers in the U.S. (SC5-1)	Define, based on the analysis completed in FY 2003, a research strategy that will deliver by 2007 effective operating systems for high performance scientific computers with 20,000 or more processors. (SC5-1)
		Complete, by the end of FY 2004, a roadmap that defines the critical, applied mathematics research issues which must be addressed to enable the development of mathematical algorithms that can operate efficiently on computers with thousands of

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
		processors and address the needs of DOE mission applications. This roadmap will be completed through a series of workshops sponsored by ASCR and ASCAC.
Appointed 25 new students to the Computational Science Graduate Fellowship Program to develop the next generation of leaders in computational science for DOE and the Nation. (SC5-1) [Exceeded Goal]		
		Respond to recommendations of Advanced Scientific Computing Advisory Committee sub panel on computational biology.

SC5-2: Create the Mathematical and Computing Systems Software and the High Performance Computing Facilities that enable Scientific Simulation and Modeling Codes to take full advantage of the extraordinary capabilities of terascale (trillions of operations per second) computers, and the Collaboratory Software Infrastructure to enable geographically-separated scientists to effectively work together as a team as well as provide electronic access to both facilities and data. (Mathematical, Information and Computational Sciences subprogram)

Performance Indicator

Validation of results by merit review with external peer evaluation.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Achieved operation of the IBM-SP computer at 5.0 Teraflop "peak" performance. These computational resources will be integrated by a common high performance file storage system that facilitates interdisciplinary collaborations. (SC5-2) [Met Goal] Migrated the users with the largest allocations to the IBM-SP from the previous generation Cray T3E. (SC5-2) [Met Goal]	Begin installation of next generation NERSC computer, NERSC-4, that will at least double the capability available in FY 2002 to solve leading edge scientific problems. (SC5-2)	Complete installation of next generation NERSC computer, NERSC-3e, that will at least double the capability available to solve leading edge scientific problems. The number of Massively Parallel Processor Hours (MPP Hours) available will increase from 53 million in FY 2003 to 110 million in FY 2004.
	Initiate at least 8 competitively selected interdisciplinary research teams to provide computational science and applied mathematics advances that will accelerate biological discovery in microbial systems and develop the next generation of computational tools required for nanoscale science based on peer review, in partnership with the	Deliver enhanced versions of software from Integrated Software Infrastructure Centers established in FY 2001 to scientific application research teams. This software will increase the average efficiency of those applications by 50% (from the current 10% average baseline efficiency of peak processor power to 15%). This improvement in efficiency

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
	Biological and Environmental Research and Basic Energy Sciences programs, respectively, of submitted proposals. (SC5-2)	will enable a 30% increase in the amount of science research/analysis that can be accomplished at the existing high performance computing facilities.
	Evaluate effectiveness of a new software tool-(GRID middleware) as a tool to enable SC user communities in High Energy Physics and Global Climate to effectively access very large data resources over the Internet.	Plan upgrade of ESnet that will satisfy transatlantic data requirements of Large Hadron Collider (LHC) experiment at CERN outside of Geneva, Switzerland.

SC7-5: Provide advanced scientific user facilities where scientific excellence is validated by external review; average operational downtime does not exceed 10 percent of schedule; construction and upgrades are within 10 percent of schedule and budget; and facility technology research and development programs meet their goals. (Mathematical, Information and Computational Sciences subprogram)

Performance Indicator

Percent unscheduled downtime.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Maintained and operated facilities, including NERSC and ESnet, so the unscheduled downtime on average is less than 10 percent of the total scheduled operating time.[Met Goal]	Maintain and operate facilities, including NERSC and ESnet, so the unscheduled downtime on average is less than 10 percent of the total scheduled operating time. (SC7-5)	Maintain and operate facilities, including NERSC and ESnet, so the unscheduled downtime on average is less than 10 percent of the total scheduled operating time. (SC7-5)
Deliver preliminary report of ASCAC review of ASCR high performance computing facilities. (SC7-5) [Met Goal]	Complete the review of ASCR high performance computing facilities by the Advanced Scientific Computing Advisory Committee (ASCAC) and implement action plans to respond to recommendations. (SC7-5)	Complete the review of ASCR high performance network facilities by the Advanced Scientific Computing Advisory Committee (ASCAC) and implement action plans to respond to recommendations.

Program Assessment Rating Tool (PART) Assessment

The Office of Management and Budget has provided the ASCR program with input using their Program Assessment Rating Tool (PART). The OMB states that ASCR's program has a fairly well defined mission and merit-based reviews for awarding contracts and grants, leading to high scores for both purpose and management practices. Despite the problems inherent in predicting and then measuring scientific progress, the OMB has acknowledged that ASCR has made significant strides in developing long-term and annual performance measures. The OMB also stated that in the past several years, ASCR has recast its focus between several large initiatives since 2000. The OMB suggested that this situation reflected a lack of long-term vision for the program, and recommended that ASCR develop a long-term strategic plan. The OMB also noted that the ASCR program does not yet have regular reviews of its research portfolio and processes by a Committee of Visitors (COV). Both suggestions have been adopted by ASCR as action items to be completed by the end of FY 2003.

Significant Program Shifts

The ASCR program advances mathematics and computer science, and develops the specialized algorithms, the scientific software tools, and the software libraries needed by DOE researchers to effectively use high-performance computing and networking hardware for scientific discovery. The ASCR program has been a leader in the computational sciences for several decades and has been acknowledged for pioneering accomplishments.

High-performance computing and networking resources will be provided to meet the needs of the base research programs throughout the Office of Science. Research efforts initiated in FY 2001 in Scientific Discovery through Advanced Computing (SciDAC) will be continued, as planned. The FY 2004 budget includes $13,968,000 to launch a research investment in Next Generation Computer Architecture for science. The NGA will increase the delivered computing capability available to address the Office of Science mission through optimization of computer architectures to meet the special requirements of scientific problems. This investment positions the nation to realize extraordinary scientific opportunities in computing for science and enable new classes of scientific problems to be addressed. The NGA effort complements SciDAC and integrates advanced computer architecture researchers and engineers, application scientists, computer scientists, and applied mathematicians.

The computational needs of the SciDAC research program will be addressed by investments focused on providing high-performance computing pilot capability for Topical Applications. The FY 2004 budget request includes $7,867,000 for continued support of the Genomes to Life research program, in partnership with the Biological and Environmental Research program; and $3,072,000 for the Nanoscale Science, Engineering and Technology initiative led by the Basic Energy Sciences program. ASCR's contributions to these partnerships will consist of advancing the mathematics and developing new mathematical algorithms to simulate biological systems and physical systems at the nanoscale.

In FY 2004, the Mathematical, Information and Computational Sciences subprogram will continue to support core research activities at current levels.

The Laboratory Technology Research subprogram will be brought to a successful conclusion in FY 2004.

Interagency Environment

The activities funded by the MICS subprogram are coordinated with other Federal efforts through the Interagency Principals Group, chaired by the President's Science Advisor, and the Information Technology Working Group (ITWG). The ITWG evolved through an interagency coordination process that began under the 1991 High Performance Computing Act as the High Performance Computing, Communications, and Information Technology (HPCCIT) Committee. DOE has been an active participant in these coordination groups and committees since their inception. The MICS subprogram will continue to coordinate its activities through these mechanisms and will lead the development of new coordinating mechanisms as needs arise. The DOE program solves mission critical problems in scientific computing. In addition, results from the DOE program benefit the Nation's Information Technology Basic Research effort. The FY 2004 program positions DOE to make additional contributions to this effort. In the area of high performance computing and computation, ASCR has extensive partnerships with other Federal agencies and the NNSA. Examples include: acting as a technical agent for one of the DARPA High Productivity Computing Systems contracts; serving on the planning group for the Congressionally mandated DOD plan for high performance computing to serve the national security mission; and extensive collaboration with NNSA-Advanced Simulation Computing.

Scientific Discovery through Advanced Computing

The SciDAC activity is a set of coordinated investments across all Office of Science mission areas with the goal to achieve breakthrough scientific advances through computer simulation that were impossible using theoretical or laboratory studies alone. By exploiting advances in computing and information technologies as tools for discovery, SciDAC encourages and enables a new model for multi-discipline collaboration among the scientific disciplines, computer scientists and mathematicians. The product of this collaborative approach is a new generation of scientific simulation codes that can fully exploit terascale computing and networking resources. The program will bring simulation to a parity level with experiment and theory in the scientific research enterprise as demonstrated by major advances in climate prediction, plasma physics, particle physics, astrophysics and computational chemistry.

Next Generation Computer Architecture

The goal of the Next Generation Computer Architecture (NGA) research activity is to identify and address major architectural bottlenecks, such as internal data movement in very large systems, in the performance of existing and planned DOE science applications. Emphasis will be placed on understanding the impact of alternative computer architectures on application performance with particular attention paid to data movement from memory to processor and between processors in highly parallel systems. Software research will be initiated to improve application performance and system reliability through innovative approaches to next generation operating systems. Emphasis will also be placed on hardware evaluation testbeds of sufficient size to understand key issues impacting application performance scalability and portability. The NGA activity will be coordinated with other Federal agencies to gain additional insight into research directions, optimize the utilization of resources, and establish the framework for a national effort.

Scientific Facilities Utilization

The ASCR program request includes support to the National Energy Research Scientific Computing (NERSC) Center, a component of the Office of Science-wide Scientific Facilities Initiative. This investment will provide computer resources for about 2,400 scientists in universities, DOE laboratories, federal agencies, and U.S. companies. The proposed funding will enable NERSC to maintain its role as one of the Nation's premier unclassified computing centers, a critical element for success of many Office of Science research programs.

(hours)	FY 2000	FY 2001	FY 2002	FY 2003 Est.	FY 2004 Est.
Maximum Hours – NERSC	8,760	8,760	8,760	8,760	8,760
Scheduled Hours – NERSC	8,497	8,585	8,585	8,585	8,585
Unscheduled Downtime – NERSC	1%	1%	1%	–	–

Workforce Development

The R&D Workforce Development mission is to ensure the supply of computational and computer science and Ph.D. level scientists for the Department and the Nation through graduate student and postdoctoral research support. In FY 2004, this program will support approximately 800 graduate students and post doctoral investigators, of which 500 will be supported at Office of Science user facilities.

ASCR will continue the Computational Science Graduate Fellowship Program with the successful appointment of 20 new students to support the next generation of leaders in computational science.

	FY 2000	FY 2001	FY 2002	FY 2003 est.	FY 2004 est.
# University Grants	128	170	163	144	140
Size, Duration	$95,000/yr-3 yrs	$157,000/yr-3yrs	$157,000/yr-3yrs	$197,000/yr-3yrs	$197,000/yr-3yrs
# Lab Groups	148	226	209	165	165
# Grad Students	290	370	354	354	354
# PhD's Awarded	550	660	604	675	675

Funding Profile

	(dollars in thousands)				
	FY 2002 Comparable Appropriation	FY 2003 Request	FY 2004 Request	$ Change	% Change
Advanced Scientific Computing Research					
Mathematical, Information, and Computational Sciences	147,159	163,557	170,490	+6,933	+4.2%
Laboratory Technology Research	3,046	3,000	3,000	0	--
Total, Advanced Scientific Computing Research	150,205[abc]	166,557[c]	173,490	+6,933	+4.2%

Public Law Authorization:
Public Law 95-91, "Department of Energy Organization Act"
Public Law 103-62, "Government Performance and Results Act of 1993"

[a] Excludes $3,731,000 which was transferred to the SBIR program and $224,000 which was transferred to the STTR program.
[b] Excludes $88,000 for the FY 20023 rescission contained in section 1403 of P.L. 107-226, Supplemental Appropriations for further recovery from and response to Terrorist attacks on the United States.
[c] Excludes $3,068,000 in FY 2002, FY 2003 and FY 2004 for Homeland Security activities that are funded in a separate Department of Homeland Security budget.

Funding by Site[a]

	(dollars in thousands)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
Los Alamos National Laboratory	3,709	5,020	3,570	-1,450	-28.9%
Sandia National Laboratories	5,783	3,889	6,047	+2,158	+55.5%
Total, Albuquerque Operations Office	9,492	8,909	9,617	+708	+7.9%
Chicago Operations Office					
Ames Laboratory	2,183	1,625	1,578	-47	-2.9%
Argonne National Laboratory	13,503	8,573	11,646	+3,073	+35.8%
Brookhaven National Laboratory	1,359	542	960	+418	+77.1%
Fermi National Accelerator Laboratory	326	60	226	+166	+276.7%
Princeton Plasma Physics Laboratory	400	0	420	+420	+100.0%
Chicago Operations Office	17,147	7,240	24,556	+17,316	+239.2%
Total, Chicago Operations Office	34,918	18,040	39,386	+21,346	+118.3%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	65,872	53,223	57,686	+4,463	+8.4%
Lawrence Livermore National Laboratory	4,119	0	3,068	+3,068	+100.0%
Stanford Linear Accelerator Center	702	234	613	+379	+162.0%
Oakland Operations Office	2,122	960	3,115	+2,155	+224.5%
Total, Oakland Operations Office	72,815	54,417	64,482	+10,065	+18.5%
Oak Ridge Operations Office					
Oak Ridge Inst. For Science and Education	306	99	200	+101	+102.0%
Oak Ridge National Laboratory	26,629	10,496	9,819	-677	-6.4%
Thomas Jefferson National Accelerator Facility	100	0	0	0	--
Total, Oak Ridge Operations Office	27,035	10,595	10,019	-576	-5.4%
Richland Operations Office					
Pacific Northwest National Laboratory	4,097	1,003	3,601	+2,598	+259.0%
Washington Headquarters	1,848	73,593	46,385	-27,208	-37.0%
Total, Advanced Scientific Computing Research	150,205	166,557	173,490	+6,933	+4.2%

[a] On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format.

Site Description

Ames Laboratory

Ames Laboratory is a Multiprogram Laboratory located on 10 acres in Ames, Iowa. The MICS subprogram at Ames Laboratory conducts research in computer science and participates on one of the SciDAC teams. The LTR subprogram at Ames conducts research in the physical, chemical, materials, mathematical, engineering, and environmental sciences through cost-shared collaborations with industry.

Argonne National Laboratory

Argonne National Laboratory (ANL) in Argonne, Illinois, is a Multiprogram Laboratory located on a 1,700 acre site in suburban Chicago. ANL has a satellite site located in Idaho Falls, Idaho. The MICS subprogram at ANL conducts basic research in mathematics and computer science, as well as research in advanced computing software tools and collaboratory tools. ANL also participates in several scientific application and collaboratory pilot projects as well as supporting an advanced computing research testbed and participates on a number of the SciDAC teams. The ANL also focuses on testing and evaluating leading edge research computers. The LTR subprogram at ANL conducts research motivated by practical energy payoffs through cost-shared collaborations with industry. The areas emphasized in the research portfolio are chemistry of ceramic membranes, separations technology, near-frictionless carbon coatings, and advanced methods for magnesium production.

Brookhaven National Laboratory

Brookhaven National Laboratory (BNL) is a Multiprogram Laboratory located on a 5,200 acre site in Upton, New York. BNL has a computing capability for Quantum Chromodynamics (QCD) simulations. The MICS subprogram at BNL participates on one of the SciDAC teams. The LTR subprogram at BNL conducts research motivated by practical energy payoffs through cost-shared collaborations with industry. The areas emphasized in the research portfolio are materials for rechargeable lithium batteries, sensors for portable data collection, catalytic production of organic chemicals, and DNA damage responses in human cells.

Fermi National Accelerator Laboratory (Fermilab)

Fermilab is located on a 6,800-acre site about 35 miles west of Chicago, Illinois. The LTR subprogram at Fermilab conducts research in areas such as superconducting magnet research, design and development, detector development and high-performance computing through cost-shared collaborations with industry.

Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory (LBNL) is a Multiprogram Laboratory located in Berkeley, California. The Laboratory is on a 200 acre site adjacent to the Berkeley campus of the University of California. The MICS subprogram at LBNL conducts basic research in the mathematics and computer science, as well as research in advanced computing software tools and collaboratory tools. LBNL participates in several scientific application and collaboratory pilot projects and participates on a number of the SciDAC teams. LBNL manages the Energy Sciences Network (ESnet). ESnet is one of the world's most effective and progressive science-related computer networks that provides worldwide access and communications to Office of Science (SC) facilities. In 1996, the National Energy Research Scientific Computing Center (NERSC) was moved from the Lawrence Livermore National Laboratory to LBNL. NERSC provides a range of high-performance, state-of-the-art computing resources that are a critical element in the success of many SC research programs. The LTR subprogram at LBNL conducts research motivated by practical energy payoffs through cost-shared collaborations with industry. The areas emphasized in the research portfolio are molecular lubricants for computers, advanced material deposition systems, screening novel anti-cancer compounds, and innovative membranes for oxygen separation.

Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory (LLNL) is a Multiprogram Laboratory located on an 821 acre site in Livermore, California. The MICS subprogram at LLNL involves participation in base research and SciDAC efforts.

Los Alamos National Laboratory

Los Alamos National Laboratory (LANL) is a Multiprogram Laboratory located on a 27,000 acre site in Los Alamos, New Mexico. The Mathematical Information and Computational Sciences (MICS) subprogram at LANL conducts basic research in the mathematics and computer science and in advanced computing software tools. LANL also participates in several scientific application and collaboratory pilot projects and participates on a number of the SciDAC teams.

Oak Ridge Institute for Science and Education

Oak Ridge Institute for Science and Education (ORISE) is located on 150 acres in Oak Ridge, Tennessee. ORISE provides support for education activities funded within the ASCR program.

Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL) is a Multiprogram Laboratory located on a 24,000 acre site in Oak Ridge, Tennessee. The MICS subprogram at ORNL conducts basic research in the mathematics and computer science, as well as research in advanced computing software tools and collaboratory tools. ORNL also participates in several scientific application and collaboratory pilot projects and participates on a number of the SciDAC teams. ORNL also supports Advanced Computing Research Testbeds (ACRTs) focused on the evaluation of leading edge research computers. The LTR subprogram at ORNL conducts research motivated by practical energy payoffs through cost-shared collaborations with industry. The areas emphasized in the research portfolio are high temperature superconducting wires, microfabricated instrumentation for chemical sensing, and radioactive stents to prevent reformation of arterial blockage.

Pacific Northwest National Laboratory

Pacific Northwest National Laboratory (PNNL) is a Multiprogram Laboratory located on 640 acres at the Department’s Hanford site in Richland, Washington. The MICS subprogram at PNNL conducts basic research in the mathematics and computer science, as well as research in advanced computing software tools and collaboratory tools. PNNL also participates in several scientific application pilot projects and participates on a number of the SciDAC teams. The LTR subprogram at PNNL conducts research motivated by practical energy payoffs through cost-shared collaborations with industry. The areas emphasized in the research portfolio are mathematical simulations of glass production, interactions of biological polymers with model surfaces, and characterization of microorganisms in environmental samples.

Princeton Plasma Physics Laboratory

The Princeton Plasma Physics Laboratory (PPPL), a laboratory located in Plainsboro, New Jersey, is dedicated to the development of magnetic fusion energy. The LTR subprogram at PPPL conducts research in areas that include the plasma processing of semiconductor devices and the study of beam-surface interactions through cost-shared collaborations with industry.

Sandia National Laboratories

Sandia National Laboratories (SNL) is a Multiprogram Laboratory, with a total of 3,700 acres, located in Albuquerque, New Mexico, with sites in Livermore, California, and Tonopah, Nevada. The MICS subprogram at SNL conducts basic research in mathematics and computer science, as well as research in advanced computing software tools and collaboratory tools. SNL also participates in several scientific application and collaboratory pilot projects and participates on a number of the SciDAC teams.

Stanford Linear Accelerator Center

The Stanford Linear Accelerator Center (SLAC) is located at the edge of Silicon Valley in California about halfway between San Francisco and San Jose on 426 acres of Stanford University land. The LTR subprogram at SLAC conducts research in areas such as advanced electronics, large-scale ultra-high vacuum systems, radiation physics and monitoring, polarized and high-brightness electron sources, magnet design and measurement, and controls systems through cost-shared collaborations with industry.

Thomas Jefferson National Accelerator Facility

The Thomas Jefferson National Accelerator Facility (TJNAF) is a basic research laboratory located on a 200 acre site in Newport News, Virginia. The LTR subprogram at the TJNAF conducts research in such areas as accelerator and detector engineering, superconducting radiofrequency technology, speed data acquisition, and liquid helium cryogenics through cost-shared collaborations with industry.

All Other Sites

The ASCR program funds research at 71 colleges/universities located in 24 states supporting approximately 126 principal investigators. Also included are funds for research awaiting distribution pending completion of peer review results.

A number of Integrated Software Infrastructure Centers will be established at laboratories and/or universities. Specific site locations will be determined as a result of competitive selection. These centers will focus on specific software challenges confronting users of terascale computers.

Mathematical, Information, and Computational Sciences

Mission Supporting Goals and Measures

The Mathematical, Information, and Computational Sciences (MICS) subprogram is responsible for carrying out the primary mission of the ASCR program: discovering, developing, and deploying advanced scientific computing and communications tools and operating the high performance computing and network facilities that researchers need to analyze, model, simulate, and — most importantly — predict the behavior of complex natural and engineered systems of importance to the Office of Science and to the Department of Energy.

The computing and the networking required to meet Office of Science needs exceed the state-of-the-art by a wide margin. Furthermore, the algorithms, software tools, the software libraries and the software environments needed to accelerate scientific discovery through modeling and simulation are beyond the realm of commercial interest. To establish and maintain DOE's modeling and simulation leadership in scientific areas that are important to its mission, the MICS subprogram employs a broad, but integrated research strategy. The MICS subprogram's basic research portfolio in applied mathematics and computer science provides the foundation for enabling research activities, which includes efforts to advance networking, to develop software tools, software libraries and software environments. Results from enabling research supported by the MICS subprogram are used by computational scientists supported by other Office of Science and other DOE programs. This link to other DOE programs provides a tangible assessment of the value of the MICS subprogram for advancing scientific discovery and technology development through simulations.

In addition to its research activities, the MICS subprogram plans, develops, and operates supercomputer and network facilities that are available to researchers working on problems relevant to DOE's scientific missions 24 hours a day, 365 days a year.

The Early Career Principal Investigator (ECPI) activity was initiated in FY 2002 for scientists and engineers in tenure track positions at U.S. universities. Seventeen (17) awards were made. The goal of the ECPI activity is to support Office of Science mission related research in applied mathematics, computer science and high-performance networks performed by exceptionally talented university investigators, who are at an early stage in their professional careers.

ACCOMPLISHMENTS

- **ParamBench demonstrates the significant impact of concurrent memory accesses** - Computer scientists at the Lawrence Livermore National Laboratory, in collaboration with researchers at the University of Utah and North Carolina State University have implemented ParamBench, low-level benchmarks of memory performance in symmetric multiprocessors (SMPs). These benchmarks measure the raw memory performance of SMPs, including the effect of multiple processors accessing the memory system concurrently. Results with this benchmark suite demonstrate that standard latency-hiding techniques, such as hardware prefetching, are less effective in SMPs, even with a crossbar-based memory interconnection.
- **New Analysis Tools for Innovative Materials -** Mathematicians at the Oak Ridge National Laboratory have extended the class of materials science problems that can be solved by a powerful technique known as the "Boundary Element Method." This numerical method significantly

reduces the number of operations that are needed to solve materials science problems, but has traditionally been applicable only to homogeneous materials. The researchers derived the fundamental solution to a set of integral equations for "Functionally Graded Materials," an important class of materials that are not homogeneous, but whose properties vary smoothly. These materials already play an important role in many applications, including coatings for protecting turbine blades, special optical materials, and dental implants and other bio-materials.

- **Scientific Data Objects: A Common Language for Exchanging Parallel Data** - Arrays, or matrices, are one of the basic data structures of scientific computing. In large-scale simulations, arrays are often so large that they must be distributed across many processors. In order for different software modules to work together on a distributed array, a method must exist to precisely describe the distribution of the data. As part of the SciDAC Center for Component Technology for Simulation Software, researchers at the Oak Ridge National Laboratory developed such a description, thus greatly simplifying the development of components that need to exchange distributed array data objects with other components. The new interface specification is capable of describing the layouts used by a wide range of distributed array tools, including CUMULVS (ORNL), Global Arrays (PNNL), High Performance Fortran, A++/P++ (LLNL), and others.
- **New Scientific Data Index Performs 100 Times Faster Than Commercial Database Systems -** Terascale computing and large scientific experiments produce enormous quantities of data that require effective and efficient management. The task of managing scientific data is overwhelming. Researchers at the Lawrence Berkeley National Laboratory have developed a specialized index for accessing very large datasets that contain a large number of attributes that may be queried. This new index performs 12 times faster than the previous best-known method, and 100 times faster than conventional indexing methods in commercial database systems. The prototype index is being used by researchers in high energy physics and combustion modeling.
- **Faster Reconstruction Methods are Making Waves -** Mathematicians at the Lawrence Berkeley National Laboratory have developed efficient and fast techniques for solving the problem of multiple arrivals; that is, detecting and separating the arrival of waves that have taken differing paths through a medium. Example applications include geophysical analysis, which is important for oil exploration, and antenna design. The methods are fast enough that they can be embedded inside "inverse solvers," computer codes that use information about the arriving waves to deduce the characteristics of an unknown body between the source and detector. This will result in new computational tools to examine hidden objects, accurately reconstruct inaccessible regions, and rapidly test proposed models.
- **Increasing Scientific Productivity through Automated Optimization** - Many complex problems in science, engineering and business require the solution of optimization problems, but the conventional approach to solving such problems can be extremely time-consuming and difficult to apply. Researches at Argonne National Laboratory have developed the Network-Enabled Optimization System (NEOS) that allows users to solve optimization problems over the Internet with state-of-the-art software and without tedious downloading and linking of specialized optimization code. Because of its ease of use, the NEOS server has gained widespread popularity with more than 5,000 job requests each month from users around the world. Recent NEOS applications include circuit simulation, protein folding, circuit design, brain modeling, airport crew scheduling, and modeling of electricity markets.

- **OSCAR Cluster Software Distribution A Big "Hit" Worldwide -** The Open Source Cluster Application Resources package, OSCAR, is a collection of software tools for managing Linux-based computer clusters developed by a consortium of academic, research, and industry members led by scientists at the Oak Ridge National Laboratory. According to the Top 500 Clusters web site, OSCAR has become the most used cluster computing distribution available today. OSCAR is also used as the core cluster base package in the MacNeil Schwindler (MSC) Linux commercial cluster distribution as well as the NCSA "in-a-box" series of cluster computing solutions. OSCAR has a "market share" of over 30% according to the poll – more than twice its nearest competitor. OSCAR has been downloaded over 53,000 times and has received over 140,000 web page hits during the past year.
- **Tiled Displays: Automatic Calibration of Scalable Display Systems -** Today's scientific simulations and rich multimedia collaborative environments can easily produce many millions to tens of millions of pixels for display. Tiled display systems built by combining the images from arrays of projectors can provide massive numbers of pixel elements to visually represent large amounts of information. Multiprojector tiled arrays can be a cost-effective way to create these displays, and they may be the only practical way to create large information dense displays. But, it is difficult to create the illusion of a unified seamless display for a variety of reasons, including projector-to-projector color and luminosity differences, variation of luminosity across the image from a single projector, and optical distortion of the individual projector images caused by imperfections in the lenses and misalignment of projectors. Researchers at Argonne National Laboratory have developed methods to attack these fundamental issues which provide an efficient and optimized measurement process using inexpensive components that is tolerant of a wide range of imperfections in components and measurement setup such as lighting conditions and camera optics.
- **NERSC Improves Supercomputer Performance.** The Department of Energy's National Energy Research Scientific Computing (NERSC) Center at the Lawrence Berkeley National Laboratory has improved the utilization of its 5 Tflops supercomputer, NERSC-3. After only six months of operation, NERSC-3 began to deliver 90-95% of its cycles to users, on a routine basis.
- **ESnet deploys next general protocol** – ESnet has deployed Internet Protocol Version 6 (IPv6) on its production network. Enabling IPv6 on the network brings a new level of security (e.g. packet encryption and source authentication) and supports real-time traffic, such as video conferencing. IPv6 is expected to become the protocol of choice throughout the Internet.

AWARDS

Top Young Innovator Award – A computer scientist at Argonne National Laboratory has been named one of the world's top 100 young innovators by Technology Review, MIT's Magazine of Innovation. The list recognizes 100 individuals under the age of 35 whose innovative work in business and technology is having a profound influence on today's world. This scientist's work centers on development of Grid technologies for connecting geographically dispersed resources. He also leads standardization efforts of the Globus Project™.

Scientific Computing Research Investments

High-performance computing hardware is important for meeting DOE's modeling and simulation needs. However, computer hardware can only enable scientific advances when the appropriate algorithms, scientific software tools, libraries, software environments, and the networking infrastructure are easy to use and are readily available to the users. The MICS subprogram differs from high performance computing efforts in other Federal agencies because of its management focus to integrate research investments to enable new science. Desktop systems realize advances in computing power primarily through increases in the processor's clock speed. High performance computers employ a different strategy for achieving performance, complicating the architecture and placing stringent requirements on software. The MICS subprogram supports software research over a broad range, but that research is tailored to DOE's science needs. Research is underway to improve the performance of simulations on high-end computers, to remove constraints on the human-computer interface and to discover the specialized information management and analysis techniques that scientists need to manage, analyze and visualize extremely large data files.

Technology trends and business forces in the U.S. computer system industry over the past decade caused most domestic vendors to curtail or abandon the development of high-end systems designed to meet the most demanding requirements of scientific research. Instead, large numbers of smaller commercial systems were combined and integrated into terascale computers to achieve the peak performance levels required for agency missions in computational science. The hardware is complicated, unwieldy and not balanced for scientific applications. Enabling software has been developed for scientists to take advantage of these new computers. However, this software is extraordinarily complex. Consequently, the DOE, primarily through the MICS subprogram, and other Federal agencies whose missions depend on high-performance computing, must make basic research investments to adapt high-performance computing and networking hardware into tools for scientific discovery.

To make progress in the future, our current strategy needs to be adjusted. Continued emphasis on developing software-based solutions to enable scientific simulations on large clusters of computers designed for mid-range applications is no longer the basis for a sustainable strategy for many high-end applications. Rather, our emphasis needs to broaden to include computer hardware technology, architecture, and design trends motivated from a scientific user perspective. This can be accomplished by making research investments that couple computational scientists and computer scientists with U.S. computer vendors to orient future computer architectures towards the need of science. Additional research investments would be made to ensure that the software takes full advantage of the computer architecture. The status of the technology, the conditions of the current business market for computing, and the success of the Earth Simulator supercomputer in Japan are strong indicators that this strategy will provide tangible near-term results for scientific simulation. This revised strategy is the tenet for the NGA effort. While NGA will be instrumental in removing architectural bottlenecks to performance on actual scientific simulations, others will remain and possibly become persistent obstacles in the future.

To illustrate the complexities involved, think of a high-performance computer as a large number of conference rooms distributed around a region. Each conference room is connected through the region's transportation and communications infrastructure. Now, the task of a successful scientific application is analogous to getting everyone in the region to a pre-assigned conference room on time. Instructions are given to each participant (systems software). Results from each conference (calculations) will be documented (stored in memory) for distribution. New conferences are convened, new instructions are given and new decisions are made. Now repeat this process trillions of times, as occurs in a scientific simulation! As one can appreciate, this process can only work if the region's infrastructure is properly configured and operating efficiently. That is, the buses, subways, taxicabs, roads, elevators and telephones can efficiently handle the demand. Most of the systems available from computer vendors are analogous to small regions, a limited number of conference rooms and an inefficient infrastructure. Computers for scientific simulation on the other hand, must be analogous to large cities, large numbers of conference rooms, and an efficient infrastructure, with alternative modes of transportation and communication.

Advances in *computer science* research can enable scientists to overcome these remaining barriers. For example,

- efficient, high-performance operating systems, compilers, and communications libraries for high-end computers;
- software to enable scientists to store, manage, analyze, visualize, and extract scientific understanding from the enormous (terabyte to petabyte) data archives that these computers will generate;
- software frameworks that enable scientists to reuse most of their intellectual investment when moving from one computer to another and make use of lower-level components, such as runtime services and mathematical libraries, that have been optimized for the particular architecture;
- scalable resource management and scheduling software for computers with thousands of processors;
- performance monitoring tools to enable scientists to understand how to achieve high performance with their codes; and
- provide computational scientists with tools, options, and strategies to obtain the maximum scientific benefit from their computations.

Research advances in computer science do not provide the full range of capabilities that computational scientists need, especially for the complex problems faced by the Office of Science. Significant efforts in the applied mathematical research activity will be required for the Department to satisfy its mission requirements for computational science. Historically, improvements in mathematical algorithms have yielded at least as much increase in performance as have improvements in hardware. A large proportion of these advances resulted from the MICS subprogram applied mathematics research activity. The requirements of scientific domains for new algorithms that can scale to work effectively across thousands of processors and produce the most science in the fewest number of computer operations drives the need for improved mathematical algorithms and the supporting software libraries that must be made available for ready use by scientists. In this area of research, the MICS applied mathematics activity is the core of the nationwide effort.

The MICS subprogram research activities that respond to these challenges are described below in the Detailed Program Justification section of the MICS subprogram budget under the headings:

- Applied Mathematics
- Computer Science
- Advanced Computing Software Tools

High Performance Networking, Middleware and Collaboratory Research Investments

Advances in network capabilities and network-enabled technologies now make it possible for large geographically distributed teams to effectively collaborate on solutions to complex problems. It is now becoming possible to harness and integrate the collective capabilities of large geographically distributed data archives, research teams, and computational resources. This collective capability is especially important for the teams using the major experimental facilities, computational resources, and data resources supported by DOE because all of the necessary resources are not available at one location. To successfully realize the potential of this collective research capability, additional research is needed to bring network, data, and computational resources to the members of a distributed team in a manner that is easy to use and guarantees end-to-end performance. For example:

- Significant research is needed to augment the capability of the Internet to support distributed high-end data-intensive applications and to secure large-scale scientific collaborations. The requirements of high-performance networks that support distributed data-intensive computing and scientific collaborations on a national and international scale are very different than the requirements of the current commercial networks where millions of users are moving small web pages. The MICS-supported research on high-performance networks includes research on high-performance protocols, network-aware operating system services, advanced network coprocessors, network measurement and analysis.
- Research is also needed for the development and testing of high-performance middleware needed to seamlessly couple scientific applications to the underlying transport networks. These include high-performance middleware such as advanced security services for grid computing, ultra-high-speed data transfer services, services to guarantee Quality of Service (QoS) for delay sensitive applications, and grid resources discovery. This high-performance middleware provides the scalable software components needed to integrate data, visualization, computation and high-speed networks into a scalable and secure scientific collaborative environment.

The MICS subprogram will address these challenges through fundamental research in networking; software tools that integrate networking and computer science to enable scientific collaboration (collaboratory tools); partnerships with key scientific disciplines; and advanced network testbeds.

Specific responses to these challenges are described in the Detailed Program Justification section of the MICS subprogram budget under the headings:

- Networking
- Collaboratory Tools
- National Collaboratory Pilot Projects

Enhancements to High Performance Computing and Networking Facilities

To realize the scientific opportunities offered by advanced computing, enhancements to the Office of Science's computing and networking facilities are also required. The MICS subprogram supports a suite of high-end computing resources and networking resources for the Office of Science:

- **Production High Performance Computing Facilities.** The National Energy Research Scientific Computing Center (NERSC) provides high performance computing for investigators supported by the Office of Science. NERSC provides a spectrum of supercomputers offering a range of high performance computing resources and associated software support.

- **Energy Sciences Network (ESnet).** ESnet provides worldwide access to Office of Science facilities, including light sources, neutron sources, particle accelerators, fusion reactors, spectrometers, high-end computing facilities, massive data resources and other leading-edge instruments and facilities.
- **Advanced Computing Research Testbeds.** The Advanced Computing Research Testbeds (ACRTs) consist of high performance, advanced architecture computing platforms for testing and evaluation to ascertain the prospects for meeting future general, or specialized, computational science needs of the Office of Science. In FY 2004, the ACRTs will provide hardware resources for the NGA activity. Two types of computing platforms will be evaluated - early systems from vendors, and experimental systems. Based on an analysis of vendor offerings and a peer review of the potential that such offerings can meet Office of Science computational needs, hardware will be acquired at sufficient scale to address key performance and software scaling issues. The evaluation process will include computer science studies and tests of leading-edge Office of Science computational science applications, such as those being developed under SciDAC. In addition, the ACRTs will provide computing resources to SciDAC teams.
- **Trends for Future Supercomputing and Networking Resources.** The need for high performance computational resources will increase in future years as applications transition from the software development and testing phase to using the software to generate new science. As the peak performance of the computers increase, the amount of data produced in a simulation increases as well. Therefore, focused enhancements to the Office of Science's network infrastructure are required to enable scientists to access and understand the data generated by their software and by large-scale science experiments.

The MICS subprogram activities that respond to these challenges are described later in the Detailed Program Justification section of the MICS subprogram budget under the headings:

- National Energy Research Scientific Computing Center (NERSC)
- Advanced Computing Research Testbeds
- Energy Sciences Network (ESnet)

Subprogram Goals

The MICS subprogram goals are identical to the ASCR program goals, and the performance indicators and targets for ASCR apply directly to the activities of the MICS subprogram. Therefore, no subprogram goals are included in the MICS section of the ASCR budget.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Mathematical, Computational, and Computer Sciences Research	52,877	75,633	83,300	+7,667	+10.1%
Advanced Computation, Communications Research and Associated Activities	94,282	83,782	82,591	-1,191	-1.4%
SBIR/STTR	0	4,142	4,599	+457	+11.0%
Total, Mathematical, Information, and Computational Sciences	147,159	163,557	170,490	+6,933	+4.2%

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Mathematical, Computational, and Computer Sciences Research	**52,877**	**75,633**	**83,300**
■ **Applied Mathematics**	**22,655**	**23,141**	**22,634**

This activity supports research on the underlying mathematical understanding of physical, chemical and biological systems, and on advanced numerical algorithms that enable effective description and prediction of such systems on terascale computing systems. Research in Applied Mathematics supported by MICS underpins computational science throughout DOE. Historically, the numerical algorithms developed under this activity have produced more scientific advances through simulation than improvements in computer hardware. This activity supports research at DOE laboratories, universities, and private companies. Many of the projects supported by this activity involve research partnerships between DOE's national laboratories and universities. The activity supports research in a wide variety of areas of mathematics, including: ordinary and partial differential equations and solutions methods, including techniques to convert equations into discrete elements and boundary integral methods, advanced treatment of interfaces and boundaries, (fast marching and level set methods, and front tracking); numerical linear algebra (advanced iterative methods, general and problem-specific preconditioners, sparse solvers, and dense solvers); fluid dynamics (compressible, incompressible and reacting flows, turbulence modeling, and multiphase flows); optimization (linear and nonlinear programming, interior-point methods, and discrete and integer programming); mathematical physics; control theory (differential-algebraic systems, order reduction, and queuing theory); accurate treatment of shock waves; "fast" methods (fast multipole and fast wavelet transforms); mixed elliptic-hyperbolic systems; dynamical systems (chaos theory, optimal control theory, and bifurcation theory); and automated reasoning systems.

The FY 2004 budget continues the Computational Sciences Graduate Fellowship program at the current level of $3,500,000.

	FY 2002	FY 2003	FY 2004
	(dollars in thousands)		

The decrease in funding for this activity between FY 2003 and FY 2004 includes the transfer of Genomes to Life activities to Scientific Application Partnerships to better reflect the character of the research. In FY 2003, $1,491,000 was transferred to the Department of Homeland Security for evaluation of applied mathematical sciences activities at the Lawrence Livermore National Laboratory to determine which are most suitable for transfer to the Department of Homeland Security.

	FY 2002	FY 2003	FY 2004
■ **Computer Science**	**19,517**	**17,506**	**23,680**

This activity supports research in computer science to enable researchers to effectively utilize high-performance computers to advance science in areas important to the DOE mission. DOE has unique requirements for high performance computing that significantly exceed the capability of software products from computer vendors. This activity supports computer science research in two general areas: the underlying software to enable applications to make effective use of computers with hundreds or thousands of processors as well as computers that are located at different sites; and large scale data management and visualization under circumstances where the underlying resources and users are geographically distributed. The first area includes research in protocols and tools for interprocessor communication and parallel input/output (I/O) as well as tools to monitor the performance of scientific applications and advanced techniques for visualizing very large-scale scientific data. Researchers at DOE laboratories and universities, often working together in partnerships, propose and conduct this research.

In FY 2003, $1,491,000 was transferred to the Department of Homeland Security for evaluation of computer science activities at the Lawrence Livermore National Laboratory to determine which are most suitable for transfer to the Department of Homeland Security. *In addition, the FY 2004 budget includes $4,659,000 for an academic and domestic computer vendor research effort on future generation operating systems and runtime environments. Critical goals for this NGA effort will be to enable future operating systems runtime environments to deliver maximum performance to scientific applications. Projects will be competitively selected.*

	FY 2002	FY 2003	FY 2004
■ **Advanced Computing Software Tools**	**5,543**	**20,256**	**20,256**

This activity supports research that builds on the results from research in applied mathematics and computer science to develop integrated software tools that computational scientists can use to develop high performance applications (such as characterizing and predicting phase changes in materials). These tools, which enable improved performance on high-end systems, are critical to the ability of scientists to attack the complex scientific and engineering problems that can only be solved with high-end computing systems.

In FY 2004, this activity will continue to support the Integrated Software Infrastructure Centers (ISICs), a SciDAC activity, competitively selected in FY 2001. The ISICs funded under this activity focus on: structured and unstructured mesh generation for large simulations and high performance tools for solving partial differential equations on parallel computers; tools for analyzing the performance of scientific simulation software that uses thousands of processors; the

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004

development of data management and visualization software capable of handling terabyte scale data sets extracted from petabyte scale data archives, and software for managing computers with thousands of processors; and software component technology to enable rapid development of efficient, portable, high performance parallel simulation software.

These Integrated Software Infrastructure Centers are a critical component in DOE's SciDAC strategy. The ISICs are responsible for the entire lifecycle of the software that they develop. These software tools must be reliable, understandable and well documented. Also, the scientific user community to be maintained, bug-free and upgraded, as necessary. Software for tools high performance scientific simulations have no commercial market. The Integrated Software Infrastructure Centers initiated in FY 2001 provide the only means for developing and deploying these tools to the scientific community.

	FY 2002	FY 2003	FY 2004
■ **Scientific Applications Partnerships**	**5,162**	**14,730**	**16,730**

This activity, formerly titled Scientific Application Pilot Projects, supports collaborative research with disciplinary computational scientists to apply the computational techniques and tools developed by other MICS activities to address problems relevant to the mission of SC. This effort tests the usefulness of advances in computing research, transfers the results of this research to the scientific disciplines, and helps define opportunities for future research. The FY 2004 funding for this activity will allow the continuation of the partnerships that were competitively selected in FY 2001. These projects are part of the SciDAC activity and are coupled to the Integrated Software Infrastructure Centers. Areas under investigation include design of particle accelerators with the High Energy Physics (HEP) and Nuclear Physics (NP) programs; plasma turbulence in tokamaks with the Fusion Energy Sciences (FES) program; global climate change with the Biological and Environmental Research (BER) program; and combustion chemistry with the Basic Energy Sciences (BES) program.

The FY 2004 request includes funds to continue the partnership with the Biological and Environmental Research program Genomes to Life and the partnership with the Basic Energy Sciences program in nanoscale science. *The FY 2004 in request also includes $2,000,000 to support research under the NGA to understand the relationship among programming models, architecture features and application performance. Projects will be selected through a peer reviewed, open competition.*

	FY 2002	FY 2003	FY 2004
Advanced Computation, Communications Research, and Associated Activities	**94,282**	**83,782**	**82,591**
■ **Networking**	**7,329**	**7,066**	**7,066**

This activity supports research and development in high-performance networks needed to develop and deploy advanced networking capabilities to address challenging issues such as ultra-high-speed data transfers, remote visualization, real-time remote instrumentation, and large-scale scientific collaboration. Networking research is carried out at national laboratories and universities and consists of two major elements:

	(dollars in thousands)	
FY 2002	FY 2003	FY 2004

Network R&D – to address the fundamental issues of high-performance networks to support access to the next generation of scientific facilities, terascale computing resources and distributed petabyte-scale data archives. Network R&D focuses on leading-edge networking technologies such as ultra optical transport protocols and services for ultra high-speed data transfers; techniques and tools for ultra high-speed network measurement and analysis; advanced network tools and services to enable network-aware, high-end scientific applications; and scalable cyber-security technologies for open science environment.

Advanced experimental networking – to accelerate the adoption of emerging networking technologies and to transfer networking R&D results into production networks that support science applications. It includes activities such as experimental networking testbeds, advanced deployment and evaluation of new networking technologies, and exploration of advanced networking concepts. A rapid adoption of emerging network capabilities into production networks will enable scientists pushing the limits of today's networks capabilities to use networking technologies to conduct far-reaching experiments.

	FY 2002	FY 2003	FY 2004
■ **Collaboratory Tools**	**7,000**	**5,527**	**5,527**

This activity supports research that builds on results of fundamental research in computer science and networking to develop an integrated set of software tools to support scientific collaborations. This includes enabling scientists to remotely access and control facilities and share data in real time, and to effectively share data with colleagues throughout the life of a project. These tools provide a new way of organizing and performing scientific work that offers the potential for increased productivity and efficiency and will also enable broader access to important DOE facilities and data resources by scientists and educators throughout the country. It is particularly important to provide for efficient, high-performance, reliable, secure, and policy-aware management of large-scale data movement. This research includes an effort to develop a set of essential middleware services required to support large-scale data-intensive collaboratory applications. This research also includes an effort to research, develop, and integrate the tools required to support a flexible, secure, seamless collaboration environment that supports the entire continuum of interactions between collaborators. The goal is to seamlessly allow collaborators to locate each other, use asynchronous and synchronous messaging, share documents, progress, results, applications and hold videoconferences. There is also research for developing and demonstrating an open, scalable approach to application-level security in widely distributed, open network environments that can be used by all the collaboratory tools as well as by the advanced computing software tools whenever access control and authentication are issues.

	FY 2002	FY 2003	FY 2004
■ **National Collaboratory Pilot Projects**	**9,384**	**10,857**	**10,857**

This activity supports research that tests, validates, and applies collaboratory tools in real-world situations in partnership with other DOE programs. The competitively selected partnerships involve national laboratories, universities, and U.S. industry. It is important to continue to demonstrate and test the benefits of collaboratory tools technology in order to promote its widespread use and enable more effective access to the wide range of resources within the

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004

Department, from light sources to terascale computers to petabyte data storage systems. The partnerships that were initiated in FY 2001 focus on developing user environments where collaboration is ubiquitous and distributed computing is seamless and transparent for DOE mission applications. The Particle Physics Data Grid is developing middleware infrastructure to support High Energy Physics (HEP) and Nuclear Physics (NP) communities, and to enable grid-enabled data-management ("manipulation") and analysis capabilities "at the desk of every physicist." It is building one unified system that will be capable of handling the capture, storage, retrieval and analysis of particle physics experiments at the five most critical research facilities, a key collaboratory issue being the highly distributed access to, and processing of, the resulting data by a worldwide research community. In another community, the Earth System Grid II is developing a virtual collaborative environment linking distributed centers, models, data, and users that will facilitate exchange among climatologists all over the world and provide a needed platform for the management of the massive amounts of data that are being generated. Development of this and similar concepts is essential for rapid, precise, and convincing analysis of short- and long-term weather patterns, particularly in the period when increasing pollution introduces changes that may affect us for generations to come. The National Fusion Collaboratory is centered on the integration of collaborative technologies appropriate for widely dispersed experimental environments and includes elements of security, distributed systems, and visualization. All three of these pilot collaboratories will rely on the DOE Science Grid to provide the underpinnings for the software environment, the persistent grid services, that make it possible to pursue innovative approaches to scientific computing through secure remote access to online facilities, distance collaboration, shared petabyte datasets and large-scale distributed computation.

■ **National Energy Research Scientific Computing Center (NERSC)**	**31,244**	**28,244**	**28,244**

NERSC, located at LBNL, provides high performance computing for investigators supported by the Office of Science. The Center serves 2,400 users working on about 700 projects; 35 percent of users are university based, 61 percent are in National Laboratories, 3 percent are in industry, and 1 percent in other government laboratories. The major computational resource at NERSC is an IBM SP computer. The initial installation of hardware, which was completed in FY 2001 following a fully competitive process, provided a peak performance of 5 trillion floating point operations per second (teraflops) to its users. The capability of this system was increased to 10 teraflops following the acquisition of additional computer hardware in FY 2003. The FY 2004 funding will support the continued operation of the IBM SP computer at 10 teraflops peak performance. These computational resources are integrated by a common high performance file storage system that facilitates interdisciplinary collaborations. Related requirements for capital equipment, such as high-speed disk storage systems, archival data storage systems, and high performance visualization hardware, and general plant projects (GPP) funding are also supported. FY 2004 capital equipment requirements remain at the same level as in FY 2003.

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
■ **Advanced Computing Research Testbeds (ACRTs)**............	**20,295**	**15,300**	**12,609**

This activity supports the acquisition, the testing and the evaluation of advanced computer hardware testbeds to assess the prospects for meeting future computational needs of the Office of Science, such as SciDAC and special purpose applications. The ACRT activity will provide two types of computer testbeds for evaluation - early systems and experimental systems. Each testbed will involve significant research and architecture design activities. *The FY 2004 request includes $7,309,000 to complete the evaluation of Cray X1 hardware that was initiated in FY 2002. The reduction in this activity will allow the program to focus on a single new evaluation under the NGA and provide critical resources to SciDAC teams.*

■ **Energy Sciences Network (ESnet)**..	**19,030**	**16,788**	**18,288**

ESnet is a high-performance network infrastructure that supplies the DOE science community with capabilities not available through commercial networks or the commercial Internet. ESnet provides national and international high-speed access to DOE and Office of Science researchers and research facilities, including: light sources; neutron sources; particle accelerators; fusion reactors; spectrometers; supercomputers; and other high impact scientific instruments. ESnet provides the communications fabric that interconnects geographically distributed research facilities and large-scale scientific collaborations. ESnet supplies the critical infrastructure that links DOE researchers worldwide and forms the basis for advanced experimental research in networking, collaboratory tools, and distributed data-intensive scientific applications testbeds such as the national collaboratory pilot projects. ESnet provides network services through contracts with commercial vendors for advanced communications services including Asynchronous Transfer Mode (ATM), Synchronous Optical Networks (SONET) and Dense Wave Division Multiplexing (DWDM). ESnet provides interfaces between the network fabric it provides and peering arrangements with other Federal, education and commercial networks, international research network connections, and the University Corporation for Advanced Internet Development (UCAID) Abilene network that provides high performance connections to many research universities. In FY 2004, funds will be used to operate ESnet and to continue support for upgrading the capability of the ESnet backbone to 10,000 million bits per sec (Mbps) from its current capability of 155 Mbps. Remaining funds will be used to upgrade networking hardware and services at high priority ESnet sites to exploit the enhanced performance capabilities of the backbone.

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
SBIR/STTR..	**0**	**4,142**	**4,599**

In FY 2002, $3,656,000 and $220,000 were transferred to the SBIR and STTR programs, respectively. The FY 2003 and FY 2004 amounts are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Mathematical, Information, and Computational Sciences	**147,159**	**163,557**	**170,490**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Mathematical, Computational, and Computer Sciences Research	
■ **Applied Mathematics.** The decrease results from the transfer of Genomes to Life activities to Scientific Application Partnerships to better reflect the character of the research, partially offset by increases to core Applied Mathematics research. Funding for Homeland Security in FY 2003 is budgeted by the Department of Homeland Security in FY 2004.	-507
■ **Computer Science.** Provides an increase under the NGA for an academic and domestic computer vendor research effort. Includes an increase to provide core research infrastructure for NGA. Funding provided for Homeland Security in FY 2003 is budgeted by the Department of Homeland Security in FY 2004.	+6,174
■ **Scientific Application Partnerships.** Provides an increase to support research under the NGA to understand the relationship among programming models, architecture features and application performance..	+2,000
Total Mathematical, Computational, and Computer Sciences Research................................	+7,667
Advanced Computation, Communications Research, and Associated Activities	
■ **Advanced Computing Research Testbed.** Reduction in this program to focus on single new evaluation under the NGA and providing critical resources to SciDAC teams..	-2,691
■ **ESnet.** Provides an increase in this program element for upgrades to the ESnet infrastructure for an architecture tailored to a class of applications within the SciDAC research portfolio to produce new science..	+1,500
Total Advanced Computation, Communications Research, and Associated Activities	-1,191

	FY 2004 vs. FY 2003 ($000)
SBIR/STTR	
■ Increase in SBIR/STTR due to increase in operating expenses.	+457
Total Funding Change, Mathematical, Information, and Computational Sciences	+6,933

Laboratory Technology Research

Mission Supporting Goals and Objectives

The Laboratory Technology Research (LTR) subprogram is being brought to a successful conclusion in FY 2004. The mission of the Laboratory Technology Research subprogram is to support high-risk research that advances science and technology to enable applications that could significantly impact the Nation's energy economy. LTR fosters the production of research results motivated by a practical energy payoff through cost-shared collaborations between the Office of Science (SC) laboratories and industry.

An important component of the Department's strategic goals are to ensure that the United States maintains its leadership in science and technology. LTR is the lead program in the Office of Science for leveraging science and technology to advance understanding and to promote our country's economic competitiveness through cost-shared partnerships with the private sector.

The National Laboratories under the stewardship of the Office of Science conduct research in a variety of scientific and technical fields and operate unique scientific facilities. Viewed as a system, these ten laboratories — Ames Laboratory, Argonne National Laboratory, Brookhaven National Laboratory, Fermi National Accelerator Laboratory, Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, Princeton Plasma Physics Laboratory, Stanford Linear Accelerator Center, and Thomas Jefferson National Accelerator Facility — offer a comprehensive resource for research collaborations. The major component of the LTR research portfolio consists of investments at these laboratories to conduct research that benefits all major stakeholders — the DOE, the industrial collaborators, and the Nation. These investments are further leveraged by the participation of an industry partner, using Cooperative Research and Development Agreements (CRADAs). Another LTR subprogram component provides funding to the Office of Science national laboratories to facilitate rapid access to the research capabilities at the SC laboratories through agile partnership mechanisms including personnel exchanges and technical consultations with small business. The LTR subprogram currently emphasizes four critical areas of DOE mission-related research: advanced materials processing and utilization, nanotechnology, intelligent processes and controls, and energy-related applications of biotechnology.

Funding Schedule

	(dollars in thousands)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
Laboratory Technology Research	3,046	2,921	2,916	-5	-0.2%
SBIR/STTR	0	79	84	+5	+6.3%
Total, Laboratory Technology Research	3,046	3,000	3,000	0	--

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Laboratory Technology Research	**3,046**	**2,921**	**2,916**

This activity supports research to advance the fundamental science at the Office of Science (SC) laboratories toward innovative energy applications. Through CRADAs, the SC laboratories enter into cost-shared research partnerships with industry, typically for a period of three years, to explore energy applications of research advances in areas of mission relevance to both parties. The research portfolio consists of 12 projects and emphasizes the following topics: advanced materials processing and utilization, nanotechnology, intelligent processes and controls, and energy-related applications of biotechnology. Efforts underway include the exploration of (1) new cast steels with microstructures and mechanical properties better than comparable cast alloys, to provide an improved critical component material for higher efficiency steam and gas turbine technology for electric power generation; (2) radiative carrier recombination in group-III nitride thin films, to optimize the performance of GaN-based high-brightness Light Emitting Diodes for applications in energy-efficient lighting; and (3) molecular structures of new classes of hydroporphyrin photosensitizers for use with light and oxygen to destroy cancerous cells and tissues. A small but important component of this activity provides industry, particularly small businesses, with rapid access to the unique research capabilities and resources at the SC laboratories. These research efforts are usually supported for a few months to quantify the energy benefit of a specific problem posed by industry. Recent projects supported the development of: (1) an economically-viable duplex chromium nitride near-frictionless carbon film capable of providing extreme wear resistance and reduced friction to sliding engine and drive train components in advanced diesel engines; (2) a detailed understanding of the interplay between platinum/cadmium zinc telluride interfacial chemistry and radiation detector performance for applications such as finding new cancer locations; and (3) an ion source for producing negative heavy ions for ion implantation in the semiconductor industry, which will eliminate toxic gas.

SBIR/STTR	**0**	**79**	**84**

In FY 2002, $75,000 and $4,000 were transferred to the SBIR and STTR programs, respectively. The FY 2003 and FY 2004 amounts are the estimated requirement for the continuation of the SBIR and STTR program.

Total, Laboratory Technology Research	**3,046**	**3,000**	**3,000**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
There are no significant funding changes.	

Capital Operating Expenses & Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
General Plant Projects..........................	0	1,000	0	-1,000	-100.0%
Capital Equipment (total)	3,777	6,250	6,250	0	--
Total, Capital Operating Expenses	3,777	7,250	6,250	-1,000	-13.8%

Science Laboratories Infrastructure

Program Mission

The mission of the Science Laboratories Infrastructure (SLI) program is to enable the conduct of Departmental research missions at the ten Office of Science (SC) laboratories and the Oak Ridge Institute for Science and Education (ORISE) by funding line item construction to maintain the general purpose infrastructure (GPI) and the clean-up and removal of excess facilities. The program supports SC landlord responsibilities for the 36,000 acre Oak Ridge Reservation, and provides Payments in Lieu of Taxes (PILT) to local communities around ANL-E, BNL, and ORNL.

Significant Program Shifts

- The program was broadened in FY 2003 to include all SC program dedicated laboratories and ORISE along with the multiprogram laboratories. These program dedicated laboratories include Ames Laboratory, Fermi National Accelerator Laboratory, Princeton Plasma Physics Laboratory, Thomas Jefferson National Accelerator Facility, and Stanford Linear Accelerator Center.

- In FY 2003 an Excess Facilities Disposition subprogram was presented in the Science Laboratories Infrastructure program to address the disposition of excess facilities resulting in economies and efficiencies in laboratory operations. This subprogram continues the Facilities and Infrastructure (F&I) program initiated in FY 2002.
- Progress in Line Item Projects – Three projects were completed in FY 2002: the LBNL Building 77 Rehabilitation of Structures and Systems, Phase I; ORNL Roofing Improvements; and the BNL Sanitary Systems Modifications, Phase III. Two projects are scheduled for completion in FY 2003: ORNL Electrical Systems Upgrades and the ANL-E Fire Safety Improvements, Phase IV. Five projects are scheduled for completion in FY 2004: BNL Ground and Surface Water Protection Upgrades; BNL Electrical Systems Modifications, Phase II; LBNL Site-wide Water Distribution System Upgrades; ORNL Laboratory Facilities HVAC Upgrade; and the ORNL Fire Protection System Upgrades. In FY 2004, one new project, SLAC Safety and Operational Reliability Improvements, is proposed.

Funding Profile

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Request	FY 2004 Request	$ Change	% Change
Science Laboratories Infrastructure (SLI)					
Laboratories Facilities Support	22,691	32,601	33,456	+855	+2.6%
Excess Facilities Disposition	9,960	5,055	5,055	0	--
Oak Ridge Landlord	4,474	5,079	5,079	0	--
External Regulation	0	0	0	0	0
Total, Science Laboratories Infrastructure	37,125[a][b]	42,735	43,590	+855	+2.0%

Public Law Authorization:
Public Law 95-91, "Department of Energy Organization Act"
Public Law 103-62, "Government Performance and Results Act of 1993"

[a] FY 2002 Appropriation provided $10,000,000 in a new program added by Congress titled "Facilities and Infrastructure." Funding for this activity is included in the Science Laboratories Infrastructure program (Excess Facilities Disposition) in FY 2003 and FY 2004.
[b] Excludes $5,000 for the FY 2002 rescission contained in section 1403 of P.L. 107-226, Supplemental Appropriations for further recovery from and response to terrorist attacks on the United States.

Funding by Site[a]

	(dollars in thousands)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
Chicago Operations Office					
Argonne National Laboratory	3,643	4,205	6,002	+1,797	+42.7%
Brookhaven National Laboratory	7,413	8,513	5,917	-2,596	-30.5%
Fermi National Accelerator Laboratory	53	0	233	+233	+100.0%
Princeton Plasma Physics Laboratory	875	545	980	+435	+79.8%
Chicago Operations Office	894	1,020	1,520	+500	+49.0%
Total, Chicago Operations Office	12,878	14,283	14,652	+369	+2.6%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	6,900	5,607	2,975	-2,632	-46.9%
Lawrence Livermore National Laboratory	350	250	250	0	--
Stanford Linear Accelerator Center	400	0	2,000	+2,000	+100.0%
Total, Oakland Operations Office	7,650	5,857	5,225	-632	-10.8%
Oak Ridge Operations Office					
Thomas Jefferson National Accelerator Facility	0	1,500	3,914	+2,414	+160.9%
Oak Ridge National Laboratory	10,745	12,016	10,600	-1,416	-11.8%
Oak Ridge Institute for Science and Education	0	0	0	0	--
Oak Ridge Operations Office	4,474	5,079	5,079	0	--
Total, Oak Ridge Operations Office	15,219	18,595	19,593	+998	+5.4%
Richland Operations Office					
Pacific Northwest National Laboratory	1,377	4,000	4,120	+120	+3.0%
Washington Headquarters	1	0	0	0	--
Total, Science Laboratories Infrastructure	37,125[b]	42,735	43,590	+855	+2.0%

[a] On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format.

[b] FY 2002 Appropriation provided $10,000,000 in a new program added by Congress titled “Facilities and Infrastructure.” Funding for this activity is included in the Science Laboratories Infrastructure program (Excess Facilities Disposition) in FY 2003 and FY 2004.

Site Description

Ames Laboratory

Ames Laboratory (Ames) is a national center for the synthesis, analysis, and engineering of rare-earth metals and their compounds. Ames conducts fundamental research in the physical, chemical, and mathematical sciences associated with energy generation and storage. The laboratory is located on the campus of the University of Iowa, in Ames, Iowa, and consists of 10 buildings (320,000 gross square feet of space) with the average age of the buildings being 37 years. DOE does not own the land.

Argonne National Laboratory - East

Argonne National Laboratory - East (ANL-E) in Argonne, Illinois, is a Multiprogram Laboratory located on a 1,700 acre site in suburban Chicago. The laboratory consists of 106 buildings (4.6 million gross square feet of space) with the average age of the buildings being 32 years. The line item construction backlog identified in the laboratory's Strategic Facilities Plan is $190,000,000. The SLI program will continue to fund the following project in FY 2004:

- MEL-001-017 Mechanical and Control Systems Upgrade, Phase I (TEC $9,000,000) This ongoing project will upgrade or replace 30-40 year old, deteriorated mechanical system components in various facilities. These will include HVAC, drainage, steam supply, and condensate return systems. This project will optimize capacity, enhance system reliability and performance, improve safety, and reduce maintenance costs. These systems are no longer adequate, reliable, or efficient, and do not meet current ES&H standards (e.g., failure of a laboratory exhaust system could lead to release of radioactive material).

Brookhaven National Laboratory

Brookhaven National Laboratory is a Multiprogram Laboratory located on a 5,200 acre site in Upton, New York. The laboratory consists of 371 buildings (4.1 million gross square feet of space) with the average age of the buildings being 41 years. The line item construction backlog identified in the laboratory's Strategic Facilities Plan is $376,000,000. The SLI program will continue to fund the following project in FY 2004:

- MEL-001-027 Research Support Building, Phase I (TEC $18,200,000) This 55,000 sq. ft. facility is intended to consolidate Staff Services, Public Affairs, Human Resources, Credit Union, Library and other support functions in a central quadrangle to provide staff and visiting scientists with convenient and efficient support. This facility, the first of four phases in the BNL Master Revitalization Plan, will include a lobby with a visitor information center to assist visiting scientists, and a coordinated office layout of related support services. After completion of this project, 23,000 sq. ft. of World War II era structures will be torn down. Based on total life-cycle costs, productivity gains, avoided energy and maintenance costs, the Research Support Building, Phase I will provide a return on investment of 14.4% and a simple payback of 9 years.

Fermi National Accelerator Laboratory

Fermi National Accelerator Laboratory is the center for research in high-energy and particle physics and constructs and runs large particle accelerators. The laboratory is located in Batavia, Illinois, and consists of 337 buildings (2.2 million gross square feet of space) with the average age of the buildings being 37 years. The line item construction backlog identified in the laboratory's Strategic Facilities Plan is $7,000,000.

Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory is a Multiprogram Laboratory located on a 200 acre site owned by the University of California that is adjacent to the Berkeley campus of the University of California in Berkeley, California. The laboratory consists of 107 buildings (1.68 million gross square feet of space) with the average age of the buildings being 37 years. The line item construction backlog identified in the laboratory's Strategic Facilities Plan is $148,000,000. The SLI program will continue to fund the following project in FY 2004:

- MEL-001-028 Building 77 Rehabilitation of Structures and Systems, Phase II (TEC $13,360,000) This project will provide for the rehabilitation to correct mechanical, electrical, and architectural deficiencies in Buildings 77 (a 39 year old, 68,000 sq. ft. high-bay industrial facility) and 77A (a 14 year old, 10,000 sq. ft. industrial facility). Both buildings house machine shop and assembly operations in which production of highly sophisticated research components for a variety of DOE research projects is performed. Current work includes precision machining, fabrication and assembly of components for the Advanced Light Source, the Dual-Axis Radiographic Hydrodynamic Test Facility (DAHRT) project, the Spallation Neutron Source, and the ATLAS Detector. Infrastructure systems installed by this project will include HVAC, power distribution, lighting, and noise absorption materials. The improvements are necessary to satisfy urgent demands for high levels of cleanliness, temperature and humidity control, and OSHA and reliability requirements. This is the second of two projects; the first project, funded in FY 1999 and completed in FY 2002, corrected structural deficiencies in Building 77.

Oak Ridge Institute for Science and Education

Oak Ridge Institute for Science and Education (ORISE) is an academic and training facility providing specialized scientific and safety training to DOE and other institutions. ORISE is an international leader in radiation-related emergency response and epidemiological studies. The laboratory consists of 21 facilities (0.2 million gross square feet of space) with the average age of the facilities being 40 years. Approximately 92 percent of the space is considered adequate, while the remainder needs rehabilitation or replacement/demolition.

Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL) is a Multiprogram Laboratory located in Oak Ridge, Tennessee. The laboratory's 1,100 acre main site on Bethel Valley Road contains 335 buildings (3 million gross square feet of space) with the average age of the buildings being 32 years. The line item construction backlog identified in the laboratory's Strategic Facilities Plan is $209,000,000. The SLI program will continue to fund the following project in FY 2004:

- MEL-001-025 - Research Support Center (TEC $16,100,000) This ongoing project will construct a 50,000 sq. ft. facility to house the core support service facilities and serve as the cornerstone and focal point of the East Research Campus envisioned in the ORNL Facility Revitalization Project. This building will include an auditorium and conference center (currently there is no adequate auditorium conference space available at ORNL), cafeteria, visitor reception and control area, and offices for support staff. It will facilitate consolidation of functions that are presently scattered throughout the Laboratory complex in facilities that are old (30-50 years), undersized, poorly located, or scheduled to be surplused. The facility will serve as a modern center for meeting, collaborating, and exchanging scientific ideas for ORNL staff and the nearly 30,000 visitors, guests, and collaborators that use ORNL facilities each year. The new cafeteria will replace the existing cafeteria which was constructed in 1953. The existing cafeteria is poorly located to serve the current staff and is adjacent to the original production area of the laboratory now undergoing decontamination. The estimated simple payback is seven years.

Pacific Northwest National Laboratory

Pacific Northwest National Laboratory (PNNL) is a Multiprogram Laboratory located on a 960 acre site on the south end of the Hanford Reservation near Richland, Washington. The laboratory consists of 40 government owned buildings (900,000 gross square feet of space) with the average age of the buildings being 31 years. PNNL also has 451,000 square feet of space in Battelle owned buildings on Battelle owned land. The line item construction backlog identified in the laboratory's Strategic Facilities Plan is $19,000,000. The SLI program will continue to fund the following project in FY 2004:

- MEL-001-018 Laboratory Systems Upgrades (TEC $9,000,000) This ongoing project will upgrade or replace 20-50 year old mechanical system components in eight high occupancy facilities, replacing them with more efficient and better performing systems to enhance the quality of science while reducing maintenance and energy costs. This upgrade will include: replacement of HVAC supply and exhaust fans; replacement, rehabilitation or modification of numerous chemical exhaust fume hoods; and installation of computerized, remote, digital controls on various systems to improve operations.

Princeton Plasma Physics Laboratory

Princeton Plasma Physics Laboratory (PPPL) is a national center dedicated to plasma and fusion science. PPPL has a leading international role in developing the theoretical, experimental, and technology innovations needed to make fusion practical and affordable. PPPL is located in Princeton, New Jersey on Princeton University land, and consists of 35 buildings (700,000 gross square feet of space) with the average age of the buildings being 23 years. The line item construction backlog identified in the laboratory's Strategic Facilities Plan is $13,000,000.

Stanford Linear Accelerator Center

Stanford Linear Accelerator Center (SLAC) is a laboratory dedicated to the design, construction and operation of state-of-the-art electron accelerators and related experimental facilities for use in high-energy physics and synchrotron radiation research. SLAC operates the 2 mile long Stanford Linear Accelerator which began operating in 1966. SLAC is located on 426 acres of Stanford University land in Menlo Park, California, and is also the home of the Stanford Synchrotron Radiation Laboratory

(SSRL). The SSRL was built in 1974 to utilize the intense x-ray beams from the Stanford Positron Electron Accelerating Ring (SPEAR) that was built for particle physics by the SLAC laboratory. SLAC (including SSRL) consists of 166 buildings (1.8 million gross square feet of space) with the average age of 23 years. The line item construction backlog identified in SLAC's (including SSRL) Strategic Facilities Plan is $15,000,000. The SLI program will initiate the following project in FY 2004:

- MEL-001-036 - Safety and Operational Reliability Improvements (TEC $15,600,000) – This project has two components:

  - Underground Utility Upgrades - this component will replace deteriorated sections of cooling water, low conductivity water, drainage, natural gas, compressed air and fire protection which are critical to the operation of the linear accelerator and the B Factory rings which produce the essential collisions needed for the Charge-Parity Violation studies (one of the pillars of the current U.S. High Energy Physics program also carried out competitively at KEK in Japan). There have been five pipe failures over the last two years and the failure rate is expected to increase in these 35 year-old systems as they continue to age. When the pipes fail, research is slowed or halted until repairs are completed.

  - Seismic Upgrades – this component will install seismic upgrades necessary to bring various building structures into compliance with the seismic standards of the Uniform Building Code. The seismic hazard in the Bay Area is high. Nineteen "essential" facilities, i.e., those that will minimize the time required for the Laboratory to recover from an earthquake, will be retrofitted for a total of 229,000 sq. ft. Payback is nine years.

Thomas Jefferson National Accelerator Facility

Thomas Jefferson National Accelerator Facility (TJNAF) is a national user facility for nuclear science using continuous beams of high-energy electrons to discover the underlying quark and gluon structure of nucleons and nuclei. TJNAF has 1,600 users, about half of which are actively engaged in experiments at a given time. TJNAF is located in Newport News, Virginia, and consists of 65 buildings (500,000 gross sq. ft. of space) with the average age of the buildings being 12 years. The line item construction backlog identified in the lab's Strategic Facilities Plan is $24,000,000. The SLI program will continue to fund the following project in FY 2004:

- MEL-001-033 Continuous Electron Beam Accelerator Facility (CEBAF) Center Addition, Phase I (TEC $10,500,000) - This project is Phase I of three phases to provide for additions to the CEBAF Center office building. The purpose of the three phases is to provide additional critical computer center space and to eliminate off-site leases and existing trailers to collocate staff for enhanced productivity. This first addition will add 59,000 sq. ft. of computer center (7,600 sq. ft) and office space and eliminate 22,000 sq. ft. of aging trailers with a 7.4-year simple payback and a 10% rate of return. Phase I will provide additional space for 182 users and 50 staff personnel.

Chicago Operations Office

The Chicago Operations Office processes the Payments in Lieu of Taxes (PILT) made to the local taxing authorities at Brookhaven National Laboratory and Argonne National Laboratory-East. These discretionary payments are made to state or local governments where the Department or its predecessor agencies have acquired property previously subject to state or local taxation.

Oak Ridge Operations Office

The Oak Ridge Landlord program provides for centralized Oak Ridge Operations Office (ORO) infrastructure requirements and general operating costs for activities on the Oak Ridge Reservation (ORR) outside plant fences and activities to maintain a viable operations office, including maintenance of roads and grounds and other infrastructure, PILT, and other needs related to landlord activities.

Laboratories Facilities Support

Mission Supporting Goals and Measures

The Laboratories Facilities Support (LFS) subprogram improves the mission readiness of Office of Science (SC) laboratories by funding line item construction projects to refurbish or replace general purpose facilities and the site-wide infrastructure. General purpose and site-wide infrastructure includes administrative, research laboratory, user support and testing space as well as cafeterias, power plants, fire stations, electrical, gas and other utility distribution systems, sanitary sewers, roads, and other associated structures. The 10 SC laboratories have over 2,400 buildings (including 787 trailers and 150 excess buildings) with a total square footage of over 21,000,000 square feet.

Capital investment requirements for SC laboratories are identified in laboratory Strategic Facilities Plans. These plans assume the full modernization/revitalization of the infrastructure of the laboratories will be completed over a ten-year period and include priority lists of proposed facilities and infrastructure needs. The backlog of line item construction modernization needs as summarized in SC's "*Infrastructure Frontier: A Quick Look Survey of the Office of Science Laboratory Infrastructure*," April 2001, is on the order of $1 billion. Nearly 85% of this total is to rehabilitate or replace buildings.

The large backlog of line item construction needs is attributable to:

- the age of the facilities (over 69% of the buildings are 30 years old or older and, 43% are 40 years old or older);
- the use of wood and other non-permanent building materials in the original construction of the laboratories in the 40's and 50's;
- changing research needs that require:
  - different kinds of space (e.g., nuclear facilities including hot cells are in less demand while facilities that foster interaction and team-based research are in high demand) and;
  - higher quality of space (e.g., reduced vibration sensitivity and temperature variability, and increased air quality and power demand for computers and other electronic equipment, etc.)
- obsolescence of existing building systems and components and changing technology (e.g., digital controls for heating and ventilation systems, fire alarms, security, etc.);
- increased requirements for continuity of utility operations to support large user population at SC user research facilities;
- increased energy costs;
- changing environmental, safety and health regulations and security needs; and
- inadequate capital investment in the past.

For each budget, all candidate construction projects for funding by the LFS subprogram are scored using the DOE Life Cycle Asset Management (LCAM) Cost-Risk-Impact Matrix that takes into account risk, impacts, and mission need. The projects that have ES&H as the principal driver are further prioritized using the Risk Prioritization Model from the DOE ES&H and Infrastructure Management Plan process.

Based on these scores, the LFS subprogram prioritizes the projects. The prioritized list is further evaluated for SC science program mission impact by an integrated infrastructure management team composed of the LFS subprogram and SC research program offices. Projects are then proposed from this list consistent with budget availability.

The LFS subprogram ensures that the funded projects are managed effectively and completed within the established cost, scope and schedule baselines. **Performance will be measured by** the number of all SLI projects completed within the approved baseline for cost (at or below the appropriated Total Estimated Cost), scope (within 10%), and schedule (within six months). Three projects scheduled for completion in FY 2002 were completed within the approved baselines for cost, scope, and schedule. The LFS subprogram also provides Payments in Lieu of Taxes (PILT) assistance for communities surrounding Brookhaven National Laboratory and Argonne National Laboratory-East.

Subprogram Goals

Reduce the Recapitalization Period (RP) of the general purpose infrastructure (GPI) from 146 years in FY 2002 to 112 years in FY 2004. The RP is defined as the number of years it takes to replace/rehabilitate the GPI at a specified capital investment level. The period is computed by dividing the replacement plant value of GPI ($5,975,000,000 in FY 2002) by the annual capital investment funding level for GPI. The annual capital investment funding level for GPI is composed of general purpose line item funding and one half the general plant projects (GPP) funding (i.e., GPP is small construction up to $5,000,000). One-half of the GPP is used because, on average, one half funds GPI related small construction and the other half funds programmatic small construction needs. Note: Because SC research programs fund GPP - e.g., Basic Energy Sciences funds GPP at Argonne National Laboratory, Oak Ridge National Laboratory, and Ames Laboratory, this measure reflects SC's corporate efforts for capital investment in the GPI. (Laboratories Facilities Support subprogram)

Performance Indicator

The reduction in the RP from year to year

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Based on capital investment funding level of $40,840,000 for FY 2002, the RP will be 146 years.	Based on proposed capital investment funding level of $54,299,000 for FY 2003, the RP will decline to 112 years.	Based on proposed capital investment funding level of $54,428,000 for FY 2004, the RP will be 112 years.

Funding Schedule

	(dollars in thousands)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
General Purpose Facilities	5,380	19,107	24,784	+5,677	+29.7%
Environment, Safety and Health	16,416	12,474	7,152	-5,322	-42.7%
Payment in Lieu of Taxes (PILT)	895	1,020	1,520	+500	+49.0%
Total, Laboratories Facilities Support	22,691	32,601	33,456	+855	+2.6%

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
General Purpose Facilities	**5,380**	**19,107**	**24,784**

Provides funding to support continuation of two FY 2002 subprojects and three FY 2003 subprojects under the Science Laboratories Infrastructure (MEL-001) Project Engineering and Design (PED) and construction project data sheets. These are summarized below. More details are provided in the data sheets presented later.

Ongoing projects:

- LBNL Building 77 Rehabilitation of Structures and Systems, Phase II ($2,000,000)
- BNL Research Support Building, Phase I ($5,150,000)
- TJNAF CEBAF Center Addition, Phase I ($3,914,000)
- PNNL Laboratory Systems Upgrade ($4,120,000)
- ORNL Research Support Center ($9,600,000).

Environment, Safety and Health	**16,416**	**12,474**	**7,152**

Provides funding to support the initiation of one new subproject in FY 2004 as well as the continuation of one FY 2002 subproject under the Science Laboratories Infrastructure (MEL-001) PED and construction project data sheets. These are summarized below. More details are provided in the data sheets presented later.

Ongoing:

- ANL-E Mechanical and Control Systems Upgrades, Phase I ($5,152,000)

New Start:

- SLAC Safety and Operational Reliability Improvements ($2,000,000)

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
PILT	**895**	**1,020**	**1,520**

Increase Payments in Lieu of Taxes (PILT) to support the negotiated increase in the per acre land value used to calculate the PILT payment. PILT assistance requirements for communities surrounding Brookhaven National Laboratory and Argonne National Laboratory-East are negotiated between the Department and local governments based on land values and tax rates.

Total, Laboratories Facilities Support	**22,691**	**32,601**	**33,456**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Laboratories Facilities Support	
■ Increase in the General Purpose Facilities (GPF) area reflects the completion of several ES&H projects resulting from significant past ES&H investment and shifting program priorities to GPF needs.	+5,677
■ Reduction in the Environment, Safety and Health (ES&H) area reflects the completion of several ES&H projects resulting from significant past ES&H investment and shifting of program priorities to GPF needs. Funding is included for a high priority new ES&H project start at SLAC.	-5,322
■ Increase in PILT funding to meet increased tax rates and assessments	+500
Total Funding Change, Laboratories Facilities Support	+855

Excess Facilities Disposition

Mission Supporting Goals and Measures

The Excess Facilities Disposition (EFD) subprogram removes excess facilities at the SC laboratories to reduce long-term costs and liabilities in support of programmatic initiatives (e.g. making land available for new programs). In addition to removal of excess facilities, the subprogram will also clean-up facilities for reuse where such reuse is economical and can provide needed functionality.

The EFD subprogram evaluates and prioritizes the backlog based on footprint reduction, risk reduction (e.g., removal of hazards), availability of space/land for research activities, and cost savings (e.g., elimination of surveillance and maintenance costs). The prioritized list is further evaluated for mission impact by an integrated infrastructure management team composed of the EFD subprogram and SC research program offices. The estimated backlog of non-contaminated or slightly contaminated facilities at the beginning of FY 2004 will be approximately $16,000,000.

The EFD subprogram does not fund projects that replace currently active and occupied buildings (e.g., old, deteriorated and marginally functional ones that are still used but are to be replaced by new modern buildings). Such building replacement projects are funded under the previously described LFS subprogram and would include removal of the old buildings as part of the justification for the project.

Subprogram Goals

Eliminate the current backlog of excess SC facilities by the end of FY 2006. (Excess Facilities Disposition subprogram)

Performance Indicator

Reductions as measured by the number of excess facilities and square footage removed (or made usable).

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
A Congressionally added FY 2002 Facilities and Infrastructure (F&I) Program of $10,000,000 will allow the clean-up of approximately 30 excess facilities with a reduction of approximately 400,000 square feet in FY 2002.	Estimated clean-up of 9 facilities with a reduction of approximately 113,000 square feet.	Estimated clean-up of 13 facilities with a reduction of approximately 92,000 square feet. Expect to eliminate current backlog by the end of FY 2006, two years earlier than planned. However, additional needs may be identified.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Excess Facilities Disposition	9,960	5,055	5,055	0	--
Total, Excess Facilities Disposition	9,960	5,055	5,055	0	--

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Excess Facilities Disposition..	**9,960**	**5,055**	**5,055**

FY 2002 Facilities and Infrastructure (F&I) program funding of $9,960,000 allows for the clean-up/removal of approximately 30 excess facilities. In FY 2002, an estimated 400,000 total square feet of space is being removed or cleaned up for reuse in the projects listed below:

- ANL-E ($810,000) – Cleanup of Building 205 Sample Carousel; cleanup of Building 315 Cell 6 Pit; cleanup of Building 315 Radiochemistry Lab (approximately 1,300 sq. ft.)
- BNL ($1,350,000) – Demolition of Building 318; demolition of Building 960 Complex; abandoned well closure and demolition of Buildings 93, 168, 915, and 917 (approximately 34,000 sq. ft.)
- FNAL ($53,000) – Demolition of Neon Compressor Building (approximately 900 sq. ft.)
- LBNL ($2,500,000) – Removal of motor generators from Building 51; removal of the Heavy Ion Spectrometer System (HISS) Magnet and Structure "51G," removal of shielding blocks/beam lines from External Particle Beam (EPB) hall (approximately 21,000 sq. ft.)
- LLNL ($350,000) – Demolition and removal of the Magnetic Fusion Energy Direct Current power supply (approximately 60,000 sq. ft.)
- ORNL ($3,125,000) – Stabilization and cleanout of Building 9201-3; stabilization and cleanout of EN tandem space in Building 5500; demolition of Building 2013; demolition of Building 2506; deactivation/demolition of Building 6003 (approximately 224,000 sq. ft.)
- PNNL ($497,000) – Demolition of Building 331-B Radioactive Inhalation Facility and Dog Kennels (approximately 26,000 sq. ft.)
- SLAC ($400,000) – Demolition of the following: Building 232 - Experimental Facilities Department/Cryogenics Conference Room; Building 125 - Test Beam Facility Control Room; Building 111 – 40" Bubble Chamber Building; Building 109 – Experimental Facilities Department High Bay Building; Building 404 – Experimental Shelter; Building 133 – Stanford Linear Detector Cherenkov Ring Imaging Detector Clean Room; Building 265 – Computer Trailer; Building 295 – End Station A Office Trailer #1; Building 291 - End Station A Office Trailer #2; Building 296 – SLAC User Trailer #2; Building 297 – SLAC User Trailer #3 (approximately 13,000 sq. ft.)
- PPPL ($875,000) – Preparation for Princeton Beta Experiment Modification (PBX) disposition and shielding block removals (approximately 27,000 sq. ft.)

In FY 2003, funding of $5,055,000 supports the 6 projects listed below and allows for the clean-up/removal of an estimated 113,000 square feet of space:

- ANL-E ($1,160,000) – Building 40 (Instrument Calibration) Disposal and Partial Facility Demolition (approximately 7,000 sq. ft.)
- BNL ($950,000) – Demolition of Buildings 89, 90, 91 and 118 (approximately 32,000 sq. ft.)
- LBNL ($950,000) – Disposal of concrete shield blocks, beamlines, magnets, and activated components (approximately 2,000 sq. ft.)
- LLNL ($250,000) – Demolish Magnetic Fusion Energy bridge and utility lines (approximately 1,000 sq. ft.)
- ORNL ($1,200,000) – Building 1,000 deactivation/demolition (approximately 59,000 sq. ft.)
- PPPL ($545,000) – Princeton Beta Experiment Modification (PBX)/Princeton Large Torus (PLT) control room and initial subsystem removals (approximately 12,000 sq. ft.)

In FY 2004, funding of $5,055,000 supports 7 projects listed below and allows for the clean-up/removal of an estimated 92,000 square feet of space:

- ANL-E ($850,000) - Building 205 (H-125/H-126 Cell) Decontamination and Decommissioning, and Building 330 (CP-5) Partial Disposal (approximately 35,000 sq. ft.).
- BNL ($767,000) - Demolition of Buildings 208, 324, and 428 (approximately 21,000 sq. ft.)
- FNAL($233,000) –Bubble Chamber Demolition (approximately 3,000 sq. ft.)
- LBNL ($975,000) - Disposal of Pill Box Roof Concrete Blocks from Building 51 (2,000 sq. ft.)
- LLNL ($250,000) - Demolition of Magnetic Fusion Energy Legacy Facilities at Building 445 (approximately 8,000 sq. ft.)
- ORNL ($1,000,000) - Deactivation/Demolition of Building 1506 and Demolition of Freel's Bend and Solway Facilities, (approximately 5,000 sq. ft.)
- PPPL ($980,000) Princeton Beta Experiment Modification (PBX) Princeton Large Torus (PLT) final subsystem removals and cooling tower demolition (approximately 18,200 sq. ft.)

Individual projects and amounts are subject to revision based on evolving program priorities including risk reduction (e.g., removal of hazards), footprint reduction, cost savings (e.g., elimination of surveillance and maintenance costs), and availability of space/land for new research activities.

Total, Excess Facilities Disposition	**9,960**	**5,055**	**5,055**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Excess Facilities Disposition No funding change.	

Oak Ridge Landlord

Mission Supporting Goals and Measures

The Oak Ridge Landlord subprogram supports activities to maintain continuity of operations at the Oak Ridge Reservation (ORR) and the Oak Ridge Operations Office (ORO).

This subprogram supports landlord responsibilities, including infrastructure for the 24,000 acres of the ORR outside of the Y-12 plant, ORNL, and the East Tennessee Technology Park, plus DOE facilities in the town of Oak Ridge. This includes roads and grounds and other infrastructure maintenance, ES&H support and improvements, PILT for Oak Ridge communities, and other needs related to landlord requirements. These activities maintain continuity of operations at the Oak Ridge Reservation and the ORO and minimize interruptions due to infrastructure and/or other systems failures. In FY 2002 there were no significant interruptions due to infrastructure failures.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Oak Ridge Landlord	4,474	5,079	5,079	0	--

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ **Roads, Grounds and Other Infrastructure and ES&H Support and Improvements**	**2,195**	**2,488**	**2,488**
■ **Payments in Lieu of Taxes (PILT)**	**1,900**	**2,300**	**2,300**
Payments in Lieu of Taxes (PILT) to the City of Oak Ridge, and Anderson and Roane Counties.			
■ **Reservation Technical Support**	**379**	**291**	**291**
Includes recurring activities such as Site Mapping, National Archives Records Administration, and support for legacy legal cases.			
Total, Oak Ridge Landlord	**4,474**	**5,079**	**5,079**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Oak Ridge Landlord	
No funding change.	

Capital Operating Expenses & Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
General Plant Projects (ORO Landlord)........	0	0	0	0	--
Capital Equipment (ORO Landlord)	0	0	0	0	--
Total, Capital Operating Expenses................	0	0	0	0	--

Construction Projects

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior Year Approp-riations	FY 2002	FY 2003	FY 2004	Unapprop. Balance
Project – 02-SC-001 Laboratories Facilities Support Project						
FY 2002 PED Datasheet.......................	N/A	N/A	3,183	0	0	0
Project – 03-SC-001 Laboratories Facilities Support Project						
FY 2003 PED Datasheet.......................	N/A	N/A	0	3,355	0	0
Project – 04-SC-001 Laboratories Facilities Support Project						
FY 2004 PED Datasheet........................	N/A	N/A	0	0	2,000	0
Project - MEL-001 Laboratories Facilities Support Project						
FY 2004 Construction Datasheet..........	N/A	N/A	18,613	28,226	29,936	28,489
Total, LFS Construction..............................	N/A	N/A	21,796	31,581	31,936	28,489

04-SC-001 – Science Laboratories Infrastructure, Project Engineering Design (PED), Various Locations

1. Construction Schedule History

Fiscal Quarter				Total Estimated Cost ($000)
A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Complete	

N/A-See Subproject details

2. Financial Schedule

(dollars in thousands)

Fiscal Year	Appropriations	Obligations	Costs
2004	2,000	2,000	1,600
2005	0	0	400

3. Project Description, Justification and Scope

This project funds PED for two types of subprojects:

- Projects that renovate or replace inefficient and unreliable general purpose facilities (GPF) including general use, service and support facilities such as administrative space, cafeterias, utility systems, and roads; and
- Projects to correct Environment, Safety and Health (ES&H) deficiencies including deteriorated steam lines, environmental insult, fire safety improvements, sanitary system upgrades and electrical system replacements.

This updated request provides the status of ongoing PED projects funded in FY 2002 and proposed in FY 2003. This PED data sheet requests design funding for one FY 2004 new start: Stanford Linear Accelerator Center – Safety and Operational Reliability Improvements.

FY 2004 Proposed Design Projects

Environment, Safety, and Health Project:

04 -04: MEL-001-036 – Safety and Operational Reliability Improvements (SLAC)

Fiscal Quarter				Total Estimated Cost (Design Only) ($000)	Full Total Estimated Cost Projection [a] ($000)
A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Complete		
1Q 2004	3Q 2004	4Q 2004	N/A	2,000	15,600

Fiscal Year	Appropriations	Obligations	Costs
2004	2,000	2,000	1,600
2005	0	0	400

This project has two components:

- Underground Utility Upgrades - this component will replace deteriorated sections of cooling water, low conductivity water, drainage, natural gas, compressed air and fire protection which are critical to the operation of the linear accelerator and the B Factory rings which produce the essential collisions needed for the Parity Violation studies (one of the pillars of the current US High Energy Physics program also carried out competitively at KEK in Japan). There have been five pipe failures over the last two years and the failure rate is expected to increase in these 35 year-old systems as they continue to age. When the pipes fail, research is slowed or halted until repairs are completed.
- Seismic Upgrades – this component will install seismic upgrades necessary to bring various building structures into compliance with the seismic standards of the Uniform Building Code. The seismic hazard in the Bay Area is high. 19 "essential" facilities, i.e., those that will minimize the time required for the Laboratory to recover from an earthquake, will be retrofitted for a total of 229,000 sq. ft. Payback is 9 years.

FY 2003 Ongoing Design Projects

(dollars in thousands)

(Design Project No. PED-03-SC-001) Multiprogram Energy Laboratories, Project Engineering Design (PED), Various Locations	Location	Design TEC	Approp. to Date	Obligs. to Date	Costs to Date	Design Start	Design Completion	Constr. Status (Fiscal Year)
General Purpose Facilities Projects:								
03 -01: MEL-001-028 Building 77 Rehabilitation Of Structures and Systems, Phase II	LBNL	1,100	0	0	0	1Q2003	2Q2004	3Q2004

This project will provide for rehabilitation to correct mechanical, electrical and architectural deficiencies in Buildings 77 (a 39 year old, 68,000 sq. ft. high-bay industrial facility) and 77A (a 14 year old, 10,000 sq. ft. industrial facility). Both buildings house machine shop and assembly operations in which production of highly sophisticated research components for a variety of DOE research projects is performed. Current work includes precision machining, fabrication and assembly of components for the Advanced Light Source, the Dual-Axis Radiographic Hydrodynamic Test Facility (DAHRT) project, the Spallation Neutron Source, and the ATLAS Detector. Infrastructure systems installed by this project will include HVAC, power distribution, lighting, and noise absorption materials. The improvements are necessary to satisfy urgent demands for high levels of cleanliness, temperature and humidity control, and OSHA and reliability requirements. This is the second of two projects; the first project, funded in FY 1999 and completed in FY 2002, corrected structural deficiencies in Bldg. 77.

(dollars in thousands)

(Design Project No. PED-03-SC-001) Multiprogram Energy Laboratories, Project Engineering Design (PED), Various Locations	Location	Design TEC	Approp. to Date	Obligs. to Date	Costs to Date	Design Start	Design Completion	Constr. Status (Fiscal Year)
03 -02: MEL-001-027 Research Support Building, Phase I	BNL	1,710	0	0	0	1Q2003	2Q2004	3Q2004

This design project will provide design for construction of the Research Support Building, Phase I. This 55,000 sq. ft. Research Support Building is intended to consolidate Staff Services, Public Affairs, Human Resources, Credit Union, Library and other support functions in a central quadrangle to provide staff and visiting scientists with convenient and efficient support. This facility, the first of four phases in the BNL Master Revitalization Plan, will include a lobby with a visitor information center to assist visiting scientists, and a coordinated office layout of related support services. After completion of this project, 23,000 sq. ft. of World War II era structures will be torn down. Based on total life-cycle costs, productivity gains, avoided energy and maintenance costs, the Research Support Building will provide a return on investment of 14.4% and a simple payback of 9 years.

(dollars in thousands)

(Design Project No. PED-03-SC-001) Multiprogram Energy Laboratories, Project Engineering Design (PED), Various Locations	Location	Design TEC	Approp. to Date	Obligs. to Date	Costs to Date	Design Start	Design Completion	Constr. Status (Fiscal Year)
03 -03: MEL-001-033 CEBAF Center Addition, Phase I	TJNAF	545	0	0	0	1Q2003	4Q2003	1Q2004

This project is Phase I of three phases to provide for additions to the CEBAF Center office building. The purpose of the three phases is to provide additional critical computer center space and to eliminate off-site leases and existing trailers to collocate staff for enhanced productivity. This first addition will add 59,000 sq. ft. of computer center (7,600 sq. ft) and office space and eliminate 22,000 sq. ft. of aging trailers with a 7.4-year simple payback and a 10% rate of return. Phase I will provide additional space for 182 users and 50 staff personnel.

FY 2003 Total		3,355	0	0	0

FY 2002 Ongoing Design Projects

(dollars in thousands)

(Design Project No. PED-02-SC-001) Multiprogram Energy Laboratories, Project Engineering Design (PED), Various Locations	Location	Design TEC	Approp. to Date	Obligs. to Date	Costs to Date	Design Start	Design Completion	Constr. Status (Fiscal Year)

<u>General Purpose Facilities Projects:</u>

02-01: MEL-001-018 Lab. Systems Upgrade	PNNL	880	880	880	622	1Q2002	3Q2003	2Q2003

This design project will provide design to upgrade or replace 20-50 year old mechanical system components in eight high occupancy facilities, replacing them with more efficient, better performing systems to enhance the quality of science while reducing maintenance and energy costs. This upgrade will include: replacement of HVAC supply and exhaust fans; replacement, rehabilitation or modification of numerous chemical exhaust fume hoods; installation of computerized, remote, digital controls on various systems to improve operations.

(dollars in thousands)

(Design Project No. PED-02-SC-001) Multiprogram Energy Laboratories, Project Engineering Design (PED), Various Locations	Location	Design TEC	Approp. to Date	Obligs. to Date	Costs to Date	Design Start	Design Completion	Constr. Status (Fiscal Year)
02-03: MEL-001-025 Research Support Center	ORNL	1,500	1,500	1,500	522	1Q2002	3Q2003	2Q2003

This design project will construct a 50,000 sq. ft. facility to house the core support service facilities and serve as the cornerstone and focal point of the East Research Campus envisioned in the ORNL Facility Revitalization Project. This building will include an auditorium and conference center (currently there is no adequate auditorium/conference space available at ORNL), cafeteria, visitor reception and control area, and offices for support staff. It will facilitate consolidation of functions, which are presently scattered throughout the Laboratory complex in facilities that are old (30-50 years), undersized, poorly located, or scheduled for surplus. The facility will serve as a modern center for meeting, collaborating, and exchanging scientific ideas for ORNL staff and the nearly 30,000 visitors, guests, and collaborators that use ORNL facilities each year. The new cafeteria will replace the existing cafeteria, which was constructed in 1953. The existing cafeteria is poorly located to serve the current staff and is adjacent to the original production area of the laboratory now undergoing decontamination. The estimated simple payback is seven years.

(dollars in thousands)

(Design Project No. PED-02-SC-001) Multiprogram Energy Laboratories, Project Engineering Design (PED), Various Locations	Location	Design TEC	Approp. to Date	Obligs. to Date	Costs to Date	Design Start	Design Completion	Constr. Status (Fiscal Year)

<u>Environment, Safety & Health Projects:</u>

02-08: MEL-001-017 Mechanical Control Systems Upgrade, Ph. I	ANL	803	803	803	230	1Q2002	3Q2003	2Q2003

(dollars in thousands)

(Design Project No. PED-02-SC-001) Multiprogram Energy Laboratories, Project Engineering Design (PED), Various Locations	Location	Design TEC	Approp. to Date	Obligs. to Date	Costs to Date	Design Start	Design Completion	Constr. Status (Fiscal Year)

This design project will provide design to upgrade and replace 30-40 year old mechanical system components in various facilities. It will optimize capacity, enhance system reliability and performance, improve safety, and reduce maintenance and repair costs of primary building mechanical equipment and control systems. The mechanical systems designated for replacement are no longer adequate, reliable, or efficient, and do not meet current ES&H standards (i.e. failure of laboratory exhaust systems could lead to the release of radioactive material). Specifically, this project will: upgrade HVAC systems in Bldgs. 221 and 362, including heating and cooling coils, fans, filter systems, ductwork, controls, and variable frequency drive fans; upgrade lab exhaust systems in Bldgs. 202 and 306, including new fans, ductwork, and controls; upgrade corroded drainage systems in Bldgs. 200, 205 and 350; and upgrade steam and condensate return systems in 12 facilities in the 360 area. This will include high and low pressure steam supply piping and associated pressure reducing stations, valves, and accessories; and replacing condensate pumping systems including piping, valves and system controls.

FY 2002 Total		3,183	3,183	3,183	1,374			

4. Details of Cost Estimate

N/A

5. Method of Performance

Design services will be obtained through competitive and/or negotiated contracts. M&O contractor staff may be utilized in areas involving security, production, proliferation, etc. concerns.

6. Schedule of Project Funding

N/A

MEL-001 – Science Laboratories Infrastructure Project, Various Locations

(Changes from FY 2003 Congressional Budget Request are denoted with a vertical line in the left margin.)

1. Construction Schedule History

Fiscal Quarter				Total Estimated Cost ($000)	Total Project Cost ($000)
A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Complete		

N/A -- See subproject details

2. Financial Schedule

(dollars in thousands)

Fiscal Year	Appropriations	Obligations	Costs
Project Engineering & Design (PED)			
FY 2002	3,183 [a]	3,183	2,385
FY 2003	3,355 [b]	3,355	3,573
FY 2004	2,000	2,000	2,080
FY 2005	0	0	500
Construction			
Prior Years	10,879	10,879	2,672
FY 2002	18,613	18,613	12,262
FY 2003	28,226	28,226	27,445
FY 2004	29,936	29,936	31,900
FY 2005	28,489	28,489	29,400
FY 2006	0	0	12,464

[a] Title I and Title II Design funding of $880,000 (Subproject 18); $803,000 (Subproject 17); and $1,500,000 (Subproject 25) provided under PED Project No. 02-SC-001.
[b] Title I and Title II Design funding of $1,710,000 (Subproject 27); $1,100,000 (Subproject 28); $545,000 (Subproject 33) requested under PED Project No. 03-SC-001.

3. Project Description, Justification and Scope

This project funds two types of subprojects:

- Projects that renovate or replace inefficient and unreliable general purpose facilities (GPF) including general use, service and user support facilities such as administrative space, cafeterias, utility systems, and roads; and
- Projects to correct Environment, Safety, and Health (ES&H) deficiencies including deteriorated steam lines, environmental insult, fire safety improvements, sanitary system upgrades and electrical system replacements.

General Purpose Facilities Projects:

a. Subproject 15 – Laboratory Facilities HVAC Upgrade (ORNL)

TEC	Prev.	FY 2002	FY 2003	FY 2004	Outyear	Construction Start/ Completion Dates
7,100	500	3,000	3,600	0	0	3Q 2002 – 2Q 2004

This project will provide improvements to aging (average 38 years old) HVAC systems located throughout the 13 buildings which comprise ORNL's central research complex, thereby improving the research environment and reducing operations and maintenance costs. Work will include: 1) installation of a primary/secondary Central Chilled Water Plant pumping system by replacing existing inefficient primary and booster pumps with a variable volume distribution system and 2-way chilled water control valves; 2) installation of a chilled water cross-tie to Buildings 4501/4505 from the underground tie-line between Buildings 4500N and 4509 to address low capacity problems; 3) upgrading of a corroded hot water reheat distribution system which supplies reheat water for zone control of the primary air handlers; 4) upgrade of deteriorated air handlers in selected buildings with new filters, steam and chilled water coils, and controls; 5) installation of new chilled water coils and chilled water supply piping for the east wing of Building 3500 to replace the refrigerant system that has high maintenance requirements; and 6) replacement of control valves in various buildings to improve system efficiency.

b. Subproject 18 – Laboratory Systems Upgrades (PNNL)

TEC	Prev.	FY 2002	FY 2003	FY 2004	Outyear	Construction Start/ Completion Dates
9,000	0	880[a]	4,000	4,120	0	2Q 2003 – 2Q 2005

This project will upgrade or replace 20-50 year old mechanical system components in eight high occupancy facilities, replacing them with more efficient and better performing systems to enhance the quality of science while reducing maintenance and energy costs. This upgrade will include: replacement of HVAC supply and exhaust fans; replacement, rehabilitation or modification of numerous chemical exhaust fume hoods; installation of computerized, remote, digital controls on various systems to improve operations.

[a] Title I and Title II Design funding provided under PED Project No. 02-SC-001.

c. Subproject 25 – Research Support Center (ORNL)

TEC	Prev.	FY 2002	FY 2003	FY 2004	Outyear	Construction Start/ Completion Dates
16,100	0	1,500[a]	5,000	9,600	0	2Q 2003 – 2Q 2005

This project will construct a 50,000 sq. ft. facility to house the core support service facilities and serve as the cornerstone and focal point of the East Research Campus envisioned in the ORNL Facility Revitalization Project. This building will include an auditorium and conference center (currently there is no adequate auditorium/conference space available at ORNL), cafeteria, visitor reception and control area, and offices for support staff. It will facilitate consolidation of functions, which are presently scattered throughout the Laboratory complex in facilities that are old (30-50 years), undersized, poorly located, or scheduled for surplus. The facility will serve as a modern center for meeting, collaborating, and exchanging scientific ideas for ORNL staff and nearly 30,000 visitors, guests, and collaborators that use ORNL facilities each year. The new cafeteria will replace the existing cafeteria, which was constructed in 1953. The existing cafeteria is poorly located to serve the current staff and is adjacent to the original production area of the laboratory now undergoing decontamination. The estimated simple payback is seven years.

d. Subproject 27 – Research Support Building, Phase I (BNL)

TEC	Prev.	FY 2002	FY 2003	FY 2004	Outyear	Construction Start/ Completion Dates
18,200	0	0	3,250[b]	5,150	9,800	2Q 2004 – 3Q 2006

This 55,000 sq. ft. facility is intended to consolidate Staff Services, Public Affairs, Human Resources, Credit Union, Library and other support functions in a central quadrangle to provide staff and visiting scientists with convenient and efficient support. This facility, the first of four phases in the BNL Master Revitalization Plan, will include a lobby with a visitor information center to assist visiting scientists, and a coordinated office layout of related support services. After completion of this project, 23,000 sq. ft. of World War II era structures will be torn down. Based on total life-cycle costs, productivity gains, avoided energy and maintenance costs, the Research Support Building will provide a return on investment of 14.4% and a simple payback of 9 years.

[a] Title I and Title II Design funding of $1,500,000 provided under PED Project No. 02-SC-001.
[b] Title I and Title II Design funding of $1,710,000 requested under PED Project No. 03-SC-001.

e. Subproject 28 – Building 77 Rehabilitation of Structures and Systems, Phase II (LBNL)

TEC	Prev.	FY 2002	FY 2003	FY 2004	Outyear	Construction Start/ Completion Dates
13,360	0	0	1,757[a]	2,000	9,603	3Q 2004 – 2Q 2006

This project will provide for rehabilitation to correct mechanical, electrical and architectural deficiencies in Buildings 77 (a 39 year old, 68,000 sq. ft. high-bay industrial facility) and 77A (a 14 year old, 10,000 sq. ft. industrial facility). Both buildings house machine shop and assembly operations in which production of highly sophisticated research components for a variety of DOE research projects is performed. Current work includes precision machining, fabrication and assembly of components for the Advanced Light Source, the Dual-Axis Radiographic Hydrodynamic Test Facility (DAHRT) project, the Spallation Neutron Source, and the ATLAS Detector. Infrastructure systems installed by this project will include HVAC, power distribution, lighting, and noise absorption materials. The improvements are necessary to satisfy urgent demands for high levels of cleanliness, temperature and humidity control, and OSHA and reliability requirements. This is the second of two projects; the first project, funded in FY 1999 and completed in FY 2002, corrected structural deficiencies in Bldg. 77.

f. Subproject 33 – Continuous Electron Beam Accelerator Facility (CEBAF) Center Addition, Phase I (TJNAF)

TEC	Prev.	FY 2002	FY 2003	FY 2004	Outyear	Construction Start/ Completion Dates
10,500	0	0	1,500[b]	3,914	5,086	1Q 2004 – 1Q 2006

This project is Phase I of three phases to provide for additions to the CEBAF Center office building. The purpose of the three phases is to provide additional critical computer center space and to eliminate off-site leases and existing trailers to collocate staff for enhanced productivity. This first addition will add 59,000 sq. ft. of computer center (7,600 sq. ft.) and office space and eliminate 22,000 sq. ft. of aging trailers with a 7.4-year simple payback and a 10% rate of return. Phase I will provide additional space for 182 users and 50 staff personnel.

ES&H Projects:

a. Subproject 09 - Fire Safety Improvements, Phase IV (ANL-E)

TEC	Prev.	FY 2002	FY 2003	FY 2004	Outyear	Construction Start/ Completion Dates
8,381	6,351	2,030	0	0	0	3Q 2001 - 2Q 2003

This project will complete the effort of correcting known deficiencies with respect to fire detection and alarm systems; life safety and OSHA related sprinkler systems; and critical means of egress in twenty-eight (28) buildings at the Argonne National Laboratory-East (ANL-E) site. Correction of these deficiencies is required to comply with DOE Order 420.1, OSHA 1910,164, and OSHA Subpart C. These deficiencies, if uncorrected, could result in unmitigated risks of injury to personnel and/or damage to DOE property in case of fire.

a Title I and Title II Design funding of $1,100,000 requested under PED Project No. 03-SC-001.
b Title I and Title II Design funding of $545,000 requested under PED Project No. 03-SC-001.

b. Subproject 12 - Site-wide Water Distribution System Upgrade (LBNL)

TEC	Prev.	FY 2002	FY 2003	FY 2004	Outyear	Construction Start/ Completion Dates
8,300	1,000	4,400	2,900	0	0	2Q 2002 –1Q 2004

This project will rehabilitate the Laboratory's High Pressure Water (HPW) System that supplies over 100 facilities at LBNL. The HPW System provides domestic water, fire water, treated water, cooling tower water and low conductivity water. It consists of 9.6 km of pipe (1.4 km of cast iron pipe, 6.3 km of ductile iron pipe, and 1.9 km of cement lined coated steel pipe), associated valves, pumps, fittings etc. and two 200,000 gallon emergency fire water tanks. This project will: replace all cast iron pipe, which is in imminent danger of failing, with ductile iron pipe; electrically isolate pipe and provide cathodic protection; replace leaking valves and add pressure reducing stations to prevent excessive system pressure at lower laboratory elevations; add an emergency fire water tank to serve the East Canyon; and provide the two current emergency fire water tanks with new liners and seismic upgrades.

c. Subproject 13 - Groundwater and Surface Water Protection Upgrades (BNL)

TEC	Prev.	FY 2002	FY 2003	FY 2004	Outyear	Construction Start/ Completion Dates
6,050	1,889	2,763	1,398	0	0	2Q 2002 - 1Q 2004

This project will implement a backlog of ground and surface water protection projects that are commitments to regulators. These include: proper closure of inactive supply and injection wells; runoff control for the surplus material storage yard; containment and runoff control for the radioactive material storage yard; replacement of 12 hydraulic elevator cylinders; removal of 22 underground fuel oil tanks; and other Suffolk County Article 12 upgrades.

d. Subproject 14 - Fire Protection Systems Upgrades (ORNL)

TEC	Prev.	FY 2002	FY 2003	FY 2004	Outyear	Construction Start/ Completion Dates
5,920	584	3,120	2,216	0	0	3Q 2002 – 4Q 2004

This project will upgrade the 36 year-old fire protection system with improved, more reliable fire alarm capabilities by: replacing deteriorated, obsolete systems; replacing the single 16-inch water main in the east central section of ORNL with a looped system (4,000 lf of 16 inch pipe); and by extending coverage of automatic alarm systems to areas not previously served. New fire alarm equipment will provide emergency responders with greatly improved annunciation of the causes and locations of alarms and will provide code compliant occupant notification evacuation alarms for enhanced life safety. It will also include timesaving, automatic diagnostic capabilities that will reduce maintenance costs. The new occupant notification systems will comply with the Americans with Disabilities Act. The fire alarm receiving equipment at the site fire department headquarters will be upgraded to ensure its reliability, modernize its technology, and meet the demands of an expanded fire alarm system network.

e. Subproject 16 – Electrical Systems Modifications, Phase II (BNL)

TEC	Prev.	FY 2002	FY 2003	FY 2004	Outyear	Construction Start/ Completion Dates
6,770	555	3,300	2,915	0	0	2Q 2002 – 1Q 2004

This project is the second phase of the modernization and refurbishment of the Laboratory's deteriorating 50 year-old electrical infrastructure. The project includes: installation of two new 13.8 kV feeders to provide alternate sources to existing, aged feeders; installation of additional underground ductbanks to support a new 13.8 kV feeder; replacement of 24 kV switchgear to increase system reliability/safety; reconditioning of 50 480-volt circuit breakers including replacing obsolete trip units with modern, solid-state trip devices; and the retrofit of 10 13.8 kV air breakers with new vacuum technology.

f. Subproject 17 – Mechanical and Control Systems Upgrade, Phase I (ANL-E)

TEC	Prev.	FY 2002	FY 2003	FY 2004	Outyear	Construction Start/ Completion Dates
9,000	0	803[a]	3,045	5,152	0	3Q 2003 – 3Q 2005

This design project will provide design to upgrade and replace 30-40 year old mechanical system components in various facilities. It will optimize capacity, enhance system reliability and performance, improve safety, and reduce maintenance and repair costs of primary building mechanical equipment and control systems. The mechanical systems designated for replacement are no longer adequate, reliable, or efficient, and do not meet current ES&H standards (i.e. failure of laboratory exhaust systems could lead to the release of radioactive material). Specifically, this project will: upgrade HVAC systems in Buildings 221 and 362, including heating and cooling coils, fans, filter systems, ductwork, controls, and variable frequency drive fans; upgrade lab exhaust systems in Buildings 202 and 306, including new fans, ductwork, and controls; upgrade corroded drainage systems in Buildings 200, 205 and 350; and upgrade steam and condensate return systems in 12 facilities in the 360 area. This will include high and low pressure steam supply piping and associated pressure reducing stations, valves, and accessories; and replacing condensate pumping systems including piping, valves and system controls.

4. Details of Cost Estimate

N/A

5. Method of Performance

To the extent feasible, construction and procurement will be accomplished by fixed-price contracts awarded on the basis of competitive bids.

6. Schedule of Project Funding

N/A

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a Title I and Title II Design funding provided under PED Project No. 02-SC-001.

a Title I and Title II Design funding of $2,000,000 (Subproject 36) requested under PED Project No. 04-SC-001.

7. Related Annual Funding Requirements

N/A

8. Design and Construction of Federal Facilities

All DOE facilities are designed and constructed in accordance with applicable Public Laws, Executive Orders, OMB Circulars, Federal Property Management Regulations, and DOE Orders. The total estimated cost of the project includes the cost of measures necessary to assure compliance with Executive Order 12088, "Federal Compliance with Pollution Control Standards;" section 19 of the Occupational Safety and Health Act of 1970, the provisions of Executive Order 12196, and the related Safety and Health provisions for Federal Employees (CFR Title 29, Chapter XVII, Part 1960); and the Architectural Barriers Act, Public Law 90-480, and implementing instructions in 41 CFR 101-19.6. The project will be located in an area not subject to flooding determined in accordance with Executive Order 11988. DOE has reviewed the GSA inventory of Federal Scientific laboratories and found insufficient space available, as reported by the GSA inventory.

Fusion Energy Sciences

Program Mission

The Fusion Energy Sciences (FES) program leads the national research effort to advance plasma science, fusion science, and fusion technology—the knowledge base needed for an economically and environmentally attractive fusion energy source. The National Energy Policy states that fusion power has the long-range potential to serve as an abundant and clean source of energy and recommends that the Department develop fusion. The next frontier in the quest for fusion power is a sustained, burning (or self-heated) plasma, and the Fusion Energy Sciences Advisory Committee (FESAC) has concluded that the fusion program is technically and scientifically ready to proceed with a burning plasma experiment and has recommended joining the ongoing negotiations to construct the international burning plasma experiment, ITER. The National Research Council of the National Academy of Sciences has endorsed this strategy. Based in part on these recommendations and an assessment by the Office of Science of the cost estimate for the construction of ITER, the President has decided that the U.S. should join the ITER negotiations.

Overview:

Fusion science is a subfield of plasma science that deals primarily with studying the fundamental processes taking place in plasmas where the temperature and density approach the conditions needed to allow the nuclei of two low-mass elements, like hydrogen isotopes, to join together, or fuse. When these nuclei fuse, a large amount of energy is released. Fusion science research is organized around the two leading methods of confining the fusion plasma—magnetic, where strong magnetic fields constrain the charged plasma particles, and inertial, where laser or particle beams compress and heat the plasma in very short pulses.

During 1998-1999, the FESAC conducted a major review of the fusion program that culminated in the report, "Priorities and Balance within the Fusion Energy Sciences Program," dated September 1999. A hallmark of this report is that it presents the first approach to an evenhanded treatment of magnetic fusion science and inertial fusion science. In December 2000, FESAC reviewed a more detailed, independent report, "Report of the Integrated Program Planning Activity for the DOE Fusion Energy Sciences Program," (IPPA) that reaffirmed that the priorities, balance, and strategic vision laid out in the FESAC 1999 report remain valid. Recommendations in the report of the 2001 National Research Council (NRC) Fusion Assessment Committee review of the quality of the science in the program are consistent with the report. Further, the NRC Fusion Assessment also states "*that the quality of science funded by the United States fusion research program in pursuit of a practical source of power from fusion (the fusion energy goal) is easily on a par with the quality in other leading areas of contemporary physical science*."

Based on these recent recommendations and assessments, the programmatic goals for the Magnetic Fusion Energy (MFE) and the Inertial Fusion Energy (IFE) parts are designed to address the scientific and technology issues facing fusion energy development.

For magnetic fusion, the scientific and technology issues include:

- the transport of plasma heat from the core outward to the plasma edge and to the material walls as a result of electromagnetic turbulence in the plasma (chaos, turbulence, and transport),

- the stability of the magnetic configuration and its variation in time as the plasma pressure, density, turbulence level, and population of high energy fusion products change (stability, reconnection, and dynamo),
- the role of the colder plasma at the plasma edge and its interaction with both material walls and the hot plasma core (sheaths and boundary layers),
- the interaction of electrons and ions in the plasma with high-power electromagnetic waves injected into the plasma for plasma heating, current drive and control (wave-particle interaction), and
- the development of reliable and economical superconducting magnets, plasma heating and fueling systems, vacuum chamber, and heat extraction systems and materials that can perform satisfactorily in an environment of fusion plasmas and high energy neutrons.

For inertial fusion, the scientific and technology issues include:

- The high-energy-density physics necessary to understand the plasmas produced by intense laser-plasma and beam-plasma interactions,
- the behavior of non-neutral plasmas (such as beams of heavy ions), and
- the acceleration and transport of high-current beams, the development of a target chamber and associated debris clearing, and the fabrication and accurate injection of low-cost targets.

These issues have been codified into four thrusts that characterize the program activities:

- Burning Plasmas, which will include our efforts in support of ITER;
- Fundamental Understanding, which includes Theory and Modeling, as well as general plasma science;
- Configuration Optimization, which includes experiments on advanced tokamaks, magnetic alternates, and inertial fusion concepts, as well as facility operations and enabling R&D; and
- Materials and Technology, which includes fusion specific materials research and fusion nuclear technology research.

Progress in each and all of these thrust areas, in an integrated fashion, is required for ultimate success in achieving a practical fusion energy source.

In light of the President's decision to join the ITER negotiations, many elements of the current fusion program that are broadly applicable to burning plasmas will now be directed more specifically toward the needs of ITER, which will be the focal point of burning plasma fusion research around the world. These elements represent areas of fusion research in which the U.S. has particular strengths, such as theory, modeling and tokamak experimental physics. Longer range technology activities aimed at an eventual commercial fusion reactor will be curtailed to fund new activities related to participating in the ITER project, and to focus on aspects of the present program that most directly support preparations for building and operating ITER: operations and research for the tokamak experimental program (DIII-D and Alcator C-Mod) relevant to burning plasma physics, and ITER-specific computer simulations. The new and redirected elements of the fusion program, and the associated increases in FY 2004 resources, are detailed in the table below. These are resources that would have been allocated differently in this request had the President decided to not enter the negotiations. The U.S. funding commitment to ITER will increase significantly in the outyears as the project moves to construction and eventually to science operations.

Fusion Program Resource Changes in Preparation for ITER

Elements	FY 2004 Resources
DIII-D Experimental Program	$5,000,000
Alcator C-Mod Experimental Program	2,000,000
Fusion Plasma Theory & Computation	3,000,000
ITER Preparations	2,000,000
Total	$12,000,000

How We Work:

The primary role of the Fusion Energy Sciences (FES) program governance is the funding, management, and oversight of the program. FES has established an open process for obtaining scientific input for major decisions, such as planning, funding, evaluating and, where necessary, terminating facilities, projects, and research efforts. There are also mechanisms in place for building fusion community consensus and orchestrating international collaborations that are fully integrated with the domestic program. FES is likewise active in promoting effective outreach to and communication with related scientific and technical communities, industrial and government stakeholders, and the public.

Advisory and Consultative Activities:

The Department of Energy uses a variety of external advisory entities to provide input that is used in making informed decisions on programmatic priorities and allocation of resources. The FESAC is a standing committee that provides independent advice to the Director of the Office of Science on complex scientific and technological issues that arise in the planning, implementation, and management of the fusion energy sciences program. The Committee members are drawn from universities, national laboratories, and private firms involved in fusion research. The Director of the Office of Science charges the Committee to provide advice and recommendations on various issues of concern to the fusion energy sciences program. The Committee conducts its business in public meetings, and submits reports containing its advice and recommendations to the Department.

In December 1998, Secretary Richardson asked the Secretary of Energy Advisory Board (SEAB) to form a Task Force on Fusion Energy to conduct a review of the Department's fusion energy technologies, both magnetic and inertial, and to provide recommendations as to the role of these technologies as part of a national fusion energy research program. The final report, "Realizing the Promise of Fusion Energy," August 9, 1999, stated "The scientific progress on fusion has been remarkable. As a result, it is the Task Force's view that the threshold scientific question – namely, whether a fusion system producing sufficient net energy gain to be attractive as a commercial power source can be sustained and controlled – can and will be solved…it is our view that we should pursue fusion energy aggressively."

In December 2002, the National Research Council recommended to the Department that, "…the United States enter ITER negotiations while the strategy for an expanded U.S. fusion program is defined and evaluated."

A variety of other committees and groups provide input to program planning. Ad hoc activities by fusion researchers, such as the 2002 Snowmass meeting, provide a forum for community debate and formation of consensus. The President's Committee of Advisors on Science and Technology (PCAST) has also examined the fusion program on several occasions. As noted, the National Research Council, whose Plasma Physics Committee serves as a continuing connection to the general plasma physics community, recently carried out an assessment of the Department of Energy's Fusion Energy Sciences' strategy for addressing the physics of burning plasmas. In addition, the extensive international collaborations carried out by U.S. fusion researchers provide informal feedback regarding the U.S. program and its role in the international fusion energy effort. These sources of information and advice are integrated with peer reviews of research proposals and when combined with high-level program reviews and assessments provide the basis for prioritizing program directions and allocations of funding.

Program Advisory Committees (PACs) serve an extremely important role in providing guidance to facility directors in the form of program review and advice regarding allocation of facility run time. These PACs are formed primarily from researchers from outside the host facility, including non-U.S. members. They review proposals for research to be carried out on the facility and assess support requirements, and, in conjunction with host research committees, provide peer recommendations regarding priority assignments of facility time. Because of the extensive involvement of researchers from outside the institutions, PACs are also useful in assisting coordination of overall research programs. Interactions among PACs for major facilities assure that complementary experiments are appropriately scheduled and planned.

Facility Operations Reviews:

FES program managers perform quarterly reviews of the progress in operating the major fusion facilities. In addition, a review of each of these major facilities occurs periodically by peers from the other facilities. Further, quarterly reviews of each major project are conducted by the Associate Director for Fusion Energy Sciences with the Federal project manager in the field and other involved staff from both the Department and the performers.

Program Reviews:

The peer review process is used as the primary mechanism for evaluating proposals, assessing progress and quality of work, and for initiating and terminating facilities, projects, and research programs. This policy applies to all university and industry programs funded through grants, national laboratory programs funded through Field Work Proposals (FWPs), and contracts from other performers. Peer review guidelines for FES derive from best practices of government organizations that fund science and technology research and development, such as those documented in the General Accounting Office report, "Federal Research: Peer Review Practices at Federal Science Agencies Vary" (GAO/RCED-99-99, March 1999), as well as more specifically from relevant peer review practices of other programs in the Office of Science.

Merit review in FES is based on peer evaluation of proposals and performance in a formal process using specific criteria and the review and advice of qualified peers. In addition to the review of the scientific quality of the programs provided by the peer review process, FES also reviews the programs for their balance, relevance, and standing in the broader scientific community.

Universities and most industries submit grant proposals to receive funding from FES for their proposed work. The grant review process is governed by the already established SC Merit Review System. DOE national laboratories submit annual field work proposals for funding of both new and ongoing activities. These are subject to peer review according to procedures that are patterned after those given in 10 CFR Part 605 that govern the SC grant program. For the major facilities that FES funds, these extensive reviews are conducted as part of a contract or cooperative agreement renewal, with nominally five-year renewal dates. External peer reviews of laboratory programs are carried on a periodic basis. Grants are typically reviewed every three years.

Planning and Priority Setting:

The FESAC carries out an invaluable role in the fusion energy program by identifying critical scientific issues and providing advice on medium- and long-term goals to address these issues. Most recently, the

FESAC has restated support for conclusions and recommendations first given in the 1999 report "Priorities and Balance within the Fusion Energy Sciences Program."

A program planning activity carried out by the research community, "Report of the Integrated Program Planning Activity for the DOE Fusion Energy Sciences Program," (IPPA) December 2000, provides goals for magnetic and inertial fusion, and a framework and process necessary for the achievement of these goals. The long-term program goals developed in the IPPA are:

- Advance the fundamental understanding of plasma, the fourth state of matter, and enhance predictive capabilities, through the comparison of well-diagnosed experiments, theory and simulation.
- Resolve outstanding scientific issues and establish reduced-cost paths to more attractive fusion energy systems by investigating a broad range of innovative magnetic plasma confinement configurations.
- Advance understanding and innovation in high-performance plasmas, optimizing for projected power plant requirements; and participate in a burning plasma experiment.
- Develop enabling technologies needed to advance fusion science; pursue innovative technologies and materials to improve the vision for fusion energy; and apply systems analysis to optimize fusion development.
- Advance the fundamental understanding and predictability of high-energy-density plasmas for IFE, leveraging from the Inertial Confinement Fusion (ICF) target physics work sponsored by the National Nuclear Security Agency (NNSA).
- Develop the science and technology of attractive repetition-rated IFE power systems, leveraging from the ICF work sponsored by NNSA.

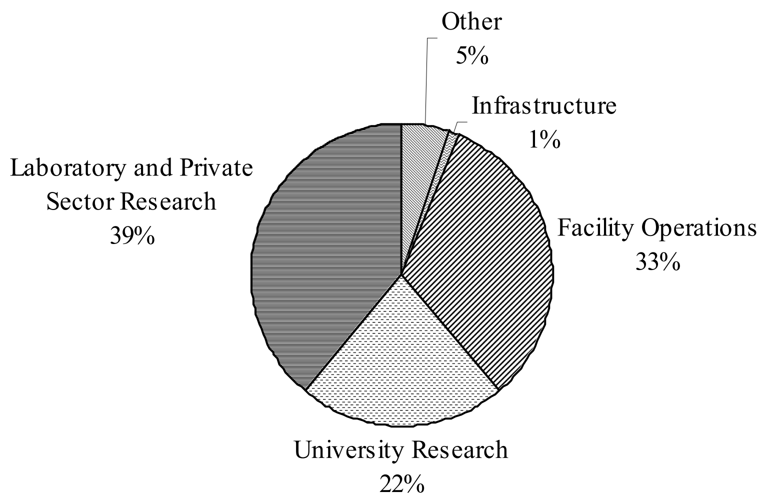
A variety of sources of information and advice, as noted above under the heading "Advisory Activities," are integrated with peer reviews of research proposals and when combined with high-level program reviews and assessments provide the basis for prioritizing program directions and allocations of funding.

How We Spend Our Budget:

The FES budget has three major components: Science, Facility Operations, and Enabling Research and Development. Research efforts are distributed across universities, laboratories, and private sector institutions. In addition to a major research facility at Massachusetts Institute of Technology (MIT), there are several smaller experimental facilities located at universities. There are two other major facilities, located at a national laboratory, and a private sector institution. Enabling Research and Development supports and improves the technical capabilities for ongoing experiments and provides limited long-term development for future fusion power requirements.

The balance of funding levels and priorities underwent overall scrutiny in 1996 by the FESAC when the fusion program focus changed to an increased emphasis on the science underpinnings of fusion research and away from timeline-driven technology development. Subsequent reviews of program quality, relevance, and performance, such as the FESAC review in 1999, "Priorities and Balance Within the Fusion Energy Sciences Program" have made additional adjustments to funding levels for individual programs. As an example, facility operations were planned to be enhanced in FY 2003 relative to FY 2002 and operating time for FY 2004 will remain at the planned FY 2003 level. The research results from these facilities provide a significant addition to the knowledge base required for fusion energy, and therefore it is essential to exploit these facilities to the fullest extent possible. The following chart illustrates the allocation of funding to the major program elements.

Fusion Energy Sciences
Category Breakdown (FY 2004 Request)



Who Does the Research:

The DOE fusion energy sciences program involves over 1,100 researchers and students at more than 70 U.S. academic, federal, and private sector institutions. The program funds research activities at 67 academic and private sector institutions located in 30 states and at 11 DOE and Federal laboratories in 8 states. The three major facilities are operated by the hosting institutions, but are configured with national research teams made up of local scientists and engineers, and researchers from other institutions and universities, as well as foreign collaborators.

University Research:

University researchers continue to be a critically important component of the fusion research program and are responsible for training graduate students. University research is carried out on the full range of scientific and technical topics of importance to fusion energy. University researchers are active participants on the major fusion facilities and one of the major facilities is sited at a university (Alcator C-Mod at MIT). In addition, there are 16 smaller research and technology facilities located at universities, including a basic plasma user science facility at UCLA that is jointly funded by DOE and NSF. There are 5 universities with significant groups of theorists and modelers. About 50 Ph.D. degrees in plasma science and engineering are awarded each year. Over the past three decades, many of these graduates have gone into the industrial sector and brought with them the technical basis for many of the plasma applications found in industry today, including the plasma processing on which today's semiconductor fabrication lines are based.

The university grants program is proposal driven. External scientific peers review proposals submitted in response to announcements of opportunity and funding is competitively awarded according to the guidelines published in 10 CFR Part 605. Support for basic plasma physics is carried out through the NSF/DOE Partnership in Basic Plasma Science and Engineering.

National Laboratory and Private Sector Research:

The Fusion Energy Sciences program supports national laboratory-based fusion research groups at the Princeton Plasma Physics Laboratory, Oak Ridge National Laboratory, Sandia National Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Idaho National Engineering and Environmental Laboratory, Argonne National Laboratory, and Los Alamos National Laboratory. In addition, one of the major research facilities is located at and operated by General Atomics in San Diego, California. The laboratory programs are driven by the needs of the Department, and research and development carried out there is tailored to take specific advantage of the facilities and broadly based capabilities found at the laboratories.

Laboratories submit field work proposals for continuation of ongoing or new work. Selected parts of proposals for continuing work are reviewed on a periodic basis, and proposals for new work are peer reviewed. FES program managers review laboratory performance on a yearly basis to examine the quality of their research and to identify needed changes, corrective actions, or redirection of effort.

Program Strategic Performance Goals

SC6-1: Improve the basis for a reliable capability to predict the behavior of magnetically confined plasma and use the advances in the Tokamak concept to enable the start of the burning plasma physics phase of the U.S. fusion sciences program. (Science and Enabling Technologies subprograms)

Performance Indicator

Eighty percent of all new research projects will be peer reviewed and deemed excellent and relevant, and annually, 30% of all ongoing projects will be subject to peer review with merit evaluation.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
	Complete installation of internal coils for feedback control of plasma instabilities on DIII-D, and conduct a first set of experiments demonstrating the effectiveness of these coils in controlling plasma instabilities, and compare with theoretical predictions. (SC6-1)	Conduct feedback control experiments in DIII-D with the new internal control coils to reach plasma operating conditions beyond the limits that can be achieved without the stabilizing effect of a near-by conducting wall. (SC6-1)
	Produce high temperature plasmas with 5 Megawatts of Ion Cyclotron Radio Frequency (ICRF) power for pulse lengths of 0.5 second in Alcator C-Mod. Assess the stability and confinement properties of these plasmas, which would have collisionalities in the same range as that expected for the burning plasma regime. (SC6-1)	Compare energy confinement, H-mode thresholds, and divertor particle dynamics in single-null, double-null, and inner-wall-limited discharges in Alcator C-Mod, establishing limits of divertor power handling for advanced tokamak plasma regimes and requirements for advanced divertors for planned burning plasma tokamaks. (SC6-1)
		Include electron dynamics in turbulent transport simulations and compare the results with experimental results from both U.S. and foreign tokamaks to benchmark the simulation code.

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
		(SC6-1)
Use recently upgraded plasma microwave heating system and new sensors on DIII-D to study feedback stabilization of disruptive plasma oscillations. (met goal)		Expand the experiments on stabilization of Neoclassical Tearing Mode instabilities with increased electron cyclotron heating power in DIII-D and compare the results with computational models to benchmark the theories. (SC6-1)
		Complete detailed design of an advanced, high-power, load tolerant, ion cyclotron radio frequency antenna for C-Mod. (SC6-1)
Complete design and fabrication of the High-Power Prototype advanced ion-cyclotron radio frequency antenna that will be used at the Joint European Torus. (JET) (met goal)	Complete testing of the High-Power Prototype advanced ion-cyclotron radio frequency antenna that will be used at the Joint European Torus.	

SC6-2: Resolve outstanding science/technology issues and explore options for more attractive magnetic and inertial fusion energy systems (Science and Enabling R&D subprograms)

Performance Indicator

Eighty percent of all new research projects will be peer reviewed and deemed excellent and relevant, and annually, 30% of all ongoing projects will be subject to peer review with merit evaluation.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Demonstrate innovative techniques for initiating and maintaining current in a spherical torus. (SC6-2) (Goal met)		Assess confinement and stability in NSTX by characterizing high confinement regimes with edge barriers and by obtaining initial results on the avoidance or suppression of plasma pressure limiting modes in high-pressure plasmas. (SC6-2)
		Integrate elements of initial plasma neutralized beam focus and carry out initial experiments in support of heavy ion beam inertial fusion. (SC6-2)
		Carry out full voltage beamlet acceleration and determine beamlet characteristic (multibeamlet source configured in FY 2003) for heavy ion beam inertial fusion. (SC6-2)
Complete measurements and analysis of thermal creep of Vanadium alloy (V-4Cr-4Ti) in vacuum and lithium environments, determine controlling creep mechanisms and access operating temperature limits. (goal met)	Complete preliminary experimental and modeling investigations of nano-scale thermodynamic, mechanical, and creep-rupture properties of nanocomposited ferritic steels.	Under a cost-shared collaborative program with Japan for irradiation testing of fusion materials in U.S. fission reactors, complete first phase of testing to evaluate the effects of neutron bombardment on the microstructural

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
		evolution, and property changes of candidate fusion materials.
Complete analysis of JET MARK-II inner divertor performance. (goal met)		

SC7-6: Manage facilities operations and construction to the highest standards of overall performance using merit evaluation with independent peer review. (Facility Operations subprogram)

Performance Indicator

Average operational downtime of FES facilities will not exceed 10% of total time scheduled, and construction and upgrades of facilities will be within 10% of baseline schedule and cost.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Keep deviations in cost and schedule for upgrades and construction of scientific user facilities within 10 percent of project baselines; successfully complete within cost and in a safe manner all TFTR decontamination and decommissioning activities. (goal met)	Keep deviations in cost and schedule for upgrades and construction of scientific user facilities within 10 percent of project baselines; complete the National Compact Stellarator Experiment (NCSX) Preliminary Design. (SC7-6)	Complete the Final Design of the National Compact Stellarator Experiment and begin fabrication.
Keep deviations in weeks of operation for each major facility within 10 percent of the scheduled weeks. (goal not met)	Keep deviations in weeks of operation for each major facility within 10 percent of the scheduled weeks. (SC7-6)	Keep deviations in weeks of operation for each major facility within 10 percent of the scheduled weeks. (SC7-6)

Program Assessment Rating Tool (PART) Assessment

In the PART review, the OMB gave the FES program a perfect score (100) in the “Purpose” section, and a fairly high score (73) in the “Management” section. These scores are attributed to the use of standard management practices in the Office of Science. In the “Planning” section, the low score (56) is attributed by OMB to the FES program’s lack of long-term and annual performance measures. Nevertheless, the OMB recognizes that the FES program has made significant strides toward developing such measures despite the problems inherent in predicting and then measuring scientific progress.

Specifically, OMB stated that the FES program delivers projects on cost and schedule, and it receives a significant amount of external expert assessments of its research and program management strategies. However, OMB finds that the program budget is not sufficiently aligned with program goals so that the impact of funding changes on performance is readily known and so that basic research elements can be distinguished from applied research elements.

To address these findings, the program will work to reform its performance measures and goals, understanding the difficulties that basic research program face in attempting to predict future scientific progress. The program will also work to further clarify the relationship between the program’s goals and the budget.

Significant Program Shifts

The budget requested for FY 2004 is equal to the FY 2003 Request. The FY 2004 budget generally supports the program balance and priorities recommended by the Fusion Energy Sciences Advisory Committee and supported by the Secretary of Energy Advisory Board and the National Research Council (NRC).

The principal program shifts result from a view that a burning plasma physics experiment is the appropriate next step in the fusion program. Evaluations of domestic technical progress over the past decade have led to an evolution in the program direction to include the burning plasma focus. With the President's decision to join the ITER negotiations to build a burning plasma experimental facility, longer range technology activities will be curtailed to focus on aspects of the present program that most directly support preparations for the realization of the burning plasma device and experiments. In fact, the majority of the existing and proposed program elements already contribute to improving our understanding and future advancement of tokamak science thereby providing a strong base for our future contributions to and ability to benefit from these future experiments.

Whether or not a burning plasma experiment will be realized through the construction and operation of the proposed ITER device will depend on the success of the international negotiations in determining an agreed-upon site for the facility, an agreed-upon financial and procurement arrangement, and satisfactory management and oversight arrangements. In these negotiations, the U.S. will strive for incorporation of its principles of equity, accountability and visibility, which will be an important part of any decision-making process for joining any future construction project. Should the ITER project not proceed to fruition, FESAC has recommended that the U.S. fusion program continue toward a burning plasma experiment, using the FIRE concept which is a modest size burning plasma experiment for which conceptual design studies have been carried out, and seeking partnership from within the international fusion community. Specific burning plasma tasks outlined in this budget proposal are supportive of ITER and would also be supportive of FIRE, as the technical physics issues are similar.

A new program to support fusion science "Centers of Excellence" will be initiated in FY 2004. This new program opportunity responds to recommendations made by the National Research Council in their 2001 assessment of the Fusion Energy Sciences program. This program will enhance the long term development of the human capital that will be needed to carry out a sustained fusion energy program, as well as providing key connections to cross-cutting science efforts at the university level. Proposals will be solicited and peer reviewed to select proposals for funding in FY 2004. It is intended that the role of these centers will be similar to the Science Frontier Centers funded by the National Science Foundation.

AWARDS

- A CalTech student received the 2002 Award for Outstanding Doctoral Dissertation in plasma physics.
- Seven fusion researchers were elected Fellows of the American Physical Society in 2001.
- Four fusion researchers received the 2002 Award for Excellence in Plasma Physics Research from the American Physical Society.
- A young researcher with the IFE program received a Presidential Early Career Award for Scientists and Engineers.

- The TFTR D&D effort at PPPL was honored as 2002 Project of the Year by the Professional Engineers Society of Mercer County (NJ) for use of diamond wire cutting of complex metal vessels.
- A fusion Engineer was honored by the ASME with their Engineering and Technology Management Leadership Award.

Workforce Development

The FES program, the Nation's primary sponsor of research in plasma physics and fusion science, supports development of the R&D workforce by funding undergraduate researchers, graduate students working toward a doctoral degree, and postdoctoral associates developing their research and management skills. The R&D workforce developed as a part of this program provides new scientific talent to areas of fundamental research. It also provides talented people to a wide variety of technical and industrial fields that require finely honed thinking and problem solving abilities and computing and technical skills. Scientists trained through association with the FES program are employed in related fields such as plasma processing, space plasma physics, plasma electronics, and accelerator/beam physics as well as in other fields as diverse as biotechnology and investment and finance.

In FY 2002, the FES program supported 365 graduate students and post-doctoral investigators. Of these, 50 students conducted research at the DIII-D tokamak at General Atomics, the Alcator C-Mod tokamak at MIT, or the NSTX at PPPL. A Junior Faculty development program for university plasma physics researchers and the NSF/DOE partnership in basic plasma physics and engineering focus on the academic community and student education.

	FY 2000	FY 2001	FY 2002	FY 2003, est.	FY 2004, est.
# University Grants	177	188	188	185	185
# Permanent PhD's [a]	749	741	731	740	730
# Postdocs	91	99	99	100	100
# Grad Students	246	246	266	270	260
# PhD's awarded	49	49	53	50	50

[a] Permanent PhD's includes faculty, research physicists at universities, and all PhD-level staff at national laboratories.

Scientific Discovery through Advanced Computing (SciDAC)

The Scientific Discovery through Advanced Computing (SciDAC) activity is a set of coordinated investments across all Office of Science mission areas with the goal to achieve breakthrough scientific advances through computer simulation that were impossible using theoretical or laboratory studies alone. The power of computers and networks is increasing exponentially. By exploiting advances in computing and information technologies as tools for discovery, SciDAC encourages and enables a new model of multi-discipline collaboration among the scientific disciplines, computer scientists and mathematicians. The product of this collaborative approach is a new generation of scientific simulation codes that can fully exploit tera-scale computing and networking resources. The program will bring simulation to a parity level with experiment and theory in the scientific research enterprise as demonstrated by major advances in climate prediction, plasma physics, particle physics, astrophysics and computational chemistry.

Scientific Facilities Utilization

The Fusion Energy Sciences request includes funds to operate and make use of major fusion scientific user facilities. The Department's three major fusion energy physics facilities are: the DIII-D Tokamak at General Atomics in San Diego, California; the Alcator C-Mod Tokamak at the Massachusetts Institute of Technology; and the National Spherical Torus Experiment at the Princeton Plasma Physics Laboratory. These three facilities are each unique in the world's fusion program and offer opportunities to address specific fusion science issues that will contribute to the expanding knowledge base of fusion. Taken together, these facilities represent a nearly $1,000,000,000 capital investment by the U.S. Government, in current year dollars.

The funding requested will provide research time for about 560 scientists in universities, federally sponsored laboratories, and industry, and will leverage both federally and internationally sponsored research, consistent with a strategy for enhancing the U.S. National science investment.

The total number of weeks of operation at all of the major fusion facilities is shown in the following table.	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004
Maximum weeks	75	75	75	75	75
Scheduled weeks	54	44	34	63	63
Unscheduled weeks of Downtime	7%	0%	6%	TBD	TBD

In addition to the operation of the major fusion facilities, several Major Item of Equipment projects are supported in the fusion program. Milestones for these projects are shown in the following table.

FY 2000	FY 2001	FY 2002	FY 2003	FY 2004
Completed NSTX Neutral Beam.				
			Complete NCSX preliminary design. Start NCSX project.	Complete final design of NCSX and begin fabrication.
Started C-Mod Lower Hybrid Upgrade Project.			Complete C-Mod Lower Hybrid Upgrade Project.	

Funding Profile

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Request	FY 2004 Request	$ Change	% Change
Fusion Energy Sciences					
Science	134,307	142,565	144,670	+2,105	+1.5%
Facility Operations	70,803	78,653	87,726	+9,073	+11.5%
Enabling R&D	35,990	36,092	24,914	-11,178	-31.0%
Subtotal, Fusion Energy Sciences	241,100	257,310	257,310	0	--
Adjustment	0	0	0	0	--
Total, Fusion Energy Sciences	241,100[b][c]	257,310	257,310	0	--

Public Law Authorization:
Public Law 95-91, "Department of Energy Organization Act"
Public Law 103-62, "Government Performance and Results Act of 1993"

[b] Excludes $139,000 for the FY 2002 rescission contained in section 1403 of P.L. 107-226, Supplemental Appropriations for further recovery from and response to Terrorist attacks on the United States.
[c] Excludes $5,888,000 which was transferred to the SBIR program and $353,000 which was transferred to the STTR program.

Funding By Site[a]

	(dollars in thousands)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
Los Alamos National Laboratory	7,799	7,308	3,765	-3,543	-48.5%
Sandia National Laboratories	3,178	3,213	2,786	-427	-13.3%
Total, Albuquerque Operations Office	10,977	10,521	6,551	-3,970	-37.7%
Chicago Operations Office					
Argonne National Laboratory	1,662	1,522	1,192	-330	-21.7%
Princeton Plasma Physics Laboratory	69,607	63,576	70,563	+6,987	+11.0%
Chicago Operations Office	44,586	49,317	50,140	+823	+1.7%
Total, Chicago Operations Office	115,855	114,415	121,895	+7,480	+6.5%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	2,356	2,392	1,823	-569	-23.8%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	5,952	5,799	5,718	-81	-1.4%
Lawrence Livermore National Laboratory	14,510	14,411	13,408	-1,003	-7.0%
Oakland Operations Office	69,595	73,779	69,926	-3,853	-5.2%
Total, Oakland Operations Office	90,057	93,989	89,052	-4,937	-5.3%
Oak Ridge Operations Office					
Oak Ridge Inst. For Science & Education	347	808	888	+80	+9.9%
Oak Ridge National Laboratory	19,454	19,258	18,693	-565	-2.9%
Oak Ridge Operations Office	0	0	0	0	--
Total, Oak Ridge Operations Office	19,801	20,066	19,581	-485	-2.4%
Richland Operations Office					
Pacific Northwest National Laboratory	1,415	1,556	1,440	-116	-7.5%
Richland Operations Office	0	0	0	0	--
Total, Richland Operations Office	1,415	1,556	1,440	-116	-7.5%

[a] On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format.

	(dollars in thousands)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
Savannah River Operations Office					
Savannah River Laboratory	50	49	45	-4	-8.2%
Washington Headquarters	589	14,322	16,923	+2,601	+18.2%
Total, Fusion Energy Sciences	241,100[bc]	257,310	257,310	0	--

[b] Excludes $139,000 for the FY 2002 rescission contained in section 1403 of P.L. 107-226, Supplemental Appropriations for further recovery from and response to Terrorist attacks on the United States.
[c] Excludes $5,888,000 which was transferred to the SBIR program and $353,000 which was transferred to the STTR program.

Site Description

Argonne National Laboratory

Argonne National Laboratory (ANL) in Argonne, Illinois, is a Multiprogram Laboratory located on a 1,700-acre site in suburban Chicago. ANL has a satellite site located in Idaho Falls, Idaho. Argonne's Fusion Energy Sciences program contributes to a variety of enabling R&D program activities. Argonne has a lead role internationally in analytical models and experiments for liquid metal cooling in fusion devices. Studies of coatings for candidate structural alloy materials are conducted in a liquid lithium flow loop. Argonne's capabilities in the engineering design of fusion energy systems have contributed to the design of components, as well as to analysis supporting the studies of fusion power plant concepts.

Idaho National Engineering and Environmental Laboratory

Idaho National Engineering and Environmental Laboratory (INEEL) is a Multiprogram Laboratory located on 572,000 acres in Idaho Falls, Idaho. Since 1978, INEEL has been the Fusion Energy Sciences program's lead laboratory for fusion safety. As the lead laboratory, it has helped to develop the fusion safety database that will demonstrate the environmental and safety characteristics of both nearer term fusion devices and future fusion power plants. Research at INEEL focuses on the safety aspects of magnetic fusion concepts for existing and planned domestic experiments, and developing further our domestic safety database using existing collaborative arrangements to conduct work on international facilities. In addition, with the shutdown of the Tritium Systems Test Assembly (TSTA) facility at LANL, INEEL will expand their research and facilities capabilities to include tritium science activities. In FY 2003, INEEL will complete a small tritium laboratory (Safety and Tritium Applied Research Facility).

Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory (LBNL) is a Multiprogram Laboratory located in Berkeley, California. The Laboratory is on a 200-acre site adjacent to the Berkeley campus of the University of California. For the Fusion Energy Sciences program, the laboratory's mission is to study and apply the physics of heavy ion beams and to advance related accelerator technologies for the U.S. Inertial Fusion Energy program. LBNL, LLNL, and PPPL work together in advancing the physics of heavy ion drivers through the Heavy Ion Fusion Virtual National Laboratory.

Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory (LLNL) is a Multiprogram Laboratory located on an 821-acre site in Livermore, California. LLNL works with the Lawrence Berkley National Laboratory on the Heavy Ion Fusion program. The LLNL program also includes collaborations with General Atomics on the DIII-D tokamak, operation of an innovative concept experiment, the Sustained Spheromak Physics Experiment (SSPX) at LLNL, and benchmarking of fusion physics computer models with experiments such as DIII-D. LLNL, LBNL, and PPPL work together in advancing the physics of heavy ion drivers through the Heavy Ion Fusion Virtual National Laboratory.

Los Alamos National Laboratory

Los Alamos National Laboratory is a Multiprogram Laboratory located on a 27,000-acre site in Los Alamos, New Mexico. The budget supports the creation of computer codes for modeling the stability of plasmas, as well as work in diagnostics, innovative fusion plasma confinement concepts such as Magnetized Target Fusion, and the removal of the remainder of the recoverable tritium from and completion of the stabilization of the Tritium Systems Test Assembly facility prior to turning the facility over to the Office of Environmental Management for Decontamination and Decommissioning at the end of FY 2003.

Oak Ridge Institute for Science and Education

Oak Ridge Institute for Science and Education (ORISE), operated by Oak Ridge Associated Universities (ORAU), is located on a 150-acre site in Oak Ridge, Tennessee. Established in 1946, ORAU is a consortium of 88 colleges and universities. The institute undertakes national and international programs in education, training, health, and the environment. For the FES program, ORISE supports the operation of the Fusion Energy Sciences Advisory Committee and administrative aspects of some FES program peer reviews. It also acts as an independent and unbiased agent to administer the Fusion Energy Sciences Graduate and Postgraduate Fellowship programs, in conjunction with FES, the Oak Ridge Operations Office, participating universities, DOE laboratories, and industries.

Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL) is a Multiprogram Laboratory located on a 24,000-acre site in Oak Ridge, Tennessee. ORNL develops a broad range of components that are critical for improving the research capability of fusion experiments located at other institutions and that are essential for developing fusion as an environmentally acceptable energy source. The laboratory is a leader in the theory of heating of plasmas by electromagnetic waves, antenna design, and design and modeling of pellet injectors to fuel the plasma and control the density of plasma particles. Research is also done in the area of turbulence and its effect on the transport of heat through plasmas. Computer codes developed at the laboratory are also used to model plasma processing in industry. While some ORNL scientists are located full-time at off-site locations, others carry out their collaborations with short visits to the host institutions, followed by extensive computer communications from ORNL for data analysis and interpretation, and theoretical studies. ORNL is also a leader in stellarator theory and design, is a major partner with PPPL on the NCSX. ORNL leads the advanced fusion structural materials science program, contributes to research on all materials systems of fusion interest, coordinates experimental collaborations for two U.S.-Japan programs, and coordinates fusion materials activities.

Pacific Northwest National Laboratory

Pacific Northwest National Laboratory (PNNL) is a Multiprogram Laboratory located on 640 acres at the Department’s Hanford site in Richland, Washington. The Fusion Energy Sciences program at PNNL is focused on research on materials that can survive in a fusion neutron environment. The available facilities used for this research include mechanical testing and analytical equipment, including state-of-the-art electron microscopes, that are either located in radiation shielded hot cells or have been adapted for use in evaluation of radioactive materials after exposure in fission test reactors. Experienced scientists and engineers at PNNL provide leadership in the evaluation of ceramic matrix composites for fusion applications and support work on vanadium, copper and ferritic steels as part of the U.S. fusion materials team. PNNL also plays a leadership role in a fusion materials collaboration with Japan, with Japanese owned test and analytical equipment located in PNNL facilities and used by both PNNL staff and up to ten Japanese visiting scientists per year.

Princeton Plasma Physics Laboratory

Princeton Plasma Physics Laboratory (PPPL) is a program-dedicated laboratory (Fusion Energy Sciences) located on 72 acres in Princeton, New Jersey. PPPL is the only U.S. Department of Energy (DOE) laboratory devoted primarily to plasma and fusion science. It hosts experimental facilities used by multi-institutional research teams and also sends researchers and specialized equipment to other fusion facilities in the United States and abroad. PPPL is the host for the NSTX, which is an innovative toroidal confinement device closely related to the tokamak, and has completed the conceptual design of another innovative toroidal concept, the NCSX, a compact stellarator. PPPL scientists and engineers have significant involvement in the DIII-D and Alcator C-Mod tokamaks in the U.S. and the large JET (Europe) and JT-60U (Japan) tokamaks abroad. This research is focused on developing the scientific understanding and innovations required for an attractive fusion energy source. PPPL scientists are also involved in several basic plasma science experiments, ranging from magnetic reconnection to plasma processing. PPPL, through its association with Princeton University, provides high quality education in fusion-related sciences, having produced more than 175 Ph.D. graduates since it's founding in 1951. PPPL, LBNL, and LLNL work together in advancing the physics of heavy ion drivers through the Heavy Ion Fusion Virtual National Laboratory.

Sandia National Laboratory

Sandia National Laboratory is a Multiprogram Laboratory, located on a 3,700 acre site in Albuquerque, New Mexico, with other sites in Livermore, California, and Tonopah, Nevada. Sandia's Fusion Energy Sciences program plays a lead role in developing components for fusion devices through the study of plasma interactions with materials, the behavior of materials exposed to high heat fluxes, and the interface of plasmas and the walls of fusion devices. Sandia selects, specifies, and develops materials for components exposed to high heat and particles fluxes and conducts extensive analysis of prototypes to qualify components before their use in fusion devices. Materials samples and prototypes are tested in Sandia's Plasma Materials Test Facility, which uses high-power electron beams to simulate the high heat fluxes expected in fusion environments. Materials and components are exposed to tritium-containing plasmas in the Tritium Plasma Experiment. Tested materials are characterized using Sandia's accelerator facilities for ion beam analysis. Sandia supports a wide variety of domestic and international experiments in the areas of tritium inventory removal, materials postmortem analysis, diagnostics development, and component design and testing.

All Other Sites

The Fusion Energy Sciences program funds research at more than 50 colleges and universities located in approximately 30 states. It also funds the DIII-D tokamak experiment and related programs at General Atomics, an industrial firm located in San Diego, California.

Science

Mission Supporting Goals and Measures

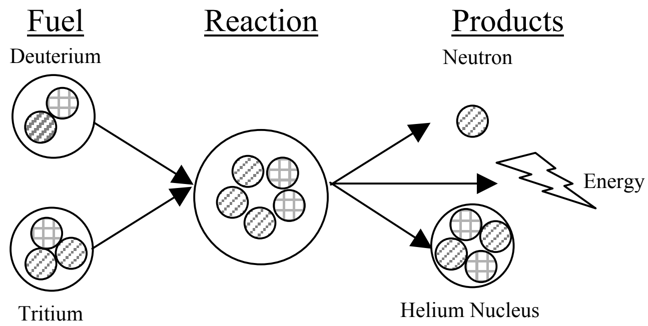
The Science subprogram supports the quest for fusion power by fostering fundamental research in plasma science aimed at a predictive understanding of plasmas in a broad range of plasma confinement configurations. There are two basic approaches to confining a fusion plasma and insulating it from its much colder surroundings—magnetic and inertial confinement. In the former, carefully engineered magnetic fields isolate the plasma from the walls of the surrounding vacuum chamber, while in the latter, a pellet of fusion fuel is compressed and heated so quickly that there is no time for the heat to escape. There has been great progress in plasma science during the past three decades, in both magnetic and inertial confinement, and today the world is at the threshold of a major advance in fusion power development--the study of burning plasmas, in which the self-heating from fusion reactions dominates the plasma behavior.

Plasmas, the fourth state of matter, comprise over 99% of the visible universe and are rich in complex, collective phenomena. During the past decade there has been considerable progress in our fundamental understanding of key individual phenomena in fusion plasmas, such as transport driven by micro-turbulence, and macroscopic equilibrium and stability of magnetically confined plasmas. Over the next five years the Science subprogram will continue to advance the understanding of plasmas through an integrated program of experiments, theory, and simulation as outlined in the ***Integrated Program Planning Activity for the Fusion Energy Sciences Program*** prepared for FES and reviewed by the Fusion Energy Sciences Advisory Committee. This integrated research program will focus on well-defined plasma scientific issues including turbulent transport, macroscopic stability, wave particle interactions, multiphase interfaces, hydrodynamic stability, implosion dynamics, and heavy-ion beam transport and focusing. We expect this research program to yield new methods for sustaining and controlling high temperature, high-density plasmas, which will have a major impact on a burning plasma experiment, such as ITER, and to benefit from ignition experiments on the NNSA-sponsored National Ignition Facility (NIF).

An additional objective of the Science subprogram is to broaden the intellectual and institutional base in fundamental plasma science. Two activities, an NSF/DOE partnership in plasma physics and engineering, and Junior Faculty development grants for members of university plasma physics faculties, will continue to contribute to this objective. A new "Centers of Excellence in Fusion Science" program will also foster fundamental understanding and connections to related sciences.

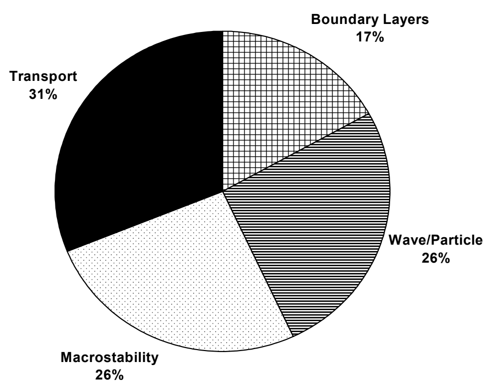
Plasma science includes not only plasma physics but also physical phenomena in a much wider class of ionized matter, in which atomic, molecular, radiation-transport, excitation, and ionization processes are important. These phenomena can play significant roles in partially ionized media and in the interaction of plasmas with material walls. Plasma science contributes not only to fusion research, but also to many other fields of science and technology, such as astrophysics, industrial processing, and national security.

Fusion science, a major sub-field of plasma science, is focused primarily on describing the fundamental processes taking place in plasmas where the peak temperatures are greater than 100 million degrees Celsius and densities great enough that hydrogenic nuclei collide and fuse together, releasing energy and producing the nucleus of a helium atom and a neutron.



The Fusion Process

Fusion science shares many scientific issues with plasma science. For Magnetic Fusion Energy (MFE), these include: (1) chaos, turbulence, and transport; (2) stability, magnetic reconnection, and dynamos; (3) wave-particle interaction and plasma heating; and (4) sheaths and boundary layers. Progress in all of these fields is likely to be required for ultimate success in achieving a practical fusion energy source.



The total funding spent on MFE in FY 2002 is split roughly as shown to address major scientific issues.

For Inertial Fusion Energy (IFE), the two major science issues are: (1) high energy density physics that describes intense laser-plasma and beam-plasma interactions; and (2) non-neutral plasmas, as is seen in the formation, transport, and focusing of intense heavy ion beams.

SCIENCE ACCOMPLISHMENTS

Research funded by the Fusion Energy Sciences program in FY 2002 produced major scientific results over a wide range of activities. Selected accomplishments that address scientific issues for fusion and long-term fusion goals include:

- Studies of feedback stabilization of disruptive plasma oscillation were successfully carried out in DIII-D in FY 2002, using the recently acquired electron cyclotron heating (ECH) power. Up to 4.0

MW of ECH power was deposited in selected regions of the plasma, using steerable ECH antennae, to drive additional plasma current. These currents alter the conditions for detrimental plasma oscillations and stabilize them to avoid disruptions. The stabilization of different modes of oscillations has been demonstrated, raising the performance of the plasma and extending its pulse length. (SC6-1 FY 2002 Target)

- NSTX has successfully demonstrated innovative techniques for initiating and maintaining current in a spherical torus. The device initiated plasmas using Coaxial Helicity Injection and maintained high ratios of plasma pressure to applied magnetic pressure for increased durations by raising current drive while reducing induction. A number of these plasmas were operating in the High-Confinement-Mode (H-mode) lasting essentially the flat-top duration of the plasma current. (SC6-1 FY 2002 Target)
- Improved modeling of macroscopic stability has been achieved. Improvements in extended magnetohydrodynamic codes enabled by the Scientific Discovery through Advanced Computing initiative have made it possible to simulate the dynamics of NSTX plasmas that have strong sheared flows.
- There are new results in the area of transport and turbulence in tokamaks. New measurements using high speed cameras on C-Mod, NSTX and DII-D have shown the presence of "blobs" of high density plasma being formed and moving outward from the region of good confinement in all three machines. Movies showing the time evolution of this process have been made. These "blobs" may account for the bigger part of the turbulent transfer across the magnetic field. Together with other direct measurements, this work is now providing some insight into the cause of the density limits observed in tokamaks.
- With the availability of the new, high-performance computer at the National Energy Research Scientific Computing Center, it is now possible to simulate the turbulence in tokamaks approaching the size of the International Thermonuclear Experimental Reactor (ITER). Simulations performed in the past year indicate that the transport caused by the plasma turbulence initially increases with the size of the plasma, but then levels off at a constant value. This is a favorable result for reactor-scale tokamaks like ITER and provides increased confidence that they will achieve their desired fusion energy gain.
- One major concern for tokamaks is that tokamak discharges might prematurely terminate (disrupt) when the plasma pressure or density exceeds their limits, and cause excessive current or heat loads on the tokamak components. On DIII-D, such disruptions have been successfully terminated by injecting high-pressure noble gas into the plasma, thereby, avoiding high-energy runaway electrons, unwanted plasma currents in the vessel, and excessive heat load on divertor target plates.
- Innovative confinement concepts have also shown improvements in stability, turbulence and transport. New results have been achieved in some of these concepts that will provide the basis in the future for further development as fusion power sources. As an example, current profile modification experiments in the Madison Symmetric Torus (MST) at the University of Wisconsin have greatly reduced magnetic fluctuations, increasing the energy confinement time by a factor of 10 above the usual empirical scaling for reversed-field pinches (RFPs).
- Inertial fusion energy is a non-magnetically confined approach to fusion energy in which energy-producing targets are compressed and ignited by external beams. For heavy ion beam drivers, producing, transporting, and focusing the beams are the main technical challenges and are one of the

main IFE program goals. Recent experiments at LBNL have achieved record currents in the high current experiment (HCX) using both electrostatic and magnetic focusing elements. The results from these measurements provide an important database for validating beam transport calculations.

Subprogram Goals

Advance the fundamental understanding of plasma, the fourth state of matter, and enhance predictive capabilities, through the comparison of well-diagnosed experiments, theory and simulation.

Resolve outstanding scientific issues and establish reduced-cost paths to more attractive fusion energy systems by investigating a broad range of innovative magnetic and inertial plasma confinement configurations.

Advance understanding and innovation in high-performance magnetically confined plasmas, optimizing for projected power plant requirements and participate in an international burning plasma experiment.

Advance the fundamental understanding and predictability of high energy density plasmas for IFE, leveraging from the Inertial Confinement Fusion (ICF) target physics work sponsored by the National Nuclear Security Agency (NNSA).

Performance Indicators

(1) Fraction of all new research projects that are peer reviewed and deemed excellent and relevant; target 80%.
(2) Fraction of all ongoing projects subject to peer review with merit evaluation; target 30% per year.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Show that stability in a tokamak can be affected by the interaction of microwaves with electrons in the core of the plasma. Result: achieved on DIII-D.	Maintain high performance in DIII-D by controlling plasma instabilities with microwaves.	Use higher power radio frequency and microwave systems to extend the range of validity for the negative central shear mode of advanced tokamak operation on the DIII-D facility.
	Explore operating regime of the newly discovered “quiescent double barrier” mode on DIII-D.	Develop improved physics understanding of the “quiescent double barrier” mode on DIII-D and evaluate its impact on the operational range of advanced tokamaks.
Apply new diagnostics including high speed cameras to increase understanding of transport at the edge of tokamaks. Result: achieved on C-Mod and NSTX.	Demonstrate the role of self-driven currents in edge instabilities in DIII-D using the new edge current diagnostics.	Carry out studies of transport in the edge of C-MOD plasmas for high densities near density limits.
Using improved magnetohydrodynamic codes developed under SciDAC to analyze NSTX modes with toroidal totation to explain changes in plasma profiles. Result: achieved on NSTX.	Measure and analyze the dispersion of heat flux on plasma facing components under conditions of high heating power in NSTX.	Assess confinement and stability in NSTX by characterizing high confinement regimes with edge barriers and by obtaining initial results on the avoidance or suppression of plasma pressure plasmas.

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Demonstrate enhanced energy confinement times in a reversed-field-pinch by use of current modification. Result: achieved transiently on MST at the University of Wisconsin.	Study the effects of magnetic fluctuations in high temperature plasmas on magnetic reconnection and dynamo.	Continue the study of the magnetic dynamo, which is intrinsic to the reversed-field –pinch and is of interest to several other fields of non-fusion plasma science.
Bring on line 3 new experimental facilities for heavy ion inertial fusion research (high current experiment, source test stand and plasma system for beam focusing) and begin initial operation of each. Result: Each of the facilities was completed and brought into operation.	Conduct beam transport analysis for full current beams in HCX to provide a data base for "end to end" beam simulations.	Evaluate the effects of stray electrons on heavy ion beam instabilities by comparing results from the high current experiment (HCX) with calculations of beam transport through HCX.
	Carry out detailed comparisons of experimental measurements of turbulence in tokamak facilities with calculations made with codes enhanced under SciDAC.	Explore MHD equilibrium and stability in stellarators using linear and nonlinear global stability codes, including free-boundary and finite larmor radius effects. Compare code calculations with experimental results from international stellarators in preparation for the operation of NCSX.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Tokamak Experimental Research	45,479	48,609	46,340	-2,269	-4.7%
Alternative Concept Experimental Research	52,328	50,913	52,169	+1,256	+2.5%
Theory	27,628	27,608	28,508	+900	+3.3%
General Plasma Science	8,872	9,060	11,050	+1,990	+22.0%
SBIR/STTR	0	6,375	6,603	+228	+3.6%
Total, Science	134,307	142,565	144,670	+2,105	+1.5%

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Tokamak Experimental Research	**45,479**	**48,609**	**46,340**

The tokamak magnetic confinement concept has thus far been the most effective approach for confining plasmas with stellar temperatures within a laboratory environment. Many of the important issues in fusion science are being studied in an integrated program on the two major U.S. tokamak facilities, DIII-D at General Atomics and Alcator C-Mod at the Massachusetts Institute of Technology. Both DIII-D and Alcator C-Mod are operated as national science user facilities with research programs established through public research forums, program advisory committee recommendations, and peer review. There is also a very active program of collaboration with comparable facilities abroad aimed at establishing an international database of Tokamak experimental results. In association with the International Tokamak Physics Activity, both DIII-D and Alcator C-Mod will increase their efforts on joint experiments with other major facilities in Europe and Japan in support of ITER-relevant physics issues.

Both DIII-D and Alcator C-Mod will focus on using their flexible plasma shaping and dynamic control capabilities to attain good confinement and stability by controlling the distribution of current in the plasma with radio and microwave current drive and the interface between the plasma edge and the material walls of the confinement vessel by means of a "magnetic divertor." Achieving high performance regimes for longer pulse duration, approaching the steady state, will require simultaneous advances in all of the scientific issues listed above.

▪ **DIII-D Research**	**23,747**	**22,733**	**23,329**

The DIII-D tokamak is the largest magnetic fusion facility in the United States. DIII-D provides for considerable experimental flexibility and has extensive diagnostic instrumentation to measure what is happening in a high temperature plasma. It also has unique capabilities to shape the plasma, which, in turn, affects particle transport in the plasma and the stability of the plasma. DIII-D has been a major contributor to the world fusion program over the past decade in the areas of plasma turbulence, energy and particle transport, electron-cyclotron plasma heating and current drive, plasma stability, and boundary layer physics using a "magnetic divertor" to control the magnetic field configuration at the edge of the plasma. (The divertor is produced by magnet coils that bend the magnetic field at the edge of the tokamak out into a region where plasma particles following the field are neutralized and pumped away.)

The DIII-D experimental program contributes to all four key Magnetic Fusion Energy (MFE) fusion topical science areas—energy transport, stability, plasma-wave interactions, and boundary physics, and various thrust areas that integrate across topical areas to support the goal of achieving a burning plasma. The level of effort for most physics research topics in FY 2004 remains essentially flat from FY 2003, however, *there will be an increased effort on joint research topics in support of burning plasma physics, specifically for ITER. The research will elucidate the effects of plasma edge instabilities and high pressure in various plasma confinement regimes, extending the duration of stable plasma operation, and helping build cross-machine data bases using dimensionless parameter ("wind tunnel") techniques among other topics.*

	(dollars in thousands)	
FY 2002	FY 2003	FY 2004

The program will also continue the investigation of the scientific basis for optimization of the tokamak approach to fusion energy production. This research includes investigation of different modes of operation of fusion plasmas in the so-called Advanced Tokamak (AT) regime for enhancing the attractiveness of tokamak plasmas for energy production. In particular, the experimental program will aim at accomplishing the following three related research goals in FY 2004: 1) demonstrate the technical benefits of operating AT plasmas with a normalized beta (a measure of plasma pressure) value above the "standard" value, made possible by feedback control of new internal wall stabilization coils installed in FY 2003. The initial experiments in FY 2003 with these coils will set direction of the experiments in FY 2004. 2) Extend the "Negative Central Shear" mode of AT research to higher performance and long pulse plasmas using the 6 MW Ion Cyclotron Range Frequency (ICRF) system, and the 6 MW Electron Cyclotron Heating (ECH) system. The refurbishment and commissioning of the ICRF system, which was built about 4 years ago, will start in FY 2003, and it will be available for these experiments in FY 2004. This system will provide additional electron heating capability and improve the current drive provided by the ECH system. 3) Investigate further the physics of the Quiescent Double Barrier (QDB) AT regime, which was discovered in DIII-D 3 years ago. The QDB regime is attractive for steady-state operation of AT plasmas because of the absence of periodic heat pulses that impinge on divertor target plates. The activities in all these three areas are interrelated, and they will improve the physics basis and demonstration of a long-pulse, high-performance AT for energy production purposes.

	FY 2002	FY 2003	FY 2004
▪ **Alcator C-Mod Research**..	**7,479**	**8,464**	**8,458**

Alcator C-Mod is a unique, compact tokamak facility that uses intense magnetic fields to confine high-temperature, high-density plasmas in a small volume. It is also unique in the use of metal (molybdenum) walls to accommodate high power densities.

By virtue of these characteristics, Alcator C-Mod is particularly well suited to operate in plasma regimes that are relevant to future, much larger fusion tokamaks as well as to compact, high field, high density burning plasma physics tokamaks. Burning plasmas can be achieved for short pulses in a low cost tokamak by trading high magnetic field for large size (and cost). Alcator C-Mod has made significant contributions to the world fusion program in the areas of plasma heating, stability, and confinement in high field tokamaks, which are important integrating issues related to ignition and burning of a fusion plasma. In FY 2004 the C-Mod research effort is approximately level with that of FY 2003. However, *resources will be focused on ITER relevant topics such as understanding the physics of the plasma edge in the presence of large heat flows, measuring the effects of and mitigating disruptions in the plasma, controlling the current density profile for better stability, and helping build cross-machine data bases using dimensionless parameter ("wind tunnel") techniques*.

Research will also continue to examine the physics of the plasma edge, power and particle exhaust from the plasma, mechanisms of self-generation of plasma flows, and the characteristics of the Advanced Tokamak modes achieved when currents are driven by radio and microwaves. It will also focus on studying transport in the plasma edge at high densities and in relation to the plasma density limit. A diagnostic neutral beam will further improve visualization of turbulence in the edge and core of high density plasmas, and beam enabled diagnostics will shed light on the plasma physics of temperature and density profile pedestals whose features are now thought to predict future machine behavior. Active MHD spectroscopy is a novel method for sensing the onset of instability and will also be implemented in FY 2004. This diagnostic may well revolutionize the way a plasma discharge is feedback controlled to avoid disruptions. Compact high field tokamak regimes and operation scenarios required for ignition in compact devices will be further explored. The new lower hybrid (microwave) current drive system will be in operation, and experiments will begin using it for control of the current density profile.

	FY 2002	FY 2003	FY 2004
▪ **International Collaborations, Education and Other**	**7,158**	**10,255**	**7,540**

In addition to their work on domestic experiments, scientists from the United States participate in leading edge scientific experiments on fusion facilities abroad, and conduct comparative studies to enhance understanding of underlying physics. The Fusion Energy Sciences program has a long-standing policy of seeking collaboration internationally in the pursuit of timely scientific issues. Collaboration avoids duplication of facilities that exist abroad. These include the world's highest performance tokamaks (JET in England and JT-60 in Japan), a stellarator (the Large Helical Device) in Japan, a superconducting tokamak (Tore Supra) in France, and several smaller devices. In addition, the U.S. is collaborating with South Korea on the design of a long-pulse, superconducting, advanced tokamak (KSTAR). These collaborations provide a valuable link with the 80% of the world's fusion research that is conducted outside the U.S.

International collaboration will continue on unique tokamaks abroad. However, *the United States will reduce the international program activities in FY 2004 and focus on joint International Tokamak Physics Activity (ITPA) with Japan, Europe, and Russia to enhance collaboration on physics issues related to tokamak burning plasmas.* In FY 2004, the remaining direct collaboration with international programs will focus on ways of using the unique aspects of these facilities to make progress on the four key MFE Science issues cited in the Science Subprogram description. Funding for the relocation of personnel and facilities to a new location within ORNL has been transferred to the facility operations subprogram. Funding for educational activities in FY 2004 will support research at historically black colleges and universities, graduate and postgraduate fellowships in fusion science and technology, summer internships for undergraduates, and outreach efforts related to fusion science and technology.

	FY 2002	FY 2003	FY 2004
▪ **Experimental Plasma Research (Tokamaks)**.........................	**7,095**	**7,157**	**7,013**

Funding provided in this category, for FY 2004, will continue to support research on innovative tokamak experiments at universities and the development of diagnostic instruments.

The Electric Tokamak (ET) at UCLA will explore several new approaches to toroidal magnetic confinement using radio waves to drive plasma rotation and in order to achieve a very high plasma pressure relative to the applied magnetic field, which in turn will produce a deep magnetic well for good plasma confinement. Complementing the advanced tokamak research on DIII-D and Alcator C-Mod is the exploratory work on two university tokamaks. This has the prospect of leading to more efficient use of magnetized volume and steady-state plasma stability, with associated attractiveness in eventual fusion power applications. The goal of the High Beta Tokamak (HBT) at Columbia University is to demonstrate the feasibility of stabilizing instabilities in a high pressure tokamak plasma using a combination of a close-fitting conducting wall, plasma rotation, and active

	(dollars in thousands)	
FY 2002	FY 2003	FY 2004

feedback. This work is closely coordinated with the DIII-D program, and promising results have already been achieved on DIII-D.

Development of unique measurement capabilities (diagnostic systems) that provide an understanding of the plasma behavior in fusion research devices will continue. This research provides the necessary information for analysis codes and theoretical interpretation. Some key areas of diagnostic research include the development of: (1) techniques to measure the cause of energy and particle loss from the core to the edge of magnetically confined plasmas, including techniques aimed at understanding how barriers to heat loss can be formed in plasmas; (2) methods to measure the production, movement, and loss/retention of the particles that are needed to ignite and sustain a burning plasma; and (3) new approaches that are required to measure plasma parameters in alternate magnetic configurations, which add unique constraints due to magnetic field configuration and strength, and limited lines of sight into the plasma. The requested funding level in FY 2004 supports research that will enhance our understanding of critical plasma phenomena and the means of affecting these phenomena to improve energy and particle confinement in tokamaks and innovative confinement machines. *The funding will also support development of diagnostic systems related to the processes associated with burning plasmas, on U.S. and foreign facilities.* Currently supported programs were the highest ranked proposals submitted to a competitive peer review in FY 2002.

	FY 2002	FY 2003	FY 2004
Alternative Concept Experimental Research	**52,328**	**50,913**	**52,169**

The next largest research component is work on alternative concepts, aimed at extending fusion science and identifying concepts that may have favorable stability or transport characteristics that could improve the economic and environmental attractiveness of fusion energy sources. The largest element of the alternative concepts program is the NSTX at Princeton Plasma Physics Laboratory, which began operating in FY 2000. Like DIII-D and Alcator C-Mod, NSTX is also operated as a national scientific user facility.

	FY 2002	FY 2003	FY 2004
▪ **NSTX Research**	**12,780**	**13,696**	**15,951**

NSTX is one of the world's two largest embodiments of the spherical torus confinement concept. NSTX has a unique, nearly spherical plasma shape that complements the doughnut shaped tokamak and provides a test of the theory of toroidal magnetic confinement as the spherical limit is approached. Plasmas in spherical torii have been predicted to be stable even when high ratios of plasma-to-magnetic pressure and self-driven current fraction exist simultaneously in the presence of a nearby conducting wall bounding the plasma. If these predictions are verified in detail, it would indicate that spherical torii use applied magnetic fields more efficiently than most other magnetic confinement systems and could, therefore, be expected to lead to more cost-effective fusion power systems in the long term. An associated issue for spherical torus configurations is the challenge of driving plasma current via radio-frequency waves or biased electrodes. Such current drive techniques are essential to achieving sustained operation of a spherical torus.

The spherical torus plasma, as in all high beta plasmas, is uniquely characterized by high velocity fast ions and with a large radius of gyration relative to plasma size that could potentially lead to new plasma behaviors of interest. In FY 2004, increased funding will allow enhanced participations by national team members in several areas. Comparison of experimental results with theory will contribute to the scientific understanding of these effects needed to consider future experiments with similar energetic ion properties. Several new diagnostics that will become operational will be used on NSTX. Using these new diagnostics, assessment of long wavelength turbulence in the plasma core in a range of operating scenarios will also be undertaken. Additionally, measurement of current profile modifications from the applications of RF techniques, neutral beam injection, and the bootstrap effect will be pursued with measurement techniques suitable for low magnetic field devices. Finally, new measurement techniques using beams of energetic atoms and lasers will be employed to assess changes in the profile of the plasma current induced by radio-frequency waves, injected energetic neutral particles, and changes in the plasma pressure profile to determine how best to sustain large currents in spherical torii.

- **Experimental Plasma Research (Alternatives)** **25,955** **23,443** **22,721**

This budget category includes most of the experimental research on plasma confinement configurations outside of the three major national facilities described above. Funds in this category are provided for twelve small experiments, one intermediate level proof-of-principle experiment (reversed field pinch), and research in support of both the NCSX and QPS novel compact stellarator designs.

The goals of this work are to: a) find new innovative confinement schemes that have advantages when compared to the tokamak; b) find new innovative ways of increasing the plasma performance of advanced confinement schemes like the tokamak, stellarator, or reversed field pinch; and c) find innovative ways to study in an isolated manner key issues of plasma behavior, such as reconnection or turbulence. All these efforts are to be done on small, low cost experimental devices.

The Innovative Confinement Concept (ICC) development program is a broad-based activity with researchers located at national laboratories, universities, and industry. Because of the small size of the experiments and the use of the latest technologies, these small-scale experiments provide excellent places to train students and post-docs, and develop the next generation of fusion scientists who will need to explore the next frontier of fusion research, burning plasma.

For example, the Madison Symmetric Torus at the University of Wisconsin is a toroidal configuration with high current but low toroidal magnetic field that reverses direction near the edge of the discharge. The magnetic dynamo effect, which results from turbulent processes inside the plasma, spontaneously generates the field reversal at the plasma edge. This innovative experiment is investigating the dynamo mechanism, which is of interest to several fields of science including space and astrophysics, and turbulent transport, which is of interest to fusion science. The Levitated Dipole Experiment, a joint Massachusetts Institute of Technology/Columbia University program is exploring plasma confinement in a novel magnetic dipole configuration (similar to the magnetic fields constraining plasma in the earth's magnetosphere). At the Princeton Plasma Physics Laboratory, the Magnetic Reconnection Experiment addresses fundamental questions in magnetic reconnection, the process by which currents and flows in a plasma can induce changes in the topology of the magnetic field by breaking and reconnecting magnetic field lines. Magnetic reconnection is important not only in fusion experiments but also in phenomena like the solar flares, the solar wind and astrophysical plasmas.

	(dollars in thousands)	
FY 2002	FY 2003	FY 2004

A different set of insights into stability properties of plasmas should be developed from investigations into new stellarator configurations taking advantage of advances in stellarator theory, new computational capabilities, and insights from recent tokamak research. These stellarator configurations are nearly axisymmetric (like a tokamak) but do not require an externally driven current to produce an equilibrium. Thus, they should have transport properties similar to a tokamak but should have different stability properties. A national team is working on the design of a medium-size National Compact Stellarator Experiment (NCSX) that would be used to study plasma turbulence, energy and particle transport, and stability in this novel geometry. Another design, the Quasi-Poloidal Stellarator (QPS), using an even more radical approach, is being pursued at ORNL. This design is based on a different symmetry to achieve an even more compact configuration. Both approaches will strengthen U.S. involvement in the much larger world stellarator program.

The magnetized target fusion program (funded by the FES program) at LANL and the Air Force Research Laboratory will study the possibility that a field reversed configuration plasma can be compressed to multi-keV temperatures using fast liner compression technology developed by NNSA's Defense Programs.

The key to success in this program is to be continually generating new innovative ideas. In order to foster a vigorous breeding ground for these kinds of ideas, each year approximately 1/3 of the concepts will be competitively peer reviewed. This review will be used to weed out the concepts that have not been able to follow through with their initial innovative ideas, and to find new innovative ideas that can be pursued in small experiments. The review will affect the innovative confinement concepts program in FY 2004. It is anticipated that there will be some changes in the program.

- **Inertial Fusion Energy Experiments**...................................... **13,593** **13,774** **13,497**

An entirely different set of science explorations is being carried out in the area of inertial fusion. In pursuing this science, the IFE activity is exploring an alternate path for fusion energy that would capitalize on the major R&D effort in inertial confinement fusion (ICF) carried out for stockpile stewardship purposes within the NNSA Office of Defense Programs. In assessments of IFE carried out by several committees and study groups in the past, heavy ions were recommended as the optimum driver for inertial fusion energy, with lasers as possible alternatives. Based on these assessments, heavy ions define the focus for the FES program. However, there have been recent advances in energy producing target design and high average power laser technology. In the NNSA inertial confinement program, there is a dual use program for high average power lasers that has inertial fusion energy relevance. Within the FES program, there are some elements that support innovation in IFE (fast ignitor science, for example) with relevance to laser driven IFE and there are commonalities in technology areas in target chambers and target technologies that are coordinated between FES and NNSA. The IFE program depends on the ICF program for experimental research into the high energy density physics required for the design of energy producing targets and for future testing of the viability of IFE targets in the National Ignition Facility at LLNL.

The inertial fusion energy program is focused on understanding the physics of systems that will be needed to produce a viable inertial fusion energy source. These include heavy ion beam systems for heating and compressing a target pellet to fusion conditions, the experimental and theoretical scientific basis for modeling target chamber responses, and the physics of high-gain targets.

Heavy ion accelerators continue to be the leading IFE driver candidate. The physics of intense heavy ion beams (multiply charged Bismuth, for example) and other non-neutral plasmas are both rich and subtle, due to the kinetic and nonlinear nature of the systems and the wide range of spatial and temporal scales involved. For these reasons, heavy ion beam physics is of interest to the larger accelerator and beam physics community. The modeling of the fusion chamber environment is very complex and must include multi-beam, neutralization, stripping, beam and plasma ionization processes, and return current effects.

Considerable progress has been made on developing a predictive physics model for intense heavy ion beams. This model, which includes aspects of the accelerator system, has the goal of providing an "end to end" simulation of a heavy ion accelerator. The close interplay between scaled experiments and theory and calculation assures that the model has been validated against experiment. Technical elements of the program include the continuing development of experimental systems to study beam formation by high current ion sources, beam acceleration and focusing. In FY 2004, the High Current Experiment (HCX) will do experiments to simulate ion bunch control with electrostatic and magnetic focusing elements. The dynamics of stray electrons will be studied, and results used to compare with beam simulation calculations. The neutralized focus experiments using the facility jointly developed by PPPL and LBNL will be completed. New ion beamlet acceleration tests will be completed to obtain beamlet characteristics. Physics experiments carried out on NNSA-funded facilities including (in the future) the National Ignition Facility (NIF) will provide high energy density physics data to be used in the design of targets for IFE experiments. Experiments on NIF will provide validation of target design for actual model targets. The IFE science program will be focused on scientific and technical elements that will allow progress toward future integrated experiments.

	FY 2002	FY 2003	FY 2004
Theory	**27,628**	**27,608**	**28,508**

The theory and modeling program provides the conceptual underpinning for the fusion sciences program. Theory efforts meet the challenge of describing complex non-linear plasma systems at the most fundamental level. These descriptions range from analytic theory to highly sophisticated computer simulation codes, both of which are used to analyze data from current experiments, guide future experiments, design future experimental facilities, and assess projections of their performance. Analytic theory and computer codes represent a growing knowledge base that, in the end, is expected to lead to a predictive understanding of how fusion plasmas can be sustained and controlled.

The theory and modeling program is a broad-based program with researchers located at national laboratories, universities, and industry. Institutional diversity is a strength of the program, since theorists at different types of institutions play different roles in the program. Theorists in larger groups, which are mainly at national laboratories and industry, generally support major experiments, work on large problems requiring a team effort, or tackle complex issues requiring a multidisciplinary teams while those at universities generally support smaller, innovative experiments or work on more fundamental problems in plasma physics.

The theory program is composed of four elements—tokamak theory, alternate concept theory, generic theory, and advanced computation. The main thrust of the work in tokamak theory is aimed at

	(dollars in thousands)	
FY 2002	FY 2003	FY 2004

developing a predictive understanding of advanced tokamak operating modes and burning plasmas, both of which are important to ITER. These tools are also being extended to innovative or alternate confinement geometries. In alternate concept theory, the emphasis is on understanding the fundamental processes determining equilibrium, stability, and confinement in each concept. The generic theory work supports the development of basic plasma theory and atomic physics theory that is applicable to fusion research and to basic plasma science. A separate modeling effort is dedicated to developing computational tools to assist in the analysis of experimental data.

An important element of the theory and modeling program is the FES portion of the Office of Science's Scientific Discovery through Advanced Computing (SciDAC) program. Major scientific challenges exist in many areas of plasma and fusion science that can best be addressed through advances in scientific supercomputing. Projects currently underway are focused on understanding and controlling plasma turbulence, investigating the physics of magnetic reconnection, understanding and controlling magnetohydrodynamic instabilities in magnetically confined plasmas, simulating the propagation and absorption of radio waves in magnetically confined plasmas, and understanding atomic physics in the edge region of plasmas.

In FY 2004 the theory and computation program will continue to emphasize advanced computing and will make use of rapid developments in computer hardware to attack complex problems involving a large range of scales in time and space. These problems were beyond the capability of computers in the past, but advancements in computation are allowing a new look at problems that once seemed almost intractable. The objective of the advanced computing activities, including the SciDAC program, is to promote the use of modern computer languages and advanced computing techniques to bring about a qualitative improvement in the development of models of plasma behavior. This will ensure that advanced modeling tools are available to support the preparations for a burning plasma experiment, a set of innovative national experiments, and fruitful collaboration on major international facilities. Through the middle of FY 2004, computational efforts will be focused on comparison of experimental results with turbulence calculations, that include kinetic electrons, the inclusion of the plasma's self-generated currents, and flows in gross stability simulations, simulation of the propagation and absorption of short wavelength waves in magnetized plasmas, and improved simulations of magnetic reconnection. These additions will improve the fidelity of the simulations and provide the basis for developing a more comprehensive predictive understanding of fusion plasmas, which will be of great value in planning for a burning plasma experimental program in ITER. *In addition, the FES program will initiate a new "Centers of Excellence in Fusion Science" program in FY 2004. This action responds to a recommendation from the NRC assessment report. It is anticipated that no more than 2 centers will be funded.* Continuation of this effort in the future could lead to a more comprehensive capability that would pave the way to improved utilization of ITER and enhanced scientific understanding from ITER.

	FY 2002	FY 2003	FY 2004
General Plasma Science	**8,872**	**9,060**	**11,050**

The general plasma science program is directed toward basic plasma science and engineering research. This research strengthens the fundamental underpinnings of the discipline of plasma physics, which makes contributions in many basic and applied physics areas, one of which is fusion energy. Principal investigators at universities, laboratories and private industry carry out the research. A critically important element is the education of plasma physicists. Continuing elements of this program are the

	(dollars in thousands)	
FY 2002	FY 2003	FY 2004

NSF/DOE Partnership in Basic Plasma Science and Engineering, the Junior Faculty in Plasma Physics Development program and the basic and applied plasma physics program at DOE laboratories. In FY 2004, the program will continue to fund proposals that have been peer reviewed. *In addition, Fusion Energy Sciences will initiate a new "Centers of Excellence in Fusion Science" program in FY 2004. This action responds to a recommendation from the NRC assessment report. It is anticipated that no more than 2 centers will be funded.* A major joint announcement of opportunity in basic plasma physics will be held in 2003 under the NSF/DOE Partnership. Basic plasma physics user facilities will be supported at both universities and laboratories. Atomic and molecular data for fusion will continue to be generated and distributed through openly available databases. The Office of Fusion Energy Sciences will continue to share the cost of funding plasma physics frontier science centers funded by NSF.

	FY 2002	FY 2003	FY 2004
SBIR/STTR	**0**	**6,375**	**6,603**

The FY 2002, FY 2003 and FY 2004 amounts are the estimated requirements for the continuation of these programs.

	FY 2002	FY 2003	FY 2004
Total, Science	**134,307**	**142,565**	**144,670**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Tokamak Experimental Research	
▪ Funding for DIII-D research in the Science subprogram has increased marginally to cover research preparations and data analysis needs.	+596
▪ A slight decrease in funding for the Alcator C-Mod.	-6
▪ Funding for support of studies using International Facilities is reduced and redirected to higher priority FES activities.	-1,194
▪ Funding for the relocation of personnel and facilities to a new location at ORNL has been transferred to the Facilities Operations subprogram.	-1,521
▪ Funding for Experimental Plasma Research (Tokamaks) has been marginally reduced to cover higher priority activities.	-144
Total, Tokamak Experimental Research	-2,269
Alternative Concept Experimental Research	
▪ Funding for NSTX research is increased to provide for additional data analysis and research in support of operations	+2,255
▪ Funding for Experimental Plasma Research is reduced and redirected to higher priority FES activities.	-722
▪ Funding for IFE is reduced and redirected to higher priority FES activities. The rate of progress in ion source development will be slowed.	-277
Total, Alternative Concept Experimental Research	+1,256

	FY 2004 vs. FY 2003 ($000)
Theory	
▪ Funding is increased for studies of innovative concepts and burning plasma physics.	+900
General Plasma Science	
▪ Funding is increased for initiation of "Centers of Excellence in Fusion Science", with 1-2 new centers.	+1,990
SBIR/STTR	
▪ Support for SBIR/STTR is provided at the mandated level.	+228
Total Funding Change, Science	**+2,105**

Facility Operations

Mission Supporting Goals and Measures

The Facility Operations subprogram manages the operation of the major fusion research facilities and the fabrication of new projects to the highest standards of overall performance, using merit evaluation and independent peer review. The facilities will be operated in a safe and environmentally sound manner, with high efficiency relative to the planned number of weeks of operation, with maximum quantity and quality of data collection relative to the installed diagnostic capability, and in a manner responsive to the needs of the scientific users. In addition, fabrication of new projects and upgrades of major fusion facilities will be accomplished in accordance with highest standards and with minimum deviation from approved cost and schedule baselines.

This activity provides for the operation, maintenance and enhancement of major fusion research facilities; namely, DIII-D at General Atomics, Alcator C-Mod at MIT, and NSTX at PPPL. These user facilities enable U.S. scientists from universities, laboratories, and industry, as well as visiting foreign scientists, to conduct world-class research funded in the Science and Enabling R&D subprograms. The facilities consist of magnetic plasma confinement devices, plasma heating and current drive systems, diagnostics and instrumentation, experimental areas, computing and computer networking facilities, and other auxiliary systems. The Facility Operations subprogram provides funds for operating and maintenance personnel, electric power, expendable supplies, replacement parts, system modifications and facility enhancements. In FY 2004, funding is requested to operate the major fusion facilities at a level of 84% of full utilization.

Funding is also provided for the continuation of the National Compact Stellarator Experiment (NCSX) Major Item of Equipment project at PPPL. In FY 2004, the project will be in its second year, following the FY 2003 request for project start, and FY 2004 funding will support the final design activities and initial procurements of hardware.

Funding is also provided for ITER transitional activities, in which U.S. scientists and engineers will be involved in various technical activities that support both ITER negotiations for a construction project as well as preparations for eventual project construction.

Funding is also included in this subprogram for general plant projects (GPP) and general purpose equipment (GPE) at PPPL. GPP and GPE funding supports essential facility renovations and other necessary capital alterations and additions to buildings and utility systems. Funding is also provided for the move of ORNL personnel and facilities to a new location at ORNL.

FACILITY OPERATIONS ACCOMPLISHMENTS

In FY 2002, funding was provided to operate facilities in support of fusion research experiments and to upgrade facilities to enable further research in fusion and plasma science. Examples of accomplishments in this area include:

- The DIII-D completed the majority of the installation of a new system of Resistive Wall Mode stabilization coils to provide for increased control of the fusion plasma in real-time. Also, 5 Electron Cyclotron Heating power systems were operated simultaneously into the DIII-D plasma, and this will enable higher performance plasma operation in the future.

- Upgrades to improve the performance capability of NSTX were completed successfully. A real-time digital control system was added to provide precision control of the coil systems and enable improved control of the fusion plasma. The vacuum vessel bakeout temperature was upgraded to 350 degrees, thereby providing for the creation of cleaner plasma in a shorter time than for the current system. The Coaxial Helical Injection system for injecting fuel particles was installed on NSTX, and initial operation to form a plasma was successful.
- In accordance with previous advice from technical experts to periodically inspect the Alcator C-Mod coil system, MIT personnel disassembled the device, performed the inspection, and confirmed coil system integrity. The device was re-assembled and returned to full operation. The C-Mod Lower Hybrid heating system remains on track for completion in FY 2003. A new diagnostic neutral beam was added to improve plasma characterization.
- The TFTR decontamination and decommissioning (D&D) activities at PPPL were completed successfully within cost and schedule.

Subprogram Goals

Operate major fusion facilities for specified number of weeks.

For facility upgrades and new projects accomplish cost and schedule targets**.**

Performance Indicator

Average operational downtime of FES facilities will not exceed 10% of total time scheduled and construction and upgrades of facilities will be within 10% of baseline schedule.

Annual Performance Results and Targets

FY 2002 Results		FY 2003 Request Targets		FY 2004 Targets	
Operate DIII-D	12 weeks vs. 14 weeks planned	Operate DIII-D	21 weeks	Operate DIII-D	21 weeks
Operate Alcator C-Mod	8 weeks	Operate Alcator C-Mod	21 weeks	Operate Alcator C-Mod	21 weeks
Operate NSTX	12 weeks	Operate NSTX	21 weeks	Operate NSTX	21 weeks
For TFTR, completed the project on cost and on schedule.					
		For NCSX, complete Preliminary Design.		For NCSX, complete the Final Design and begin hardware procurement.	
		For Alcator C-Mod, complete Lower Hybrid project.			

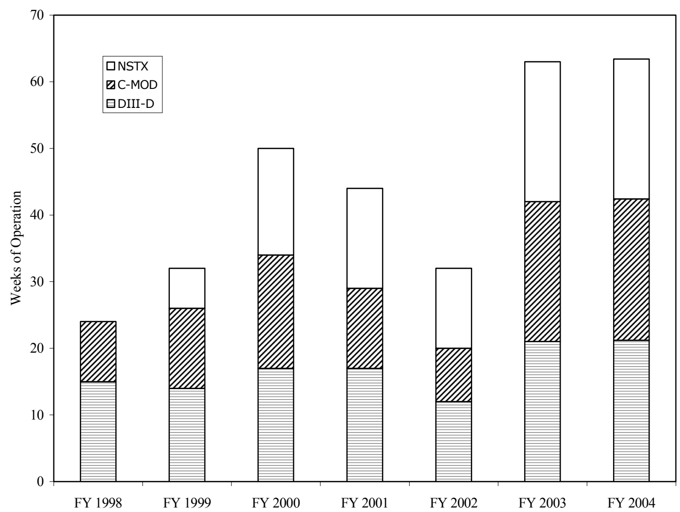
The table below summarizes the longer-term history of operation of the major fusion facilities.

Weeks of Fusion Facility Operation

(Weeks of Operations)

	FY 2002 Actual	FY 2003 Request	FY 2004
DIII-D	12	21	21
Alcator C-Mod	8	21	21
NSTX	12	21	21
Total	32	63	63

Recent operating history of major fusion experimental facilities



Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
TFTR	15,794	0	0	0	--
DIII-D	27,184	32,909	33,336	+427	+1.3%
Alcator C-Mod	10,095	13,789	14,249	+460	+3.3%
NSTX	15,241	19,446	19,237	-209	-1.1%
NCSX	0	11,026	15,921	+4,895	+44.4%
ITER	0	0	1,990	+1,990	--
GPP/GPE/Other	2,489	1,483	2,993	+1,510	+101.8%
Total, Facility Operations	70,803	78,653	87,726	+9,073	+11.5%

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
TFTR	**15,794**	**0**	**0**

The TFTR Decontamination and Decommissioning (D&D) activity was completed in FY 2002.

DIII-D	**27,184**	**32,909**	**33,336**

Provide support for operation, maintenance, and improvement of the DIII-D facility and its auxiliary systems. The improvements include replacement of two microwave heating tubes. In FY 2004, these funds support 21 weeks of single shift plasma operation during which time essential scientific research will be performed as described in the science subprogram.

Alcator C-Mod	**10,095**	**13,789**	**14,249**

Provide support for operation, maintenance, and minor machine improvements. The improvements include additional diagnostics and preparations for heating system additions. In FY 2004, these funds support 21 weeks of single shift plasma operation during which time essential scientific research will be performed as described in the science subprogram.

NSTX	**15,241**	**19,446**	**19,237**

Provide support for operation, maintenance, and improvement of the NSTX facility and installation of planned diagnostic upgrades. In FY 2004, these funds support 21 weeks of single shift plasma operation. The FY 2004 budget will continue to support preventive maintenance and purchase of critical spare parts to minimize down time and improve facility reliability. In addition, new hardware will be installed to optimize research output. This includes an improved resonant field control system, a prototype microwave scattering system to measure high-k fluctuations, an imaging diagnostic for edge helium emission, and an array of absolutely calibrated x-ray detectors for Lyman-alpha emission from the divertor.

NCSX	**0**	**11,026**	**15,921**

Funding in the amount of $15,921,000 is requested for the continuation of the National Compact Stellarator Experiment (NCSX) Major Item of Equipment, which was initiated in FY 2003 and consists of the design and fabrication of a compact stellarator proof-of-principle class experiment. These funds will allow completion of the final design of most systems and the procurement of long lead-time items. This fusion confinement concept has the potential to be operated without plasma disruptions, leading to power plant designs that are simpler and more reliable than those based on the current lead concept, the tokamak. The NCSX design will allow experiments that compare confinement and stability in tokamak and stellarator configurations. The preliminary total estimated cost (TEC) of NCSX is $73,500,000, with completion scheduled for FY 2007. When the preliminary design is completed at the end of FY 2003, the cost and schedule baseline will be established.

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
ITER	**0**	**0**	**1,990**

Funding in the amount of $1,990,000 is provided to initiate ITER transitional activities such as licensing, project management, preparation of final specifications and system integration. U.S. personnel will participate in these activities in preparation for eventual project construction.

General Plant Projects/General Purpose Equipment/Other	**2,489**	**1,483**	**2,993**

These funds provide primarily for general infrastructure repairs and upgrades for the PPPL site based upon quantitative analysis of safety requirements, equipment reliability and research needs. Funds also provide for the move of ORNL personnel and facilities to a new location at ORNL.

Total, Facility Operations	**70,803**	**78,653**	**87,726**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
DIII-D	
▪ Funding is approximately the same. The number of weeks of operation, 21, is unchanged from the FY 2003 request and the supporting activities such as maintenance, enhancement and repair are also unchanged.	+427
Alcator C-Mod	
▪ Funding is approximately the same. The number of weeks of operation, 21, is unchanged from the FY 2003 request and the supporting activities such as maintenance, enhancement and repair are also unchanged.	+460
NSTX	
▪ Funding is approximately the same. The number of weeks of operation, 21, is unchanged from the FY 2003 request. However, there is a modest reduction in facility enhancements in FY 2004 relative to FY 2003..	-209
NCSX	
▪ Funding is increased consistent with project needs to design and procure hardware for the NCSX project at PPPL. The level of design activity on key components, such as the magnets and vacuum vessel, will increase in order to keep the projection of schedule	+4,895
ITER	
▪ Funding is increased due to the start of this new activity which provides for preparatory ITER activities...	+1,990

	FY 2004 vs. FY 2003 ($000)
GPP/GPE/Other	
▪ Funding is increased to provide necessary improvements in the PPPL infrastructure and to move ORNL fusion personnel and facilities to a new location at ORNL.	+1,510
Total Funding Change, Facility Operations	**+9,073**

Enabling R&D

Mission Supporting Goals and Measures

The Enabling R&D subprogram develops the cutting edge technologies that enable both U.S. and international fusion research facilities to achieve their goals.

The Engineering Research element addresses the breadth and diversity of domestic interests in enabling R&D for magnetic fusion systems as well as international collaborations that support the mission and objectives of the FES program. The activities in this element focus on critical technology needs for enabling both current and future U.S. plasma experiments to achieve their research goals and full performance potential in a safe manner, with emphasis on plasma heating, fueling, and surface protection technologies. While much of the effort is focused on current devices, a significant amount of the research is specifically focused on future burning plasma experiments. The R&D effort on these technologies involves evolutionary development advances in present day capabilities that will make it possible to enter new plasma experiment regimes, such as burning plasmas. These nearer-term technology advancements also enable international technology collaborations that allow the United States to access plasma experimental conditions not available domestically. This element includes investigation of scientific issues for innovative technology concepts that could make revolutionary changes in the way that plasma experiments are conducted, such as liquid surface approaches to control of plasma particle density and temperature, microwave generators with tunable frequencies and steerable launchers for fine control over plasma heating and current drive, magnet technology which could improve confinement. This element also includes safety research which allows us to conduct both current and future experiments in an environmentally sound and safe manner.

Another activity is conceptual design of the most scientifically challenging systems for next-step fusion research facilities, i.e. facilities that may be needed in the immediate future. Also included are analysis and studies of critical scientific and technological issues, the results of which will provide guidance for optimizing future experimental approaches and for understanding the implications of fusion research on applications to fusion energy. In the past, longer term basic research on future magnetic and inertial fusion energy chamber concepts were conducted in this element, however, those programs are now being terminated and the funding for this category will be used for an orderly closeout of all activities.

The Materials Research element focuses on the key science issues of materials for practical and environmentally attractive uses in fusion research and future facilities. This element continues to strengthen its modeling and theory activities, which makes it more effective at using and leveraging the substantial work on nanosystems and computational materials science being funded by BES, as well as more capable of contributing to broader materials research in niche areas of materials science. Through a variety of cost-shared international collaborations, this element conducts irradiation testing of candidate fusion materials in the simulated fusion environments of fission reactors to provide data for validating and guiding the development of models for the effects of neutron bombardment on the microstructural evolution, damage accumulation, and property changes of fusion materials. This collaborative work supports both near-term fusion devices, such as a burning plasma experiment, as well as other future fusion experimental facilities. In addition, such activities support the long-term goal of developing experimentally validated predictive and analytical tools that can lead the way to nano-scale design of advanced fusion materials with superior performance and lifetime.

Management of the diverse and distributed collection of fusion enabling R&D activities is being accomplished through a Virtual Laboratory for Technology, with community-based coordination and communication of plans, progress, and results.

In FY 2002, a series of retrospective peer reviews by independent experts was completed of the scientific and technical quality, progress, and relevance of each element of the Enabling R&D subprogram. Summary reports of reviewer panel members' findings and recommendations, along with community action plans to address the most significant findings and recommendations, can be viewed on the Virtual Laboratory for Technology website at http://vlt.ucsd.edu/peer.html. Although most elements of this subprogram were determined to rank highly in most aspects of quality, progress, and relevance, steps have been taken to make improvements in all areas of concern to the reviewers.

ENABLING R&D ACCOMPLISHMENTS

A number of technological advances were made in FY 2002. Examples include:

- Scientists at Sandia National Laboratory achieved record levels of performance in proposed high heat flux components for future burning plasma experiments. The ability to reliably remove high levels of surface heat deposited by burning plasmas, while not deteriorating rapidly or contaminating the plasma with impurities, is a major technology issue for the plasma facing components. The levels of surface heat flux expected on some plasma facing components can reach as high as those observed in rocket nozzles. In testing done on water-cooled tungsten-copper mockups of proposed high heat flux components, the mockups sustained some of the highest levels of heat flux expected in burning plasma experiments for thousands of heating cycles without damage. This testing demonstrated the viability of this concept, with future research aimed at extending performance limits and testing tolerances to off-normal events.
- Scientists at Princeton Plasma Physics Laboratory, University of California San Diego, and Sandia National Laboratory continued to observe encouraging results in experiments in a toroidal plasma to investigate the phenomenon of plasma contact with liquid surfaces and to guide development of models for plasma-liquid interactions critical to research on innovative concepts for plasma particle and surface heat flux removal. Such capabilities could be readily used for scientific studies in plasma experiments to control key parameters of the plasma edge, such as plasma particle density and temperature, and to carry away intense surface heat locally deposited by the plasma at its edge. For the longer-term, liquid surface technology can provide for much longer lifetimes and higher performance plasma-facing components than is possible with conventional solid surface approaches.
- Researchers at Oak Ridge National Laboratory, University of California Los Angeles, University of California Santa Barbara, Princeton University, and Lawrence Livermore National Laboratory continued to make significant progress in developing models for micro-structural evolution in candidate fusion materials under simulated conditions associated with fusion. These models unify and integrate the theories on mechanisms that control damage production from energetic neutron bombardment. Also, the models enable nanosystem methods for designing fusion materials with significantly improved performance and lifetimes, and with elemental tailoring that minimizes radioactivity generation by neutron-induced transmutation. The ability to produce superior materials for fusion applications is critical to the viability of using fusion energy for practical applications with benign environmental impacts.
- Researchers at Oak Ridge National Laboratory and Princeton Plasma Physics Laboratory completed the design and fabrication of the prototype of a high power radio frequency antenna that will enable increased levels of plasma heating. The prototype, which is to be tested in FY 2003, will validate the

design, performance, and fabrication techniques of antennae to be built for use in the Joint European Torus plasma experiment. These antennae will provide the world's most powerful radio frequency plasma heating capability, and will permit investigation into advanced modes of fusion-relevant plasma performance.

Subprogram Goals

Develop the cutting edge technologies that enable FES research facilities to achieve their scientific goals and allow the U.S. to enter into international collaborations that enable access to plasma experiment conditions not available domestically.

Advance the science base for innovative materials to establish the technical feasibility of fusion energy and to enable fusion to reach its full potential as an environmentally and economically attractive energy source.

Performance Indicator

Percentage of milestones met for installing components developed by the Enabling R&D program on existing experimental devices.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Complete design and fabrication of at least one cutting edge technology that enables a FES research facility to achieve its scientific goals and/or allows the U.S. to enter into an international collaboration enabling access to plasma experiment conditions not available domestically. (goal met)	Initiate installation and begin testing of at least one cutting edge enabling technology.	Complete testing of at least one cutting edge enabling technology.
Complete preliminary investigation of at least one innovative technology that can create a more attractive vision of fusion energy systems. (goal met)	Design and install a liquid lithium limiter on CDX-U for testing as an advanced particle control/high heat flux handling system.	Complete closeout activities of all work on MFE and IFE chamber technologies.
Establish preliminary science base for at least one innovative low activation, high performance structural material that can validate the technical feasibility of fusion energy and enable fusion to reach its full potential as an attractive energy source. (goal met)	Complete initial experimental and modeling investigations of at least one innovative low activation, high performance structural material.	Identify elemental composition and fabrication methods through nanoscience methods to improve the performance and lifetime of at least one low activation structural material system.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Engineering Research	28,814	28,454	17,314	-11,140	-39.2%
Materials Research	7,176	7,638	7,600	-38	-0.5%
Total, Enabling R&D	35,990	36,092	24,914	-11,178	-31.0%

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Engineering Research	**28,814**	**28,454**	**17,314**
▪ **Plasma Technology**	**12,023**	**12,092**	**13,986**

Plasma Technology efforts will be focused on critical needs of domestic plasma experiments *and on the scientific foundations of innovative technology concepts for use in ITER.* Nearer-term experiment support efforts will be oriented toward plasma facing components and plasma heating and fueling technologies. Building on the testing in FY 2003 of a prototype radio frequency antenna—that will enable JET to build a powerful plasma heating device workable under rapidly changing plasma parameters—the detailed design of a similar high performance antenna will be completed for C-Mod in FY 2004. Based on the experimental research and design assessment in FY 2003 for a first-generation liquid metal system that allows lithium to interact directly with the plasma in a controlled way, the preliminary design of a lithium module for future deployment in NSTX will be initiated in FY 2004. This new plasma-facing component technology has the potential to revolutionize the approach to plasma particle density and edge temperature control in plasma experiments. Development and testing will continue for an advanced 1.5 million watt microwave generator that will efficiently heat plasmas to high temperatures, with 60% efficiency to be demonstrated in tests planned for FY 2004. Following completion in FY 2003 of the Safety and Tritium Applied Research (STAR) Facility at INEEL, material science experiments will be fully underway at STAR under a cost-sharing collaboration with Japan to resolve key issues of tritium behavior in different materials proposed to be used in fusion systems. *Additional funding will be provided to allow the STAR facility to undertake safety research for both current devices and* for ITER. Funds will be provided to continue superconducting magnet research, and innovative technology research in the area of plasma-surface interaction sciences that will enable fusion experimental facilities to achieve their major scientific research goals and full performance potential.

▪ **Fusion Technology**	**10,563**	**10,906**	**1,338**

Fusion Technology efforts such as liquid metal analysis and experiments, which were focused on basic research on future MFE and IFE chamber concepts, are being terminated to provide resources for higher priority and nearer term activities. Funding for this category will be used for an orderly closeout of all activities. With the completion in FY 2003 of the tritium inventory reduction and stabilization at TSTA, TSTA transfer to EM will have been completed by the start of FY 2004.

▪ **Advanced Design**	**6,228**	**5,456**	**1,990**

Funding for this element will focus on design studies of systems for next-step plasma science experiment options. The FIRE design effort will be completed in FY 2003. Systems science studies to assess both the research needs underlying achievement of the safety, economics, and environmental characteristics and the prospects of possible advanced magnetic confinement concepts will be conducted in an iterative fashion with the experimental community.

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Materials Research	**7,176**	**7,638**	**7,600**

Materials Research remains a key element of establishing the scientific foundations for safe and environmentally attractive uses of fusion. Through a wide variety of modeling and experiment activities aimed at the science of materials behavior in fusion environments, research on candidate materials for the structural elements of fusion chambers will continue. Priorities for this work are based on the innovative approaches to evaluating materials and improved modeling of materials behavior that were adopted as a result of recommendations from the FESAC review completed in 1998. Investigations of experimentally-validated models that can predict and quantify embrittlement produced by fusion environments of body centered cubic metals, the crystal structure of the most promising structural materials for fusion chambers, is expected to lead in FY 2004 to a Master Curve model that is based on successful approaches taken in other material science research programs. Also during FY 2004, the first phase of a cost-shared collaborative program with Japan for irradiation testing of fusion materials in a U.S. fission reactor (HFIR) will be completed, providing key data to evaluate the effects of neutron bombardment on the microstructural evolution, damage accumulation, and property changes of fusion materials that could be used in next step devices. In addition, results will be available on testing of nanocomposited ferritic steels with alloy compositions and fabrication techniques designed through nanoscience methods to operate at high temperatures without significant deformation by creep mechanisms.

Total, Enabling R&D	**35,990**	**36,092**	**24,914**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Engineering Research	
▪ Plasma Technology funding is increased due to the move of the safety and tritium research program to this category.	+1,894
▪ Funding for TSTA is terminated following completion in FY 2003 of work to clean up the facility prior to turning it over to the Office of Environmental Management for Decontamination and Decommissioning. Funding for other fusion technologies activities is decreased to meet higher priority budget needs in facility operations in preparation for participation in ITER.	-9,568
▪ Advanced Design funding is reduced in order to meet higher priority budget needs in facility operations in preparation for participation in ITER.	-3,466
Total, Engineering Research	-11,140
Materials Research	
▪ Funding is reduced due to completion of a task on irradiation testing in the HFIR reactor in FY 2003.	-38
Total Funding Change, Enabling R&D	**-11,178**

Capital Operating Expenses & Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
General Plant Projects	2,149	995	1,415	+420	+42.2%
Capital Equipment	7,411	15,774	20,089	+4,315	+27.4%
Total, Capital Operating Expenses	9,560	16,769	21,504	+4,735	+28.2%

Major Items of Equipment *(TEC $2 million or greater)*

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior Year Approp-riations	FY 2002	FY 2003	FY 2004	Accept-ance Date
DIII-D Upgrade	27,225	27,203	22	0	0	FY 2001
Alcator C-Mod LH Modification	5,200	2,966	1,505	1,019[a]	0	FY 2003
NCSX	73,500[b]	0	0	11,026	15,921	FY 2007
Total, Major Items of Equipment		30,169	1,527	12,045	15,921	

[a] During FY 2003 execution, this funding will be reduced to $729,000 to accommodate funding acceleration in FY 2002 and to retain the TEC of $5,200,000. The $1,019,000 presently in this column is the FY 2003 President's Request funding amount.

[b] The preliminary TEC has increased from $69,000,000 to $73,500,000 based on the recently completed conceptual design activities, which demonstrated that more contingency funds are needed for fabricating the highest risk components. The estimates will be improved as the preliminary design activities are completed in FY 2003 at which time the cost baseline will be set.

Safeguards and Security

Program Mission

The mission of the Office of Science (SC) Safeguards and Security program is to ensure appropriate levels of protection against: unauthorized access, theft, diversion, loss of custody or destruction of Department of Energy (DOE) assets and hostile acts that may cause adverse impacts on fundamental science, national security or the health and safety of DOE and contractor employees, the public or the environment. Each site has a tailored protection program as analyzed and defined in each site's Computer Security Program Plan (CSPP) or other appropriate plan. SC's Integrated Safeguards and Security Management (ISSM) strategy encompasses a graded approach to safeguards and security. ISSM will promote individual ownership and essential security performance at all Office of Science facilities. ISSM is not a standard, nor is it a new program; rather it is a set of principles and a formal methodology that is the basis of integrated management of security in all work practices at all levels by all DOE/SC employees. ISSM is intended to assist in weaving together existing programs into a "system" that has as its foundation personal responsibility, and including security in all work practices. This approach will enable each facility to design varying degrees of protection commensurate with the risks and consequences described with their facility-specific threat scenarios.

The following is a brief description of the types of activities performed:

Protective Forces

The Physical Protection Protective Forces activity provides for security guards or other specialized personnel and equipment training and management needed to effectively carry out the protection tasks during normal and security emergency conditions.

Security Systems

The Physical Security Protective Systems activity provides for equipment to protect vital security interests and government property per the local threat. Equipment and hardware includes fences, barriers, lighting, sensors, entry control devices, etc. This hardware and equipment is generally operated and used to support the protective guard mission as well.

Information Security

The Information Security activity ensures that materials and documents, that may contain classified or "Official Use Only" (OUO) information, are accurately and consistently identified, properly reviewed for content, appropriately marked and protected from unauthorized disclosure, and ultimately destroyed in an appropriate manner.

Cyber Security

The Cyber Security activity ensures that classified and OUO information that is electronically processed or transmitted is properly identified and protected, and that all electronic systems have an appropriate level of infrastructure reliability and integrity.

Personnel Security

The Personnel Security activity includes security clearance programs, employee security education and visitor control. Employee education and awareness is accomplished through initial and termination briefings, re-orientations, computer based training, special workshops, publications, signs, and posters.

Material Control and Accountability

The Material Control and Accountability activity provides for the control and accountability of special nuclear materials, including training and development for assessing the amounts of material involved in packaged items, process systems and wastes. Additionally, this activity documents that a theft, diversion or operational loss of special nuclear material has not occurred. Also included is on-site and off-site transport of special nuclear materials in accordance with mission, environment, safety and health requirements.

Program Management

The Program Management activity includes policy oversight and development and updating of security plans, assessments and approvals to determine if assets are at risk. Also encompassed are contractor management and administration, planning and integration of security activities into facility operations.

Significant Program Shifts

In FY 2004 there are no significant program shifts. In FY 2002 increased program emphasis was due to the heightened security demands from the September 11, 2001 incident.

Funding Profile

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Request	FY 2004 Request	$ Change	% Change
Science Safeguards and Security					
Protective Forces	23,085	22,345	22,345	0	0.0%
Security Systems	8,314	4,532	4,532	0	0.0%
Information Security	1,023	1,000	1,000	0	0.0%
Cyber Security	10,265	11,714	11,714	0	0.0%
Personnel Security	1,831	2,576	2,576	0	0.0%
Material Control and Accountability	2,031	2,676	2,676	0	0.0%
Program Management	3,681	3,284	3,284	0	0.0%
Subtotal, Science Safeguards and Security	50,230	48,127	48,127	0	0.0%
Less Security Charge for Reimbursable Work	-4,460	-4,383	-4,383	0	0.0%
Total, Science Safeguards and Security	45,770[a][b]	43,744	43,744	0	0.0%

Public Law Authorization:
Public Law 95-91, "Department of Energy Organization Act"
Public Law 103-62, "Government Performance and Results Act of 1993"

[a] Includes $2,650,000 transferred from Basic Energy Sciences ($2,600,000) and Biological and Environmental Research ($50,000) for a FY 2002 reprogramming for safeguards and security.
[b] Excludes $29,000 for the FY 2002 rescission contained in section 1403 of P.L. 107-226, Supplemental Appropriations for further recovery from and response to terrorist attacks on the United States.

Funding By Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Chicago Operations Office					
Ames Laboratory	397	409	409	0	0.0%
Argonne National Laboratory	7,679	7,809	7,809	0	0.0%
Brookhaven National Laboratory	10,916	10,970	10,970	0	0.0%
Fermi National Accelerator Laboratory	2,684	2,837	2,837	0	0.0%
Princeton Plasma Physics Laboratory	1,828	1,855	1,855	0	0.0%
Total, Chicago Operations Office	23,504	23,880	23,880	0	0.0%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	4,706	4,753	4,753	0	0.0%
Stanford Linear Accelerator Center	2,150	2,207	2,207	0	0.0%
Total, Oakland Operations Office	6,856	6,960	6,960	0	0.0%
Oak Ridge Operations Office					
Oak Ridge Inst. for Science & Education	1,081	1,254	1,254	0	0.0%
Oak Ridge National Laboratory	9,509	7,913	7,913	0	0.0%
Thomas Jefferson National Accelerator Facility	927	972	972	0	0.0%
Oak Ridge Operations Office	8,322	7,148	7,148	0	0.0%
Total, Oak Ridge Operations Office	19,839	17,287	17,287	0	0.0%
Washington Headquarters	31	0	0	0	0.0%
Subtotal, Science Safeguards and Security	50,230	48,127	48,127	0	0.0%
Less Security Charge for Reimbursable Work	-4,460	-4,383	-4,383	0	0.0%
Total, Science Safeguards and Security	45,770[bc]	43,744	43,744	0	0.0%

[a] On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format.
[b] Includes $2,650,000 transferred from Basic Energy Sciences ($2,600,000) and Biological and Environmental Research ($50,000) for a FY 2002 reprogramming for safeguards and security.
[c] Excludes $29,000 for the FY 2002 rescission contained in section 1403 of P.L. 107-226, Supplemental Appropriations for further recovery from and response to terrorist attacks on the United States.

Site Description

Safeguards and Security activities are conducted to meet the requirements of the following program elements: Physical Protection Protective Forces, Physical Security Protective Systems, Information Security, Cyber Security, Personnel Security, Material Control and Accountability, and Program Management. A summary level description of each activity is provided in the preceding Program Mission narrative. These activities ensure adequate protection of DOE security interests.

The attainment of the Safeguards and Security program goals and objectives are measured by progress made towards established performance measures. The technical excellence of the field security program is continually re-evaluated through field and Headquarters reviews. **Performance will be measured** at all sites by accomplishing the 98% success rate for preventing unauthorized intrusions into SC Cyber Systems that process "Official Use Only" (OUO) information, with a long term goal of striving for 100% in the outyears.

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Ames Laboratory	**397**	**409**	**409**

The Ames Laboratory Safeguards and Security program coordinates planning, policy, implementation and oversight in the areas of security systems, protective forces, personnel security, material control and accountability, and cyber security. A protective force is maintained to provide protection of personnel, equipment, and property from acts of theft, vandalism, and sabotage through facility walk throughs, monitoring of electronic alarm systems, and emergency communications. Reimbursable work is included in the numbers above; the amount for FY 2004 is $26,000.

Argonne National Laboratory	**7,679**	**7,809**	**7,809**

The Argonne National Laboratory Safeguards and Security program provides protection of nuclear materials, classified matter, government property, and other vital assets from unauthorized access, theft, diversion, sabotage, espionage, and other hostile acts that may cause risks to national security, the health and safety of DOE and contractor employees, the public, or the environment. Program activities include security systems, material control and accountability, information and cyber security, and personnel security. In addition, a protective force is maintained. These activities ensure that the facility, personnel, and assets remain safe from potential threats. Reimbursable work is included in the numbers above; the amount for FY 2004 is $388,000.

Brookhaven National Laboratory	**10,916**	**10,970**	**10,970**

Brookhaven National Laboratory (BNL) Safeguards and Security program activities are focused on protective forces, cyber security, physical security, and material control and accountability. BNL operates a transportation division to move special nuclear materials around the site. Material control and accountability efforts focus on accurately accounting for and protecting the sites special nuclear materials. Reimbursable work is included in the numbers above; the amount for FY 2004 is $806,000.

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Fermi National Accelerator Laboratory	**2,684**	**2,837**	**2,837**

Fermi National Accelerator Laboratory Safeguards and Security program efforts are directed at maintaining protective force staffing and operations to protect personnel and the facility as well as at continuing cyber security, security systems, and a material control and accountability program to accurately account for and protect the facilities special nuclear materials.

Lawrence Berkeley National Laboratory	**4,706**	**4,753**	**4,753**

The Lawrence Berkeley National Laboratory Safeguards and Security program provides physical protection of personnel and laboratory facilities. This is accomplished with protective forces, security systems, cyber security, personnel security, and material control and accountability of special nuclear material. Reimbursable work is included in the numbers above; the amount for FY 2004 is $830,000.

Oak Ridge Institute for Science and Education	**1,081**	**1,254**	**1,254**

The Oak Ridge Institute for Science and Education (ORISE) Safeguards and Security program provides physical protection/protective force services by employing unarmed security officers. The facilities are designated as property protection areas for the purpose of protecting government owned assets. In addition to the government owned facilities and personal property, ORISE possesses small quantities of nuclear materials that must be protected. The program includes information security, personnel security, protective forces, security systems, and cyber security. Reimbursable work is included in the numbers above; the amount for FY 2004 is $319,000.

Oak Ridge National Laboratory....................................	**9,509**	**7,913**	**7,913**

The Oak Ridge National Laboratory (ORNL) Safeguards and Security program includes security systems, information security, cyber security, personnel security, material control and accountability, and program management. Program planning functions at the Laboratory provide for short- and long-range strategic planning, and special safeguards plans associated with both day-to-day protection of site-wide security interests and preparation for contingency operations. Additionally, ORNL is responsible for provision of overall laboratory policy direction and oversight in the security arena; for conducting recurring programmatic self-assessments; for assuring a viable ORNL Foreign Ownership, Control or Influence (FOCI) program is in place; and for identifying, or tracking, and obtaining closure on findings or deficiencies noted during inspections, surveys, or assessments of safeguards and security programs. Reimbursable work is included in the numbers above; the amount for FY 2004 is $1,945,000.

Oak Ridge Operations Office..	**8,322**	**7,148**	**7,148**

The Oak Ridge Operations Office Safeguards and Security program provides for contractor protective forces for the Oak Ridge National Laboratory. This includes protection of a category 1 Special Nuclear Material Facility, Building 3019 ($6,013,000). Other small activities include security systems, information security, and personnel security.

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Princeton Plasma Physics Laboratory	**1,828**	**1,855**	**1,855**

The Princeton Plasma Physics Laboratory Safeguards and Security program provides for protection of nuclear materials, government property, and other vital assets from unauthorized access, theft, diversion, sabotage, or other hostile acts. These activities result in reduced risk to national security and the health and safety of DOE and contractor employees, the public, and the environment. Reimbursable work is included in the numbers above; the amount for FY 2004 is $54,000.

Stanford Linear Accelerator Center	**2,150**	**2,207**	**2,207**

The Stanford Linear Accelerator Center Safeguards and Security program focuses on reducing the risk to DOE national facilities and assets. The program consists primarily of physical protection protective forces and cyber security program elements. Reimbursable work is included in the numbers above; the amount for FY 2004 is $15,000.

Thomas Jefferson National Accelerator Facility	**927**	**972**	**972**

Thomas Jefferson National Accelerator Facility has a guard force that provides 24-hour services for the accelerator site and after-hours property protection security for the entire site. Other security programs include cyber security, program management, and security systems.

All Other	**31**	**0**	**0**

This funding provides for program management needs for the Office of Science in FY 2002.

Subtotal, Science Safeguards and Security	**50,230**	**48,127**	**48,127**
Less Security Charge for Reimbursable Work	**-4,460**	**-4,383**	**-4,383**
Total, Science Safeguards and Security	**45,770**	**43,744**	**43,744**

Subprogram Goals

Performance will be measured by a 98% success rate for preventing unauthorized intrusions into SC Cyber Systems that process Official Use Only information, with a long term goal of striving for 100% in the outyears.

Performance Indicator

Prevent unauthorized cyber intrusions. This will be accomplished by: (1) Reviewing Computer Incident Advisory Capability (CIAC) incident reports for SC sites that process Official Use Only information to establish a current baseline number of unauthorized intrusions into SC Cyber Systems; and (2) 100% of SC CSPPs submitted and approved in a complete and timely manner.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Establish baseline of actual intrusions.	95% success rate for preventing unauthorized intrusions into SC Cyber Systems that process official use only information commensurate with risk from FY 2002 baseline.	98% success rate for preventing unauthorized intrusions into SC Cyber Systems that process official use only information commensurate with risk from FY 2003 baseline.

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
	This will be accomplished by: (1) Reviewing Computer Incident Advisory Capability (CIAC) reports for SC sites that process Official Use Only information to establish a current baseline number of unauthorized intrusions into SC Cyber Systems; (2) Achieving, maintaining, and verifying that incidents remain below 5% and update Computer Security Program Plans (CSPPs) to reflect this posture; and (3) 100% of SC CSPPs submitted and approved in a complete and timely manner.	This will be accomplished by: (1) Reviewing Computer Incident Advisory Capability (CIAC) reports for SC sites that process Official Use Only information to establish a current baseline number of unauthorized intrusions into SC Cyber Systems; (2) Achieving, maintaining, and verifying that incidents remain below 2% and update Computer Security Program Plans (CSPPs) to reflect this posture; and (3) 100% of SC CSPPs submitted and approved in a complete and timely manner.

Detailed Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Ames Laboratory					
Protective Forces	149	143	143	0	0.0%
Security Systems	60	24	24	0	0.0%
Cyber Security	97	148	148	0	0.0%
Personnel Security	34	42	42	0	0.0%
Material Control and Accountability	7	7	7	0	0.0%
Program Management	50	45	45	0	0.0%
Total, Ames Laboratory	397	409	409	0	0.0%
Argonne National Laboratory					
Protective Forces	2,963	3,209	3,209	0	0.0%
Security Systems	715	455	455	0	0.0%
Information Security	236	211	211	0	0.0%
Cyber Security	1,705	1,888	1,888	0	0.0%
Personnel Security	865	904	904	0	0.0%
Material Control and Accountability	815	796	796	0	0.0%
Program Management	380	346	346	0	0.0%
Total, Argonne National Laboratory	7,679	7,809	7,809	0	0.0%
Brookhaven National Laboratory					
Protective Forces	6,083	6,146	6,146	0	0.0%
Security Systems	931	577	577	0	0.0%
Information Security	126	131	131	0	0.0%
Cyber Security	2,285	2,470	2,470	0	0.0%
Personnel Security	38	49	49	0	0.0%
Material Control and Accountability	482	742	742	0	0.0%
Program Management	971	855	855	0	0.0%
Total, Brookhaven National Laboratory	10,916	10,970	10,970	0	0.0%
Fermi National Accelerator Laboratory					
Protective Forces	1,447	1,700	1,700	0	0.0%
Security Systems	417	246	246	0	0.0%
Cyber Security	653	780	780	0	0.0%
Material Control and Accountability	66	49	49	0	0.0%
Program Management	101	62	62	0	0.0%
Total, Fermi National Accelerator Laboratory	2,684	2,837	2,837	0	0.0%

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Lawrence Berkeley National Laboratory					
Protective Forces	1,297	1,392	1,392	0	0.0%
Security Systems	1,113	942	942	0	0.0%
Cyber Security	1,802	2,019	2,019	0	0.0%
Personnel Security	32	11	11	0	0.0%
Material Control and Accountability	22	38	38	0	0.0%
Program Management	440	351	351	0	0.0%
Total, Lawrence Berkeley National Laboratory	4,706	4,753	4,753	0	0.0%
Oak Ridge Institute for Science and Education					
Protective Forces	165	288	288	0	0.0%
Security Systems	153	100	100	0	0.0%
Information Security	122	139	139	0	0.0%
Cyber Security	332	420	420	0	0.0%
Personnel Security	91	108	108	0	0.0%
Program Management	218	199	199	0	0.0%
Total, Oak Ridge Institute for Science and Education	1,081	1,254	1,254	0	0.0%
Oak Ridge National Laboratory					
Security Systems	4,636	1,790	1,790	0	0.0%
Information Security	246	304	304	0	0.0%
Cyber Security	2,154	2,305	2,305	0	0.0%
Personnel Security	528	1,182	1,182	0	0.0%
Material Control and Accountability	639	1,044	1,044	0	0.0%
Program Management	1,306	1,288	1,288	0	0.0%
Total, Oak Ridge National Laboratory	9,509	7,913	7,913	0	0.0%
Oak Ridge Operations Office					
Protective Forces	7,700	6,541	6,541	0	0.0%
Security Systems	86	112	112	0	0.0%
Information Security	293	215	215	0	0.0%
Personnel Security	243	280	280	0	0.0%
Total, Oak Ridge Operations Office	8,322	7,148	7,148	0	0.0%
Princeton Plasma Physics Laboratory					
Protective Forces	1,137	905	905	0	0.0%
Security Systems	35	113	113	0	0.0%
Cyber Security	559	775	775	0	0.0%
Program Management	97	62	62	0	0.0%
Total, Princeton Plasma Physics Laboratory	1,828	1,855	1,855	0	0.0%

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Stanford Linear Accelerator Center					
Protective Forces	1,742	1,606	1,606	0	0.0%
Security Systems	0	0	0	0	0.0%
Cyber Security	408	601	601	0	0.0%
Program Management	0	0	0	0	0.0%
Total, Stanford Linear Accelerator Center	2,150	2,207	2,207	0	0.0%
Thomas Jefferson National Accelerator Facility					
Protective Forces	402	415	415	0	0.0%
Security Systems	168	173	173	0	0.0%
Cyber Security	270	308	308	0	0.0%
Program Management	87	76	76	0	0.0%
Total, Thomas Jefferson National Accelerator Facility	927	972	972	0	0.0%
All Other					
Program Management	31	0	0	0	0.0%
Subtotal, Science Safeguards and Security	50,230	48,127	48,127	0	0.0%
Less Security Charge for Reimbursable Work	-4,460	-4,383	-4,383	0	0.0%
Total, Science Safeguards and Security	45,770	43,744	43,744	0	0.0%

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
No Funding Changes.	

Capital Operating Expenses & Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
General Plant Projects	2,821	0	0	0	0.0%
Capital Equipment	95	0	0	0	0.0%
Total, Capital Operating Expenses	2,916	0	0	0	0.0%

Science Program Direction

Program Mission

The mission of Science Program Direction (SCPD) is to provide a Federal workforce, skilled and highly motivated, to manage and support a broad set of scientific disciplines, research portfolio, programs, projects, and facilities under the Office of Science's (SC) leadership.

SCPD consists of four subprograms: Program Direction, Field Operations, Technical Information Management (TIM) and Energy Research Analyses (ERA). Beginning in FY 2003, Program Direction and Field Operations were realigned to include all functions performed in the SC Field complex in the Field Operations subprogram. With this change, the Program Direction subprogram continues to be the single funding source for the SC Federal staff in Headquarters responsible for directing, administering, and supporting the broad spectrum of SC scientific disciplines. The Field Operations subprogram is the centralized funding source for the Federal workforce within the field complex responsible for providing best-in-class business, administrative, and specialized technical support across the entire SC enterprise and to other DOE programs. The TIM subprogram collects, preserves, and disseminates the scientific and technical information (STI) of the DOE for use by the DOE, the scientific community, academia, U.S. industry, and the public to expand the knowledge base of science and technology. The ERA subprogram provides the capabilities needed to evaluate and communicate the scientific excellence, relevance, and performance of SC basic research programs, provide analysis of key scientific and technical issues, and document the societal outcomes of SC research.

Significant Program Shifts

- Beginning in FY 2002, and continuing into FY 2004, SC is conducting an organizational and workforce restructuring project to address fundamental issues and functions within the Office. The Office of Science (SC) Restructuring Project will realign its Headquarters and Field structure and streamline and improve the management and implementation of its programs by reducing layers of management, streamlining decision making processes, clarifying lines of authority, and making more efficient use of resources. This project reflects the changes envisioned by the President's Management Agenda (PMA) and directly supports the PMA objective to manage government programs more economically and effectively. Full implementation of the SC realignment is expected to take place during FY 2004.
- During the on-going restructuring, SC will continue to work toward rightsizing the number of full-time equivalents (FTEs) by the end of FY 2005. The FY 2003 President's Budget Request for SC Program Direction proposed to reduce the number of FTEs from 1,045 in FY 2002 to 840 in FY 2003, with corresponding reductions in program direction funding. However, the workforce restructuring project was not completed, and a reduction of this magnitude (20 percent) would have resulted in involuntary reductions-in-force (IRIFs), and substantial reduction in SC's ability to carry out its mission. In order to avoid IRIFs, SC utilized uncosted funding in the amount of $6,999,000 and delayed certain activities to offset the funding shortage in FY 2003. SC had further planned to use buyout authority to voluntarily reduce staffing, but this authority was not granted to the Department, and it was therefore necessary to revise the number of FY 2003 FTEs from 840 to 965. The FY 2004 request is also based on 965 FTEs to permit continued support for current staff (and to fill critical scientific positions), while allowing the restructuring project to be completed in FY 2004.

The restructuring will result in more informed decisions on the number of FTEs and types of position required to fulfill SC's programmatic and administration responsibilities.

- In FY 2003, the House Energy and Water Development (EWD) Appropriations Subcommittee proposed transferring TIM (from the Energy Supply appropriation) and ERA into SCPD as new subprograms. Since TIM is currently managed by SC, this transfer of funding from the Energy Supply appropriation aligns all SC program resources under the Science appropriation.
- In order to provide enhanced emphasis on education activities, Science Education, a former subprogram within SCPD, is budgeted in the newly established Workforce Development for Teachers and Scientists program, beginning in FY 2004.

Funding Profile

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Request	FY 2004 Request	$ Change	% Change
Science Program Direction					
Program Direction	51,345	55,984	58,217	+2,233	+4.0%
Science Education	0	0	0	0	--
Field Operations	89,591	72,403	83,802	+11,399	+15.7%
Technical Information Management	7,563	7,925	7,774	-151	-1.9%
Energy Research Analyses	968	1,020	1,020	0	--
Total, Science Program Direction	149,467 [ab]	137,332 [abc]	150,813	+13,481	+9.8%
Additional net budget authority to cover the cost of fully accruing retirement (non-add)	(7,479)	(6,060)	(6,567)	(+507)	(+8.4%)
Staffing (FTEs)					
Headquarters (FTEs)	261	284	284	0	--
Field Operations (FTEs)	591	609	609	0	--
Technical Information Management (FTEs)	75	72	72	0	--
Total, FTEs	927 [d]	965 [d]	965	0	--

Public Law Authorization:
Public Law 95-91, "Department of Energy Organization Act"
Public Law 103-62, "Government Performance and Results Act of 1993"

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[a] Includes TIM and ERA as proposed by the House EWD Appropriations Subcommittee to be effective in FY 2003.

[b] Excludes $4,460,000 in FY 2002 and $5,460,000 in FY 2003 for Science Education transferred to new Workforce Development for Teachers and Scientists program in FY 2004.

[c] In order to avoid IRIFs, SC utilized uncosted funding in the amount of $6,999,000 and delayed certain activities to offset the funding shortage in FY 2003.

[d] Revised estimate based on reprioritization of FY 2002 and FY 2003 activity to avoid IRIFs in both fiscal years. Also includes transfer of 72 FTEs for Technical Information Management (TIM) effective in FY 2003 consistent with the House EWD Subcommittee proposal. The FY 2002 Comparable Appropriation in the FY 2003 President's Request was 1,045 FTEs (293 FTEs in Headquarters, 676 FTEs in the Field, and 76 FTEs for TIM). The FY 2003 President's Request was 840 FTEs (299 FTEs in Headquarters, 467 FTEs in the Field, and 74 for TIM).

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office[a]					
Sandia National Laboratory/Albuquerque	155	100	100	0	--
Chicago Operations Office					
Chicago Operations Office	36,148	28,035	34,056	+6,021	+21.5%
Oak Ridge Operations Office					
Oak Ridge National Laboratory	60	0	0	0	--
Oak Ridge Institute for Science and Education	24	55	55	0	--
Office of Scientific and Technical Information	7,563	7,925	7,774	-151	-1.9%
Oak Ridge Operations Office	50,756	41,817	47,225	+5,408	+12.9%
Total, Oak Ridge Operations Office	58,403	49,797	55,054	+5,257	+10.6%
Oakland Operations Office[a]					
Lawrence Berkeley National Laboratory	0	50	50	0	--
Berkeley and Stanford Site Offices	3,000	2,861	2,831	-30	-1.0%
Total, Oakland Operations Office	3,000	2,911	2,881	-30	-1.0%
Richland Operations Office					
Pacific Northwest National Laboratory	414	465	465	0	--
Washington Headquarters	51,347	56,024	58,257	+2,233	+4.0%
Total, Science Program Direction	149,467[bc]	137,332[bc]	150,813	+13,481	+9.8%
Additional net budget authority to cover the cost of fully accruing retirement (non-add)	(7,479)	(6,060)	(6,567)	(+507)	(+8.4%)

[a] On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format.

[b] Includes TIM and ERA as proposed by the House EWD Appropriations Subcommittee to be effective in FY 2003.

[c] Excludes $4,460,000 in FY 2002 and $5,460,000 in FY 2003 for Science Education transferred to new Workforce Development for Teachers and Scientists program in FY 2004.

Site Description

Berkeley Site Office

The Berkeley Site Office provides institutional program management oversight in the execution of science programs contracted through Lawrence Berkeley National Laboratory (LBNL). LBNL is a multi-program laboratory located in Berkeley, California on a 200-acre site adjacent to the University of California campus. This activity contributes to ERA's formulation of long-term and strategic plans.

Chicago Operations Office

Chicago supports the programmatic missions performed in support of science and technology, national security, energy research, and environmental management. They are responsible for administering grants to universities as determined by the DOE sponsoring Program Offices, including non-SC offices, in addition to centrally providing administrative and specialized technical support (i.e., legal advice, personnel management, procurement services, etc.) to the Site Offices responsible for program management oversight for the five major management and operating laboratories--Argonne National Laboratory, Brookhaven National Laboratory, Fermi National Accelerator Laboratory, Princeton Plasma Physics Laboratory, and Ames Laboratory; and two government-owned and government-operated Federal laboratories--Environmental Measurements Laboratory and New Brunswick Laboratory.

Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory (LBNL) is a Multiprogram Laboratory located in Berkeley, California. The Laboratory is on a 200-acre site adjacent to the Berkeley campus of the University of California.

Oak Ridge Operations Office

Oak Ridge supports almost every major Departmental mission in science, energy resources, and environmental quality. They are responsible for grants administration to universities as determined by the sponsoring Program Offices in addition to centralized administrative and specialized technical support (i.e., legal advice, personnel management, procurement services, etc.) to the Oak Ridge National Laboratory and Thomas Jefferson National Accelerator Facility Site Offices.

Oak Ridge Institute for Science and Education

Oak Ridge Institute for Science and Education (ORISE) is located on 150 acres in Oak Ridge, Tennessee. ORISE facilitates and coordinates communication and outreach activities, and conducts studies on workforce trends in the sciences.

Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL) is a multiprogram laboratory located on a 24,000 acre site in Oak Ridge, Tennessee. ORNL carries out research in the area of retrospective analysis of research outcomes. This activity includes expert assessment of program impacts on other areas of research and the development of research tools.

Office of Scientific and Technical Information

The Office of Scientific and Technical Information (OSTI) is located on a 7-acre site in Oak Ridge, Tennessee. The OSTI facility is a 132,000 square foot secure, fire-protected, humidity-controlled building housing federal and contractor staff and over 1.2 million classified and unclassified documents. The physical facility is approximately 50 years old and is in need of large-scale capital improvements to ensure the safety and health of its occupants and to protect its contents. The large collection represents a critical component of the mission of the TIM subprogram, which is to lead DOE e-government initiatives for disseminating information resulting from the Department's multi-billion annual research and development (R&D) program. This information is the primary deliverable from DOE's $8 billion annual R&D expenditure as reported in technical reports, scientific journal articles, and preprints.

Pacific Northwest National Laboratory

Pacific Northwest National Laboratory (PNNL) is a multi-program laboratory located on a 640-acre site at the Department's Hanford site in Richland, Washington. PNNL carries out research in the areas of portfolio and economic analysis to contribute to the ERA formulation of long-term plans and science policy. This activity includes assessments of trends in R&D and the development of science management tools for R&D portfolio and outcome analyses. PNNL also provides expert assistance in state-of-the-art science communications.

Sandia National Laboratories

Sandia National Laboratories (SNL) is a multi-program laboratory, with a total of 3,700 acres, located in Albuquerque, New Mexico, with sites in Livermore, California, and Tonopah, Nevada. SNL carries out research in the areas of technical program planning and merit review practices to contribute to the ERA formulation of best practices for long term plans, science policy and peer reviews. This activity includes assessments of best practices in R&D organizations.

Stanford Site Office

The Stanford Site Office provides institutional program management oversight in the execution of basic research at the Stanford Linear Accelerator Center, a laboratory operated under a contract with Stanford University.

Program Direction

Mission Supporting Goals and Measures

The Program Direction subprogram funds all of the SC Federal staff in Headquarters responsible for directing, administering, and supporting the broad spectrum of scientific disciplines. These disciplines include High Energy Physics, Nuclear Physics, Basic Energy Sciences, Biological and Environmental Research, Fusion Energy Sciences, and Advanced Scientific Computing Research programs. Additionally, this subprogram supports management, human resources, policy, and technical and administrative support staff responsible for budget and finance; general administration; grants and contracts; information technology; policy review and coordination; infrastructure management; construction management; safeguards and security; and environment, safety and health. By supporting its Federal workforce, SC is able to successfully administer major Federal science programs and projects and facilities across the nation in a safe, secure, and efficient manner.

Accomplishments

- Achieved technical excellence in SC programs despite managing one of the largest, most diversified, and complex basic research portfolios in the Federal Government with a relatively small Federal and contractor support staff.
- Established a Workforce Restructuring Project that will realign the SC Headquarters and Field structure to streamline and improve the management and implementation of programs by reducing layers of management, streamlining decision-making processes, clarifying lines of authority, and utilizing resources more efficiently throughout SC and its Field sites. The changes planned are consistent with both the President's Management Agenda and SC's Business Vision. The Restructuring Project will determine staffing needs throughout the SC complex prior to the end of FY 2004.
- Clarify program, project management, and operational roles and responsibilities to achieve an organization that is stronger in scientific, technical and project management skills, and leaner and more integrated in administrative and support functions.
- Completed the Laboratory Best Practices Study in December 2001. Significant recommendations included simplifying line management accountability, replacing transactional oversight with performance-based management, use of external standards where possible, use of bilateral decision process for directives, and reflecting such changes in contractual language with the laboratories.
- Established a working group, in response to the challenge by the Under Secretary, to develop the principles and guidelines for a new SC contract for the SC multi-program laboratories. The guidelines should lay the groundwork for a streamlined oversight approach that builds trust and accountability, enables the contractors to make sound business decisions, and perform excellent R&D work in the most cost effective and efficient manner, with minimal risk and environmental impact.

Subprogram Goals

Implement comprehensive Human Capital Management initiatives consistent with an SC-wide workforce reengineering, restructuring and succession planning effort. Expand and integrate E:Government/Commerce and Electronic Procurement activities into the SC business systems and processes. Implement a corporate-wide information technology initiative that enables the DOE to effectively manage a broad R&D portfolio.

Performance Indicators

Increased employee/supervisor ratios from FY 2002 levels and elimination of senior level management/organization layer(s). Increased use of electronic technology business applications and the number of research proposals received electronically. Increased receipt and use of electronic information and data on R&D programs and projects by and for multiple users, e.g., DOE program/project managers, national laboratories, universities and private industry.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Initiated program planning on an SC wide workforce restructuring and reengineering effort. Advertised all recruit actions for scientific and technical positions via the automated DOE Jobs Online. Simplified SC position descriptions reducing administrative burden/processing time for position classification. Implemented (1) WorkSheet Exchange system that provides the ability to electronically update the SC corporate financial database with formulation data; (2) an Abstract Tracking system that collects, manages, and publishes abstracts on-line; and (3) 26 enhancements to the Execution Work Management system that supports the grants and Field work proposal process. Identified streamlined processes and high-level requirements for the receipt and management of annual Field budget information for R&D through business process reengineering. Defined requirements to receive new research project information electronically through the DOE integrated electronic procurement system.	Eliminate at least one layer of senior level management and clarify lines of authority, communication and programmatic responsibilities. Implement a system that manages SC's concurrence processes and supports records and document management. Electronically receive (1) 50% of all DOE Field budget information for on-going R&D projects and (2) 80% of all new research project information through the DOE integrated electronic procurement system. Identify streamlined processes and requirements for the tracking and reporting of information for R&D through business process reengineering.	Implement workforce restructuring and reengineering actions and assess the implementation effectiveness. Adjust actions as necessary to ensure organizational and work process changes are in place (e.g., organizational/structural realignment, workforce restructuring). Implement an electronic business management database and tracking application that supports the SC leadership in establishing scientific research priorities. Electronically receive (1) 80% of all DOE Field budget information for on-going R&D projects and (2) 100% of all new research project information through the DOE integrated electronic procurement system. Develop and test an electronic R&D project management and tracking database application for the DOE program managers that incorporates information from other DOE corporate systems.

Funding Schedule

(dollars in thousands, whole FTEs)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Headquarters					
Salaries and Benefits	32,769	33,851	36,077	+2,226	+6.6%
Travel	1,506	1,564	1,564	0	--
Support Services	10,041	10,882	11,850	+968	+8.9%
Other Related Expenses	7,029	9,687	8,726	-961	-9.9%
Total, Headquarters	51,345	55,984	58,217	+2,233	+4.0%
Additional net budget authority to cover the cost of fully accruing retirement (non-add)	(2,070)	(2,240)	(1,923)	(-317)	(-14.2%)
Full Time Equivalents	261 [a]	284 [a]	284	0	--

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Salaries and Benefits	**32,769**	**33,851**	**36,077**

This funds 284 FTEs in Headquarters during our Workforce Restructuring Project which will be completed by the end of FY 2004. The FY 2004 FTE request is consistent with the FY 2002 authorized level.

	FY 2002	FY 2003	FY 2004
Travel	**1,506**	**1,564**	**1,564**

Travel includes all costs of transportation of persons, subsistence of travelers, and incidental travel expenses in accordance with Federal travel regulations.

	FY 2002	FY 2003	FY 2004
Support Services	**10,041**	**10,882**	**11,850**

Provides funding for general administrative services and technical expertise provided as part of day-to-day operations, including mailroom operations; travel management; environment, safety and health (ES&H) support; security and cyber security support; and administering the Small Business Innovation Research (SBIR) program. Also provides for information technology (IT) maintenance and enhancements, including support for the e-R&D Portfolio Management, Tracking and Reporting Project.

[a] Revised estimate based on reprioritization of FY 2002 and FY 2003 activity to avoid IRIFs in both fiscal years. The FY 2002 Comparable Appropriation in the FY 2003 President's Request was 293. The FY 2003 President's Request was 299 FTEs.

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004

The $968,000 increase allows SC to fund additional costs (+$550,000) for administrative and technical support service contracts due to increased work requirements, such as implementation of more stringent foreign travel procedures mandated since the September 11 terrorist attacks. Funding (+$506,000) enables SC to develop and implement integrated business applications consistent with the President's e-government initiatives. SC promotes IT efficiencies consistent with the provisions of the Information Technology Management Reform Act of 1996 to improve how the mission is accomplished. In FY 2004, technical assistance is reduced (-$88,000) in order to support other critical needs within the Office of Science Program Direction budget. At this level of funding the e-R&D Portfolio Management, Tracking and Reporting Project will develop and implement a system to allow for the electronic receipt of DOE laboratory proposals. Additional functionality will be delivered in future years to provide project query and reporting capabilities, and further testing and integration with other corporate IT initiatives.

Other Related Expenses	**7,029**	**9,687**	**8,726**

Provides funds for a variety of tools, goods, and services that support the Federal workforce, including acquisitions made through the Working Capital Fund (WCF), computer and office equipment, publications, training, e-R&D Portfolio Management, Tracking and Reporting Project acquisitions, etc. The $961,000 decrease is the result of several items: a reduction in hardware/software goods and services in support of the e-R&D Portfolio Management, Tracking and Reporting Project requirements (-$1,470,000); the completion of the Workforce Restructuring Project by September 30, 2003, designed to identify ways to a) reduce the number of managers, organizational layers, and time needed to make decisions; b) increase the span of control; and c) redirect positions to the front lines (+478,000); supports anticipated IT efficiencies (-$107,000); and growth in the WCF (+$138,000).

Total, Program Direction...	**51,345**	**55,984**	**58,217**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Salaries and Benefits	
■ Supports 284 FTEs and factors 2.4 percent pay adjustment in personnel compensation.	+2,226
Support Services	
■ Dedicates funding to development of integrated business applications	+506
■ Decrease in technical support for the e-R&D Portfolio Management, Tracking and Reporting Project	-88

	FY 2004 vs. FY 2003 ($000)
■ Funds increased support service contract activity requirements in the areas of ES&H; safeguards and security; mail room and travel management; and SBIR (+$550,000)	+550
Total, Support Services	+968
Other Related Expenses	
■ Decrease in e-R&D Portfolio Management, Tracking and Reporting Project architecture acquisitions	-1,470
■ Reflects continuing efforts towards completion of the Workforce Restructuring Project by December 31, 2004, consistent with the President's Management Agenda Initiatives	+478
■ Supports SC Headquarters IT requirements	-107
■ Fund activities provided in the WCF	+138
Total, Other Related Expenses	-961
Total Funding Change, Program Direction	+2,233

Support Services

	(dollars in thousands)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
Technical Support Services					
Test and Evaluation Studies	650	700	750	+50	+7.1%
Total, Technical Support Services	650	700	750	+50	+7.1%
Management Support Services					
ADP Support	8,170	8,982	9,400	+418	+4.7%
Administrative Support	1,221	1,200	1,700	+500	+41.7%
Total, Management Support Services	9,391	10,182	11,100	+918	+9.0%
Total, Support Services	10,041	10,882	11,850	+968	+8.9%

Other Related Expenses

	(dollars in thousands)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
Training	96	99	99	0	--
Working Capital Fund	4,150	4,200	4,338	+138	+3.3%
Information Technology Hardware and Software/Maintenance Acquisitions	640	3,071	1,494	-1,577	-51.4%
Other	2,143	2,317	2,795	+478	+20.6%
Total, Other Related Expenses	7,029	9,687	8,726	-961	-9.9%

Field Operations

Mission Supporting Goals and Measures

The Field Operations subprogram is the centralized funding source for the SC Field Federal workforce responsible for the management and administrative functions at the Chicago and Oak Ridge Operations Offices and the Site Offices supporting SC laboratories and facilities, e.g., Ames Site Office; Argonne Site Office; Brookhaven Site Office; Fermi Site Office; Lawrence Berkeley National Laboratory Site Office; Oak Ridge National Laboratory Site Office; Princeton Plasma Physics Laboratory Site Office; Thomas Jefferson National Accelerator Facility Site Office; and Stanford Linear Accelerator Center Site Office.

This subprogram supports the Federal workforce that is responsible for SC and other DOE programmatic missions performed in support of science and technology, energy research, and environmental management, i.e., financial stewardship, personnel management, contract and procurement acquisition, labor relations, security, legal counsel, public and congressional liaison, intellectual property and patent management, environmental compliance, safety and health management, infrastructure operations maintenance, and information systems development and support.

In addition, this subprogram provides funding for the fixed requirements associated with rent, utilities, and telecommunications. Other requirements such as IT maintenance, administrative support, mail services, document classification, personnel security clearances, emergency management, printing and reproduction, travel, certification training, vehicle acquisition and maintenance, equipment, classified/unclassified data handling, records management, health care services, guard services, and facility and ground maintenance are also included. These infrastructure requirements are relatively fixed. This subprogram also supports the Inspector General operations located at each site by providing office space and materials. Other operational requirements funded include occasional contractor support to perform ecological surveys, cost validations, and environmental assessments; ensure compliance with Defense Nuclear Facilities Safety Board safety initiatives; abide by site preservation laws and regulations; and perform procurement contract closeout activities.

Accomplishments

- Completed Phase I of an electronic-based document system to electronically distribute and track documents and records. Mail handlers now use one common system to log and scan both incoming and outgoing correspondence.
- Implemented the Electronic Commerce–Web Based (EC Web) system. EC-Web is used for simplified acquisition requisitions and credit card purchases.
- Implemented the Employee Self Service feature of the Corporate Human Resources Information System. Federal employees can now view payroll, benefits, and other personal information at their desktops via Internet access.

Subprogram Goals

Implement comprehensive Human Capital Management initiatives consistent with an SC-wide workforce reengineering, restructuring and succession planning effort. Expand and integrate e-Government/Commerce and Electronic Procurement activities into the SC business systems and processes. Implement a corporate-wide information technology initiative that enables the DOE to effectively manage a broad R&D portfolio.

Performance Indicators

Increased employee/supervisor ratios from FY 2002 levels and elimination of senior level management/organization layer(s). Increased use of electronic technology business applications and the number of research proposals received electronically. Increased receipt and use of electronic information and data on R&D programs and projects by and for multiple users, e.g., DOE program/project managers, national laboratories, universities and private industry.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Initiated program planning on an SC wide workforce restructuring and reengineering effort. Advertised all recruit actions for scientific and technical positions via the automated DOE Jobs Online. Simplified SC position descriptions reducing administrative burden/processing time for position classification. Implemented (1) WorkSheet Exchange system that provides the ability to electronically update the SC corporate financial database with formulation data; (2) an Abstract Tracking system that collects, manages, and publishes abstracts on-line; and (3) 26 enhancements to the Execution Work Management system that supports the grants and Field work proposal process. Identified streamlined processes and high-level requirements for the receipt and management of annual Field budget information for R&D through business process reengineering. Defined requirements to receive new research project information electronically through the DOE integrated electronic procurement system.	Eliminate at least one layer of senior level management and clarify lines of authority, communication and programmatic responsibilities. Implement a system that manages SC's concurrence processes and supports records and document management. Electronically receive (1) 50% of all DOE Field budget information for on-going R&D projects and (2) 80% of all new research project information through the DOE integrated electronic procurement system. Identify streamlined processes and requirements for the tracking and reporting of information for R&D through business process reengineering.	Implement workforce restructuring and reengineering actions and assess the implementation effectiveness. Adjust actions as necessary to ensure organizational and work process changes are in place (e.g., organizational/structural realignment, workforce restructuring). Implement an electronic business management database and tracking application that supports the SC leadership in establishing scientific research priorities. Electronically receive (1) 80% of all DOE Field budget information for on-going R&D projects and (2) 100% of all new research project information through the DOE integrated electronic procurement system. Develop and test an electronic R&D project management and tracking database application for the DOE program managers that incorporates information from other DOE corporate systems.

Funding Schedule

	(dollars in thousands, whole FTEs)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
Chicago Operations Office					
Salaries and Benefits	26,106	24,421	27,355	+2,934	+12.0%
Travel	403	340	494	+154	+45.3%
Support Services	6,670	1,666	2,307	+641	+38.5%
Other Related Expenses	2,656	1,298	3,590	+2,292	+176.6%
Total, Chicago Operations Office	35,835	27,725	33,746	+6,021	+21.7%
Full Time Equivalents	252	267	267	0	--
Berkeley/Stanford Site Offices					
Salaries and Benefits	2,370	2,392	2,463	+71	+3.0%
Travel	60	48	48	0	--
Support Services	270	0	0	0	--
Other Related Expenses	300	421	320	-101	-24.0%
Total, Berkeley/Stanford Site Offices	3,000	2,861	2,831	-30	-1.0%
Full Time Equivalents	23	25	25	0	--
Oak Ridge Operations Office					
Salaries and Benefits	28,844	29,046	29,852	+806	+2.8%
Travel	479	387	395	+8	+2.1%
Support Services	12,116	8,174	11,868	+3,694	+45.2%
Other Related Expenses	9,317	4,210	5,110	+900	+21.4%
Total, Oak Ridge Operations Office	50,756	41,817	47,225	+5,408	+12.9%
Full Time Equivalents	316	317	317	0	--
Total Field Operations					
Salaries and Benefits	57,320	55,859	59,670	+3,811	+6.8%
Travel	942	775	937	+162	+20.9%
Support Services	19,056	9,840	14,175	+4,335	+44.1%
Other Related Expenses	12,273	5,929	9,020	+3,091	+52.1%
Total, Field Operations	89,591	72,403	83,802	+11,399	+15.7%
Additional net budget authority to cover the cost of fully accruing retirement (non-add)	(4,928)	(3,392)	(4,065)	(+673)	(+19.8%)
Full Time Equivalents	591 [a]	609 [a]	609	0	--

[a] Revised estimate based on reprioritization of FY 2002 and FY 2003 activity to avoid IRIFs in both fiscal years. The FY 2002 Comparable Appropriation in the FY 2003 President's Request was 676 FTEs. The FY 2003 President's Request was 467 FTEs.

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Salaries and Benefits	**57,320**	**55,859**	**59,670**

Supports 609 FTEs within the SC Field complex, 18 FTEs more than FY 2002 (591 FTEs). Past unstructured downsizing across SC has resulted in under-staffing in some areas and over-staffing in others. To address this, SC is working on a phased approach that spans multiple years. SC has initiated a Workforce Restructuring Project that will establish a direct reporting relationship between SC site offices and SC Headquarters, thus removing a layer of management currently residing in the Chicago and Oak Ridge Operations Offices. These operations offices will be transformed into one or more service centers, with redefined roles and responsibilities to provide best-in-class business, administrative, and specialized technical support across the entire SC enterprise and, as appropriate, to other DOE programs.

Travel	**942**	**775**	**937**

Enables Field staff to participate on task teams, work various issues, conduct compliance reviews, and perform contractor oversight to ensure implementation of DOE orders and regulatory requirements at the facilities under their purview. Also provides for attendance at conferences and training classes, and permanent change of station relocation, etc.

Support Services	**19,056**	**9,840**	**14,175**

The Field uses a variety of administrative and technical assistance services that are critical to their success in meeting local customer needs. The services provided support IT routine computer maintenance, specific improvements, operating systems upgrades, cyber security, network monitoring, firewalls, and disaster recovery tools. Other areas include staffing 24-hour emergency and communications centers, safeguarding and securing assets (protective guards, processing security clearances, classifying records, protecting assets and property, etc.), processing/distributing mail, travel management centers, contract close-out activities, copy centers, directives coordination, filing and retrieving records, etc. Requirements in FY 2003 appear artificially low because some of the requirements will be funded in FY 2003 from FY 2002 uncosted balances to avoid IRIFs in FY 2003. The funding increase from FY 2003 to FY 2004 reflects the level to which day-to-day operations are being restored in order to maintain a viable work environment.

Other Related Expenses	**12,273**	**5,929**	**9,020**

Funds day-to-day requirements associated with operating a viable office, including fixed costs associated with occupying office space, utilities, telecommunications and other costs of doing business, e.g., postage, printing and reproduction, copier leases, site-wide health care units, records storage assessments, office equipment/furniture, building maintenance, etc. Employee training and development and the supplies and furnishings used by the Federal staff are also included. Requirements in FY 2003 appear artificially low because some of the requirements will be funded in FY 2003 from FY 2002 uncosted balances to avoid IRIFs in FY 2003. The funding increase from FY 2003 to FY 2004 reflects the level to which day-to-day operations are being restored in order to sustain a productive work environment.

Total, Field Operations	**89,591**	**72,403**	**83,802**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Salaries and Benefits	
■ Supports 609 FTEs within the SC Field complex, 18 FTEs more than FY 2002 (591 FTEs). Also factors a 2.4 percent pay adjustment in personnel compensation ...	+3,811
Travel	
■ Commensurate support for Federal FTEs ...	+162
Support Services	
■ Restore funding for support service activities (contract closeout, mail/travel management, safeguards and security functions, etc.) funded in FY 2003 from FY 2002 uncosted balances to avoid IRIFs in FY 2003. ...	+4,335
Other Related Expenses	
■ Restore funding in support of day-to-day activities such as building services and maintenance, janitorial, other supplies and materials, and systems support; i.e., the Financial Service Center processes. These activities will be funded in FY 2003 from FY 2002 uncosted balances to avoid IRIFs in FY 2003...	+3,091
Total Funding Change, Field Operations ...	+11,399

Support Services

(dollars in thousands)	FY 2002	FY 2003	FY 2004	$ Change	% Change
Technical Support Services					
Economic and Environmental Analysis	5,612	0	0	0	--
Total, Technical Support Services	5,612	0	0	0	--
Management Support Services					
ADP Support	6,529	4,064	4,064	0	--
Administrative Support	6,915	5,776	10,111	+4,335	+75.1%
Total, Management Support Services	13,444	9,840	14,175	+4,335	+44.1%
Total, Support Services	19,056	9,840	14,175	+4,335	+44.1%

Other Related Expenses

(dollars in thousands)	FY 2002	FY 2003	FY 2004	$ Change	% Change
Training	600	65	65	0	--
Printing and Reproduction	380	250	250	0	--
Rent & Utilities & Telecommunication	6,536	3,495	3,395	-100	-2.9%
Information Technology Hardware, Software, and Maintenance	1,467	1,000	1,000	0	--
Working Capital Fund	474	500	500	0	--
Other	2,816	619	3,810	+3,191	+515.5%
Total, Other Related Expenses	12,273	5,929	9,020	+3,091	+52.1%

Technical Information Management

Mission Supporting Goals and Measures

R&D is the process of exploration, discovery, and sharing of the knowledge gained. Scientific progress is only possible if knowledge is shared. The Technical Information Management (TIM) subprogram is instrumental in directly performing this critical part of the R&D cycle. TIM collects the research results, maintains the information, and makes that information available to the broader scientific community to contribute to the advancement of science, thereby completing the cycle of building on knowledge previously gained and combining it with newly discovered insights. TIM assures that the scientific and technical information emanating from the myriad DOE research activities is effectively managed and disseminated per legislative mandates to benefit the nation.

DOE's missions in science and technology, national defense, energy resources, and environmental stewardship are all dependent on a strong base of R&D. DOE R&D activities are decentralized, occurring at national laboratories, in academia, and among individual contractors. TIM organizes these widely-dispersed research results into searchable sets. Using innovative information technologies, TIM makes them available to the widest possible audience in accordance with the body of legislation that dictates DOE's responsibilities to share information. In this manner, DOE is assured of having historic and current research results readily available and reusable to advance its missions; providing access to those in R&D pursuits and to the science-attentive public; and promoting and safeguarding national security interests. TIM projects and initiatives deliver the scientific knowledge emanating from DOE via cost-effective e-government information retrieval systems. These initiatives help make science information more visible and useable.

TIM Program Direction funding provides staffing and resources to both direct and execute the TIM subprogram mission. Federally-staffed functions include policy development and integration; U.S. and DOE representation in interagency and international information exchange agreements; management of safeguards and security activities; administration; personnel management; budget formulation and execution; procurement and contract management; records management; classified information program management; facility management; and collecting, preserving, organizing, and disseminating the information resulting from DOE's R&D investment, including re-engineering mission-critical systems to take full advantage of electronic information technology. As a result of the capabilities TIM uses to fulfill Department-wide responsibilities, it also provides, on a cost-reimbursable basis, specialized scientific and technical information systems or services to individual DOE Program Offices.

Accomplishments

- Progress with Information Technology and e-Government Practices: The TIM subprogram is instrumental in performing the sharing of knowledge – a critical part of the R&D cycle. Broad access, preservation, and electronic availability of this knowledge are critical. By implementing innovative information technologies, TIM has drastically changed the manner by which it does business, moving from a paper-based to an electronic work environment. As measured by the quantity of STI disseminated and the number of patrons served, TIM plays a more useful role now than in prior years. For example, in the paper environment (1995), TIM distributed 10,000 reports per year upon request; now, patrons of TIM's web-based systems are downloading 260,000 full-text reports (plus a much larger number of individual page views) per year. In 2001, TIM's web sites and e-government information systems logged nearly 6,000,000 user transactions – a 79 percent increase over the previous year. In addition, using electronic delivery of information has resulted in a 90 percent reduction in the cost per user transaction.

- Shift in Coverage of Journal Literature: Unveiled in 1999, PubSCIENCE provided researchers and science-attentive citizens access via the web to bibliographic records of peer-reviewed journal literature relating to DOE-supported work. PubSCIENCE was a modern tool to fulfill a longstanding responsibility to provide access to a collection of R&D records created by or relevant to DOE researchers. PubSCIENCE effectively served its purpose, offering citations in disciplines of interest to DOE at a time when no equivalent free-for-use private sector service was available. However, in FY 2002, after analyzing the availability of freely searchable journal citations now available via the web through secondary information providers Scirus and Infotrieve, TIM concluded that these private sector products fulfilled the needs in coverage at no cost to users. Consequently, the Department proposed to cease operation of PubSCIENCE and conducted a 30-day public notice period, as required by law; PubSCIENCE was terminated on November 4, 2002. TIM is now focused on improving coverage of DOE-sponsored journal literature, consistent with findings of several recent Inspector General reports. Information technology and software have matured, allowing for a more focused and simplified mechanism to access and account for DOE R&D results. DOE is making arrangements within the DOE community to compile this information. The modest resources that previously supported PubSCIENCE have been redirected to deploy new technologies specifically to harvest DOE journal information directly from the DOE Laboratories, contractors, and grantees.
- Board of Visitors Program Review: In June 2002, a distinguished Board of Visitors was unified in their support of TIM and the critical nature of its mission. The members of the Board specifically cited TIM’s significant progress in rapidly shifting from a paper-based operation to an efficient web-based environment; partnering and collaborating with other federal agencies and the private sector in promoting e-government systems; and maintaining a professional, productive workforce amidst severe resource constraints.
- *Science.gov* Alliance: The TIM subprogram continues its participation in the development and enhancement of *science.gov*, the Interagency Science web resource. Hosted by OSTI, *science.gov* has 12 participating federal agencies bringing S&T to citizens, including scientists, teachers, students, and business people via one Internet site. *Science.gov* provides an integrated place to search and access previously hard-to-find government sponsored R&D projects and results, through a single query. Different options and paths are available for a diverse body of users. *Science.gov* provides a giant leap toward making e-government a reality and the U.S. an international leader in the area of STI exchange.
- Awards and Recognition: The TIM subprogram has demonstrated “first in class” capabilities in information collection, processing, and dissemination technologies and concepts, resulting in recognition and increased visibility for the Department and the SC. Specific recognition from outside the Department includes a commendation from the Depository Library Council of the GPO for TIM’s Energy Citations Database (January 2002), and the 2001 Interagency Resource Management Conference (IRMCO) Award for demonstrating exceptional ability to operate across organizational boundaries to improve the government's service to its people (September 2001). Further, TIM was invited to write an article summarizing TIM’s information technology advances for “Nature” magazine (May 2001). Within the Department, support and acknowledgement for TIM’s successes is indicated by the 2001 DOE IT Quality Award for Management/Administrative Excellence recognizing TIM’s leadership in implementing a streamlined system for providing legacy and current DOE STI in the Energy Citations Database (March 2002); DOE Secretarial Certificate of Achievement recognizing TIM and Scientific and Technical Information Program partners at DOE

field offices and laboratories for the completion of a successful transition from paper to electronic technical information reporting in support of DOE's R&D mission, three years ahead of the DOE goal (March 2002); and 2000 DOE-Wide IT Quality Award for capitalizing on technological advances in the Information Age to bring science information to the desktops of U.S. and DOE researchers (March 2001).

Subprogram Goals

Deliver the scientific knowledge generated by or relevant to DOE's R&D program via cost-effective e-government information retrieval systems to government, university, and industry users "so as to provide free interchange of ideas and criticism which is essential to scientific and industrial progress and public understanding and to enlarge the fund of technical information" (excerpt from 42 U.S.C. § 2161). Provide stewardship for the Department's legacy of classified and unclassified STI; contribute to the Nation's overall information infrastructure through partnerships with international organizations and other government information dissemination organizations such as the International Energy Agency's Energy Technology Data Exchange (ETDE), International Atomic Energy Agency's International Nuclear Information System (INIS), *science.gov* Alliance, Government Printing Office (GPO), National Technical Information Service, and CENDI (Commerce, Energy, Education, EPA, NASA, NLM, Defense, and Interior) organizations.

Performance Indicators

Increased amount of DOE-sponsored STI available online and increased use of STI. Increased amount of international STI available electronically.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Advanced science knowledge and its application by providing access to 5,000 new full-text technical reports and increased access to preprint servers from 5,200 to 8,000 sites.	Increase the number of new full-text technical reports available online by 5,000.	Increase the number of new full-text scientific and technical (S&T) documents available electronically by 5,000 to a total of 75,000 and maintain access to over 2,000,000 citations. Increase in use of STI by 10 percent from a projected FY 2002 baseline of 6,000,000.
Represented DOE in the *science.gov* Alliance by providing a web-based search tool for over 30 multi-agency databases.	Continue to support the *science.gov* Alliance and establish the content and user base in partnership with other government agencies.	Continue to support the *science.gov* Alliance by hosting the *science.gov* website.
Through international partnerships, made 80,000 new international research records available through web-based databases.	Increase the volume of international full-text information made electronically available to U.S. citizens by 5 percent.	Increase the volume of international full-text information made electronically available to U.S. citizens by 5 percent.

Funding Schedule

	(dollars in thousands)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
TIM Program Support					
E-Government Information Systems	696	898	750	-148	-16.5%
R&D Tracking System	202	202	200	-2	-1.0%
Foreign R&D Records	100	100	100	0	--
Electronic and Paper Document Storage	200	200	200	0	--
Subtotal, TIM Program Support	1,198	1,400	1,250	-150	-10.7%
TIM Program Direction					
Oak Ridge, TN					
Salaries and Benefits	5,860	6,011	6,006	-5	-0.1%
Travel	75	80	80	0	--
Support Services	100	100	100	0	--
Other Related Expenses	200	200	200	0	--
Total, Oak Ridge, TN	6,235	6,391	6,386	-5	-0.1%
Full Time Equivalents	74	71	71	0	--
Headquarters					
Salaries and Benefits	130	134	138	+4	+3.0%
Travel	0	0	0	0	--
Support Services	0	0	0	0	--
Other Related Expenses	0	0	0	0	--
Total, Headquarters	130	134	138	+4	+3.0%
Full Time Equivalents	1	1	1	0	--
Subtotal TIM Program Direction					
Salaries and Benefits	5,990	6,145	6,144	-1	--
Travel	75	80	80	0	--
Support Services	100	100	100	0	--
Other Related Expenses	200	200	200	0	--
Subtotal, TIM Program Direction	6,365	6,525	6,524	-1	--
Additional net budget authority to cover the cost of fully accruing retirement (non-add)	(481)	(428)	(579)	(+151)	(+35.3%)
Full Time Equivalents	75	72	72	0	--
Total, Technical Information Management	7,563	7,925	7,774	-151	-1.9%

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
E-Government Information Systems	**696**	**898**	**750**

The TIM subprogram continues to lead DOE e-government initiatives for disseminating information, which include building the world's most comprehensive collection of physical sciences information and providing greater free, electronic, public access to full-text gray literature, journal literature, and preprints. Activities supported include the following:

- DOE Information Bridge. The free, publicly accessible DOE Information Bridge, which contains searchable, full-text access to over 70,000 technical reports (over 5 million pages) from DOE research projects, enables users to bypass expensive and time-consuming bibliographic searches and requests for paper reports. As technology and common standards advance, it becomes more timely and economical to exchange information in electronic media. Hailed as a "model" for other interagency collaborations by the Chairman of the Joint Committee on Printing, the public version of the DOE Information Bridge is available through a partnership with the GPO.
- PrePRINT Network. The PrePRINT Network is a searchable gateway to preprint servers that deal with scientific and technical disciplines of concern to DOE and provides access to over 8,000 preprint sites worldwide with over 500,000 preprints in full text. Such disciplines include the great bulk of physics, materials, and chemistry, as well as portions of biology, environmental sciences, and nuclear medicine. The PrePRINT Network also features an alert service that enables researchers to set up a personalized profile and receive notification of new additions in their areas of interest.
- Energy Citations Database. The Energy Citations Database contains over 2,000,000 bibliographic citations for energy and energy-related STI from the DOE and its predecessor agencies. Through this database, TIM provides free access to DOE publicly-available citations from 1948 through the present and includes citations to report literature, conference papers, journal articles, books, dissertations, and patents in disciplines of interest to DOE.
- DOE R&D Accomplishments. DOE R&D Accomplishments is a central forum for information about the outcomes of past DOE R&D which has had significant economic impact, has improved people's lives, or has been widely recognized as a remarkable advancement in science. The site contains searchable full-text and bibliographic citations of documents reporting accomplishments from DOE and DOE contractor facilities.
- EnergyFiles. EnergyFiles is the virtual library of energy science and technology, and is a comprehensive resource of on-line information systems, including those developed by the TIM subprogram and other government organizations. EnergyFiles provides both researchers and the general public with ever-expanding desktop access to over 500 STI resources, searchable by 14 subject categories**.** Users can search full-text heterogeneous information sources with a distributed, single query search tool called Energy Portal.
- Capital Equipment. Capital equipment funding is included for computer hardware (Sun fire server with SPARC technology) to support electronic information exchange efforts of ORACLE database.

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
R&D Tracking System	**202**	**202**	**200**

The DOE R&D Tracking System is the Department's centrally-managed database that tracks key information about each R&D project sponsored or performed by DOE. The System is used for a variety of needs including responding to the annual OSTP data call, facilitating the Department's tracking of R&D projects, and reducing the time spent in responding to ad hoc data calls from within and outside the Department. The R&D Tracking System provides an on-line mechanism for Program Offices and the DOE laboratories to review, manage, update, and analyze the Department's multi-billion dollar R&D program. The R&D Project Summaries Database, the web- based public version of the DOE R&D Tracking System, provides open access to DOE R&D project summaries to U.S. industry, educators, and the public.

Foreign R&D Records	**100**	**100**	**100**

Other industrialized nations are also investing in energy R&D, and the resulting technical information is globally recognized as a valuable commodity that can be exchanged in order to save taxpayer dollars and avoid duplicative research. As an international leader in the area of STI exchange, the TIM subprogram represents DOE and the U.S. in two international information exchanges, the International ETDE and the INIS. Through these exchanges, TIM acquires access to foreign research results. The ETDE agreement involves the exchange of energy-related information among 18 industrialized nations. INIS involves the exchange of nuclear energy information among over 104 countries and 19 international organizations. Funding at the requested level enables the Department to acquire approximately 80,000 new international research records on behalf of the domestic science community through the ETDE partnership.

Electronic and Paper Document Storage	**200**	**200**	**200**

The TIM subprogram's physical facility is the one place where the Department's collection of STI can be found. With the transition to the electronic information age, the repository function for the nation's energy-related science base must adapt to the new media. Interagency standards and agreements must be developed, adopted, and implemented while conserving resources and promoting information access and retrievability. The requested funding level allows for continued storage and preservation of a 50-year archive of 1.2 million historical technical reports. The TIM subprogram also maintains a classified information program that collects, preserves, and exchanges classified, sensitive, and limited circulation documents and houses a comprehensive repository of energy- and weapons-related classified information in a secure environment.

Subtotal, TIM Program Support	**1,198**	**1,400**	**1,250**

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
TIM Program Direction			
Salaries and Benefits	**5,990**	**6,145**	**6,144**

In the TIM subprogram, Federally-staffed functions include policy development and integration; U.S. and DOE representation in interagency and international information exchange agreements; management of safeguards and security activities; administration; personnel management; budget formulation and execution; procurement and contract management; records management; classified information program management; facility management; and collecting, organizing, preserving, and disseminating information resulting from DOE's R&D investment, including re-engineering mission-critical systems to take advantage of electronic information technology. Federal staff implements programs and practices involving all national laboratories and over 7,000 other DOE research entities producing STI.

Travel	**75**	**80**	**80**

Travel funding supports a nationwide program involving national laboratories and thousands of research entities, including coordination of common exchange standards. Alternatives to travel such as teleconferencing will continue to be utilized when possible.

Support Services	**100**	**100**	**100**

Provides for testing systems and concepts related to the TIM subprogram, web-based tools and services, and internal and external automatic data processing as well as support services needed for mailroom operations, environment, safety and health support, computer systems development, and hardware and software installation, configuration, and maintenance activities. Also includes support services needed for safeguards and security activities.

Other Related Expenses	**200**	**200**	**200**

Expenses reflect facility maintenance costs, training for federal employees, telecommunications enhancements designed to support information dissemination, and acquisition of computer hardware and software necessary to accomplish network upgrades.

Subtotal, TIM Program Direction	**6,365**	**6,525**	**6,524**
Total, Technical Information Management	**7,563**	**7,925**	**7,774**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Program Support	
The decrease is a result of the savings achieved by reducing resources dedicated to the development of new e-government information systems. In FY 2004, resources will be dedicated to maintenance of existing systems	-150
Total Funding Change, TIM Program Support	-150
Program Direction	
■ Support for Program Direction is continued at the FY 2003 level.	-1
Total Funding Change, TIM Program Direction	-1
Total Funding Change, TIM	-151

Support Services

	(dollars in thousands)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
Technical Support Services					
Test and Evaluation Studies	70	70	70	0	--
Total, Technical Support Services	70	70	70	0	--
Management Support Services					
ADP Support	30	30	30	0	--
Total, Management Support Services	30	30	30	0	--
Total, Support Services	100	100	100	0	--

Other Related Expenses

	(dollars in thousands)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
Training	10	10	10	0	--
Rental Spaces/Utilities	180	180	180	0	--
Software Procurement/Maintenance Activities/Capital Acquisitions	10	10	10	0	--
Total, Other Related Expenses	200	200	200	0	--

Energy Research Analyses

Mission Supporting Goals and Measures

The Energy Research Analyses (ERA) subprogram supports SC programs through the development of management tools and support, analysis of policy direction set by the Administration and the Congress, development and integration of SC strategic plans and research portfolios, evaluation of programs and performance, and facilitation of SC collaborations with other Federal agencies and major stakeholders.

Accomplishments

- The SC responsiveness to Government Performance and Results Act (GPRA) requirements was improved in FY 2002 through an evaluation of performance measures by a panel of experts under the Basic Energy Sciences Advisory Committee, the development of new tools and analysis mechanisms, and innovative research that has a goal of improving the performance metrics that a basic research organization should use to comply with GPRA.
- Strategic planning efforts were informed by the results of ongoing research and from a 3-year science foresighting study.
- Science policy studies and scientific research trend analyses were provided to SC program managers and to other public science organizations in FY 2002, including the results of case studies in: patent to paper citation analysis; preliminary results in novel performance measures for basic research; and "A Characterization of the Impact of the National Synchrotron Light Source on Life Sciences Research." These studies assess program outcomes and inform future planning efforts. New case studies to document, retrospectively, the outcomes of several elements of the SC Research portfolio were initiated as part of the SC's response to the OMB R&D Investment Criteria including: the "Impacts of the Microbial Genome Program," "Unexpected Applications of a Nuclear Physics Research Tool (Hyperpolarized Gas) Highlighting Fundamental Differences Between The Research Approach Of Mission Agencies When Compared To The National Institutes Of Health;" and "A Research Management Case Study – Applied Math."
- The SC led Federal government efforts to fully implement OMB's R&D Investment Criteria, including sponsoring a major inter-agency workshop that featured expert private sector evaluators.
- A new tool was developed for the analysis of public benefit outcomes from the SC research portfolio. This tool can be used to analyze and characterize the impact of SC research on U.S. patents. One insight the tool revealed provides clear evidence that U.S. companies overwhelmingly garner the most benefit (82%), compared to international companies, from SC and national laboratory research. This tool has been shared with the national laboratories for further development and use in the management of intellectual property.
- Management practices were better informed through the dissemination to DOE senior program managers of the results of a literature review of best practices in science management.
- Science communications was advanced through sponsorship of the first ever government-wide science communications best practice workshop and the complete revamping of the SC website to make it more interactive, informative and useful to the general public.

Subprogram Goals

Develop and implement best-in-class tools and methods for evaluating the excellence, relevance and performance of SC basic research programs; and conduct case studies and other evaluations to document the societal outcomes of SC basic research programs. Conduct prospective analyses of emerging science management issues, future research opportunities, and research portfolio balance to support long-range planning and decision making for SC; and prepare strategic plans for future SC investments built upon its mission, its core competencies, and emerging research issues. Develop tools and methods, communities of practice, effective networks, and deployment strategies to improve access to SC information, programs and resources.

Performance Indicators

Number and quality of evaluation techniques adopted by SC. Number and quality of analyses performed. Indicators of access and awareness of SC program information and resources by different audiences.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
In close collaboration with OMB, Office of Science and Technology Policy (OSTP) and other federal science agencies, develop an implementation strategy for the SC to fully incorporate the OMB R&D Investment Criteria for Basic Research.	Collaborate with OMB, OSTP and other federal science agencies to develop tools and methods for documenting the implementation of the OMB R&D Investment Criteria for Basic Research in the SC.	Develop software tools to manage and gather information about S&T research. This will emphasize investigation within a research area and across research areas to identify unexpected interconnections and impacts.
Initiated four pilot studies – 3 retrospective case studies and 1 prospective study to examine the societal impact of SC research.	Initiate four studies – 3 retrospective case studies and 1 prospective study to examine the societal impact of SC research.	Conduct 3 retrospective case studies to examine the outcomes and societal impact of SC research.
Complete Phase 2 and begin Phase 3 of studies to explore the global challenges over next 25 years that may affect future S&T management and policy.	Complete Phase 3 and prepare final set of scenarios on S&T management challenges that may emerge over the next 25 years.	The results of the studies commissioned in FY 2002 and FY 2003 will inform the work being pursued in FY 2004.
Create unique tools to identify the impact of publicly funded science on our nation's economy and scientific enterprise.	Conduct a study on the linkages between seemingly disparate branches of science with regard to reliance on large-scale research tools.	Advance the use of datamining and visualization tools for R&D portfolio.
Benchmark the U.S. position in international science.	Create unique resources using datamining and visualization tools for R&D portfolio management.	
Improve and integrate performance planning and measures between budget documents and DOE performance plans.	Publish results of quantitative performance measures study in open literature; fully incorporate into SC evaluation regime.	Integrate the retrospective case study findings to develop good metrics to produce excellent management techniques and processes.
Develop guidelines for consistently measuring performance of SC programs. Seek SC advisory committee advice.	Implement advisory committee recommendations. Update and publish the SC strategic plan.	

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Develop overarching strategic framework and strategic themes for new SC strategic plan.		
Sponsored a ground-breaking, international conference on "Best Practices in Public Communication of Science, Health and Technology" including presentation and publication of peer-reviewed papers to widely disseminate best practices.	Implement results of best practices studies. Develop tools to publicize SC's unique scientific achievements, initiate interagency collaborations on implementation and further best-practices research. Develop a standard set of information about each program's benefits and societal impact.	Prior-year study to culminate in integrated approach for validating to a broad audience our scientific achievements, demonstrating the linkages of SC scientific achievements and how it serves as the corner stone to other science agencies.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Energy Research Analyses	968	993	1,020	+27	+2.7%
SBIR/STTR	0	27	0	-27	-100.0%
Total, Energy Research Analyses.......	968	1,020	1,020	0	--

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Energy Research Analyses	**968**	**993**	**1,020**

In FY 2004, ERA will focus on three major areas:

- *Corporate Communications* will communicate the benefit of SC's scientific achievements and ensure that SC contributions and capabilities are widely recognized. The impact and role of the SC in the science and technology infrastructure are not well understood. Communications in this area need improvement. To better understand the barriers to communications, ERA hosted an international conference on "Best Practices in Public Communication of Science, Health and Technology." Lessons learned from this conference are currently being implemented through such efforts as: redesign of the SC web page and improvements to the web-based newsletter "Energy Science News"; improved coordination between the SC and its laboratories through clearer reporting mechanisms and the identification of a single point of contact for each laboratory and for the Office of Science; initiation of a "Science Speakers Bureau"; publication of outcome and public benefit studies in peer-reviewed literature; publication and wide-dissemination of management best practices, including science communications best practices; and stronger interagency collaborations. FY 2004 funding will allow for: continued research on science communications; better training of the Public Affairs practitioners at the National Labs, further improvements to the SC webpage; an increase in the number and quality of SC publications aimed at communicating with the public; increased presence at trade conferences and meetings; and increased use of electronic news media to reach science attentive audiences. ERA also supports management of the Enrico Fermi Awards and the E.O. Lawrence Awards.
- *Case Studies* will be conducted by independent researchers to identify trends in the DOE research portfolio, as well as areas of portfolio performance that could be optimized, and to document the impacts of the basic research supported by the SC. This activity strongly supports SC implementation of the OMB R&D Investment Criteria and the GPRA. FY 2004 funding will allow ERA to characterize and document: the linkages between basic and applied research in the DOE; societal impacts (e.g., improved health, economic growth, etc.) from SC research; the methods by which SC research diffuses through the national S&T infrastructure; and other high impact areas of study that demonstrate the impact of the SC portfolio. All case studies will be submitted for publication in peer-reviewed literature and on the SC webpage. Case studies that identify trends in the DOE research portfolio, such as undesirable duplications and gaps, are part of the legislative mandate of this program and also provide validation of the continued relevance of the SC portfolio to DOE missions as called for in the Investment Criteria.

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004

- *Original and Collaborative Research* efforts will inform policy direction, characterize key issues in the research environment and their affect on SC programs, and identify potential duplications, gaps and opportunities within the Department's basic research portfolio by collaborating with SC or DOE programs, other agencies, the national laboratories or universities. Research projects and collaborations with other agencies will inform the development of indicators of SC's performance, quality, and relevance including the development of methods and tools for collecting data, tracking progress and reporting against these indicators. This research will also contribute to a broad based effort to develop computational tools and visualization techniques designed to manage vast amounts of data to assist in policy and planning for the SC research programs. These tools complement the case studies described above by providing the means by which the need for a case study can be identified. Critical to the success of this effort is improvement in the quality and quantity of data describing SC research projects.

SBIR/STTR	**0**	**27**	**0**

In FY 2002, $25,000 and $1,000 were transferred to the SBIR and Small Business Technology Transfer (STTR) programs, respectively. The FY 2003 amount is the estimated requirement for the continuation of the SBIR and STTR program.

Total, Energy Research Analyses	**968**	**1,020**	**1,020**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Energy Research Analyses	
■ ERA is continued at the FY 2003 level with emphasis shifting to implementation of FY 2001-2003 research results and to facilitating Office of Science implementation of the OMB R&D Investment Criteria and the Government Performance and Results Act (GPRA) with a focus on improving performance goals and measures.	+27
SBIR/STTR	
■ Decrease due to elimination of SBIR/STTR requirement as ERA is consolidated into Science Program Direction.	-27
Total Funding Change, Energy Research Analyses	0

Capital Operating Expenses & Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Capital Equipment	100	150	150	0	--
Total, Capital Operating Expenses	100	150	150	0	--

Workforce Development for Teachers and Scientists

Program Mission

The mission of the Workforce Development for Teachers and Scientists program is to continue the Department's long-standing role of training young scientists, engineers and technicians in the scientifically and technically advanced environment of our National Laboratories. Through providing a wide variety of college undergraduates the opportunity to work side by side with many of the world's best scientists and use the most advanced scientific instruments available, this program intends to expand the nation's supply of well-trained scientists and engineers, especially in the physical sciences where the greatest demand lies. By providing K-14 teachers, mentor-intensive laboratory fellowships, this program will greatly enhance their content knowledge and skills of mathematics and science and can contribute to the national goal of a qualified teacher in every classroom.

The Workforce Development for Teachers and Scientists program supports three science, technology and workforce development subprograms: 1) Undergraduate Internships, for undergraduate students wishing to enter science, technology, engineering and mathematics (STEM), as well as with science and math teaching careers; 2) Graduate/Faculty Fellowships for STEM teachers and faculty; and 3) Pre-College Activities for middle and high school students such as the National Science Bowl. Each of the subprograms targets a different group of students and teachers to attract as broad a range of participants to the programs and to expand the pipeline of students who can enter the STEM workforce. In this fashion, the subprograms use our National Laboratories to meet the demand for a well-trained scientific and technical workforce, including those teachers that help spawn that workforce.

In response to the growing national need for highly trained teachers in their content area, the Office of Science plans to initiate a pilot program at Argonne National Laboratory (ANL) for K-14 STEM teachers, the *Laboratory Science Teacher Professional Development* activity within the Graduate/Faculty Fellowship subprogram. Through mentor-intensive experiences teachers will be provided a range of research, technical education, and training options designed to improve their classroom performance, their students' achievement, and their content knowledge in the subjects they teach. Follow-on support is critical. All teachers completing the initial laboratory experience will be provided: monetary support to help them extend what they have learned to their classes; support to enable student involvement, when appropriate, in National Laboratory research; long-term support through communication with other participant teachers and laboratory scientists; return trips to the laboratory; and support to present their experiences at professional conferences and in publications.

Significant Program Shifts

- The FY 2004 request of $6,470,000 for "Workforce Development for Teachers and Scientists" budgets Science Education in a new program. The former subprogram name changes from "Science Education" (budgeted in Science Program Direction prior to FY 2004) to "Workforce Development for Teachers and Scientists" program to more accurately reflect the program mission and scope.
- In response to the national need for science teachers who have strong content knowledge in the classes they teach, the Department is proposing a new $1,000,000 internship opportunity at ANL for K-14 teachers to help address that need. The Department of Energy National Laboratories can provide mentor-intensive professional development that compliments the efforts of states and federal agencies. The multidisciplinary, team-centered, scientific culture of the National Laboratories is an

ideal setting for teachers to make the connections between the science and technology principles they are asked to teach. More importantly, the extensive mentoring power of our laboratory scientists is an excellent vehicle to establish fruitful, lasting relationships that would allow teachers to remain connected to the scientific community once they return to the classroom. Armed with this knowledge and experience, each teacher could enter the classroom as a genuine effective representative of the exciting world of science and technology. Teacher classroom performance and student academic and career paths will help measure the long-term impact of this program.

- It is well recognized that the middle school years are the most productive time to exert an effort to attract students to science and math subjects. In FY 2002 and FY 2003 there was a small pilot for the Middle School Science Bowl and it was conducted under the auspices of the National Science Bowl. The Middle School Science Bowl activity will be expanded in FY 2004 and provide opportunities for students to develop their science and math skills in a non-classroom setting. Carefully crafted activities that are based on successful hands-on activity models will be conducted to attract their imagination, excite their interest and provide a chance for the students to experience applied science under the direction of professional scientists and engineers. Students who win in regional events will then enjoy a trip to a National Laboratory and participate in a final three day event that is designed to capture their interest and reward them for their hard work.

Funding Profile

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Request	FY 2004 Request	$ Change	% Change
Workforce Development for Teachers and Scientists					
Undergraduate Internships	3,165	4,075	3,768	-307	-7.5%
Graduate/Faculty Fellowships	568	725	1,900	+1,175	+162.1%
Pre-College Activities	727	660	802	+142	+21.5%
Subtotal, Workforce Development for Teachers and Scientists	4,460	5,460	6,470	+1,010	18.5%
Adjustment	0	0	0	0	--
Total, Workforce Development for Teachers and Scientists	4,460[a]	5,460[a]	6,470	+1,010	18.5%

Public Law Authorization:
Public Law 95-91, "Department of Energy Organization Act"
Public Law 103-62, "Government Performance and Results Act of 1993"

[a] Includes $4,460,000 in FY 2002 and $5,460,000 in FY 2003 for Science Education transferred from Science Program Direction.

Funding by Site[a]

	FY 2002	FY 2003	FY 2004	$ Change	% Change
	(dollars in thousands)				
Albuquerque Operations Office					
National Renewable Energy Laboratory	0	150	200	+50	+33.3%
Chicago Operations Office					
Argonne National Laboratory	430	615	570	-45	-7.3%
Brookhaven National Laboratory	430	615	522	-93	-15.1%
Fermi National Laboratory	20	100	50	-50	-50.0%
Princeton Plasma Physics Laboratory	125	100	150	+50	+50.0%
Chicago Operations Office	443	500	600	+100	+20.0%
Total, Chicago Operations Office	1,448	1,930	1,892	-38	-2.0%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	10	0	100	+100	+100.0%
Total, Idaho Operations Office	10	0	100	+100	+100.0%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	505	750	600	-150	-20.0%
Stanford Linear Accelerator Center	150	150	150	0	---
Total, Oakland Operations Office	655	900	750	-150	-16.7%
Oak Ridge Operations Office					
Oak Ridge Institute for Science and Education	1,377	1,250	1,292	+42	+3.4%
Thomas Jefferson National Accelerator Facility	50	100	100	0	---
Oak Ridge Operations Office	75	75	90	+15	+20.0%
Total, Oak Ridge Operations Office	1,502	1,425	1,482	+57	+4.0%
Richland Operations Office					
Pacific Northwest National Laboratory	635	740	690	-50	-6.8%
Richland Operations Office	150	220	0	-220	-100.0%
Total, Richland Operations Office	785	960	690	-270	-28.1%
Washington Headquarters	60	95	1,356	+1,261	+1,327.4%
Total, Workforce Development for Teachers and Scientists	4,460[b]	5,460[b]	6,470	+1,010	+18.5%

[a] On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format.

[b] Includes $4,460,000 in FY 2002 and $5,460,000 in FY 2003 for Science Education transferred from Science Program Direction.

Site Description

Argonne National Laboratory

Argonne National Laboratory (ANL) in Argonne, Illinois, is a multi-program laboratory located on a 1,700-acre site in suburban Chicago. Argonne research falls into 4 broad categories: basic science, scientific facilities, energy resources, and environmental management. ANL has a satellite site located in Idaho Falls, Idaho. This site, referred to as Argonne-West, occupies approximately 900 acres and is the home of most of Argonne's major nuclear reactor research facilities. Workforce development for scientists, technicians, engineers, and mathematics along with teachers of these disciplines are conducted at the National Laboratories through research internships and fellowships that fully immerse the participants in state-of-the-art technologies with the added benefit of a mentor-intensive relationship that helps guide them through their stay at the laboratory and fosters their continuing in STEM and science-teaching careers.

Brookhaven National Laboratory

Brookhaven National Laboratory (BNL) is a multi-program laboratory located on a 5,200-acre site in Upton, New York. BNL creates and operates major facilities available to university, industrial, and government personnel for basic and applied research in the physical, biomedical, and environmental sciences, and in selected energy technologies. Workforce development for scientists, technicians, engineers, and mathematics along with teachers of these disciplines are conducted at the National Laboratories through research internships and fellowships that fully immerse the participants in state-of-the-art technologies with the added benefit of a mentor-intensive relationship that helps guide them through their stay at the laboratory and fosters their continuing in STEM and science-teaching careers.

Fermi National Accelerator Laboratory

Fermi National Accelerator Laboratory (Fermilab) is located on a 6,800-acre site in Batavia, Illinois. It is the largest U.S. laboratory for research in high-energy physics and is second only to CERN, the European Laboratory for Particle Physics, in the world. About 2,500 scientific users, scientists from universities and laboratories throughout the U.S. and around the world, use Fermilab for their research. Fermilab's mission is the goal of high-energy physics: to learn what the universe is made of and how it works. Fermilab builds and operates the facilities that high-energy physicists need to do forefront research, and develops new accelerator technology for the experiments of the future. Fermilab is operated by Universities Research Association, a consortium of 89 research universities. Workforce development for scientists, technicians, engineers, and mathematics along with teachers of these disciplines are conducted at the National Laboratories through research internships and fellowships that fully immerse the participants in state-of-the-art technologies with the added benefit of a mentor-intensive relationship that helps guide them through their stay at the laboratory and fosters their continuing in STEM and science-teaching careers.

Idaho National Engineering and Environmental Laboratory

The Idaho National Engineering and Environmental Laboratory (INEEL) is located on 890 square miles in the southeastern Idaho desert. Other INEEL research and support facilities are located in nearby Idaho Falls. Within the laboratory complex are nine major applied engineering, interim storage and research and development facilities, operated by Bechtel, B&W Idaho for the U.S. Department of Energy. Today, INEEL is solving critical problems related to the environment, production and use of energy, U.S. economic competitiveness, and national security. Workforce development for scientists, technicians, engineers, and mathematics along with teachers of these disciplines are conducted at the National Laboratories through research internships and fellowships that fully immerse the participants in state-of-the-art technologies with the added benefit of a mentor-intensive relationship that helps guide them through their stay at the laboratory and fosters their continuing in STEM and science-teaching careers.

Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory (LBNL) is a multi-program laboratory located in Berkeley, California, on a 200-acre site adjacent to the Berkeley campus of the University of California. LBNL is dedicated to performing leading-edge research in the biological, physical, materials, chemical, energy, and computer sciences. LBNL also operates unique user facilities available to qualified investigators. Workforce development for scientists, technicians, engineers, and mathematics along with teachers of these disciplines are conducted at the National Laboratories through research internships and fellowships that fully immerse the participants in state-of-the-art technologies with the added benefit of a mentor-intensive relationship that helps guide them through their stay at the laboratory and fosters their continuing in STEM and science-teaching careers.

National Renewable Energy Laboratory

The National Renewable Energy Laboratory (NREL) is located on a 300-acre campus at the foot of South Table Mountain in Golden, Colorado. It is the world leader in renewable energy technology development. Since its inception in 1977, NREL's sole mission has been to develop renewable energy and energy efficiency technologies and transfer these technologies to the private sector. Workforce development for scientists, technicians, engineers, and mathematics along with teachers of these disciplines are conducted at the National Laboratories through research internships and fellowships that fully immerse the participants in state-of-the-art technologies with the added benefit of a mentor-intensive relationship that helps guide them through their stay at the laboratory and fosters their continuing in STEM and science-teaching careers.

Oak Ridge Institute for Science and Education

Oak Ridge Institute for Science and Education (ORISE) is located on a 150-acre site in Oak Ridge, Tennessee. ORISE conducts research into modeling radiation dosages for novel clinical, diagnostic, and therapeutic procedures. In addition, ORISE coordinates several research fellowship programs and the peer review of all Basic Energy Sciences funded research. ORISE manages and administers ORNL undergraduate research opportunities for students and faculty.

Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL) is a multi-program laboratory located on a 24,000-acre site in Oak Ridge, Tennessee. Scientists and engineers at ORNL conduct basic and applied research and development to create scientific knowledge and technological solutions that strengthen the nation’s leadership in key areas of science; increase the availability of clear, abundant energy; restore and protect the environment; and contribute to national security. Workforce development for scientists, technicians, engineers, and mathematics along with teachers of these disciplines are conducted at the National

Laboratories through research internships and fellowships that fully immerse the participants in state-of-the-art technologies with the added benefit of a mentor-intensive relationship that helps guide them through their stay at the laboratory and fosters their continuing in STEM and science-teaching careers.

Pacific Northwest National Laboratory

Pacific Northwest National Laboratory (PNNL) is a multi-program laboratory located on 640 acres at the Department's Hanford site in Richland, Washington. PNNL conducts research in the area of environmental science and technology and carries out related national security, energy, and human health programs. Workforce development for scientists, technicians, engineers, and mathematics along with teachers of these disciplines are conducted at the National Laboratories through research internships and fellowships that fully immerse the participants in state-of-the-art technologies with the added benefit of a mentor-intensive relationship that helps guide them through their stay at the laboratory and fosters their continuing in STEM and science-teaching careers.

Princeton Plasma Physics Laboratory

Princeton Plasma Physics Laboratory (PPPL) is a program-dedicated laboratory (Fusion Energy Sciences) located on 72 acres in Princeton, New Jersey. The primary mission of PPPL is to develop the scientific understanding and the innovations, which will lead to an attractive fusion energy source. Associated missions include conducting world-class research along the broad frontier of plasma science and providing the highest quality of scientific education. Workforce development for scientists, technicians, engineers, and mathematics along with teachers of these disciplines are conducted at the National Laboratories through research internships and fellowships that fully immerse the participants in state-of-the-art technologies with the added benefit of a mentor-intensive relationship that helps guide them through their stay at the laboratory and fosters their continuing in STEM and science-teaching careers.

Richland Operations Office

Richland is responsible for and manages all environmental cleanup and science and technology development at the 560 square mile Hanford Site, coordinating closely with contractor companies hired to manage and complete the work of the world's largest cleanup project. The primary contractors are Fluor Daniel Hanford and its subcontractors, the Bechtel Hanford, Inc, the Hanford Environmental Health Foundation, and the Battelle Memorial Institute, which serves as the contractor for Laboratory operations of the Pacific Northwest National Laboratory. Richland also manages the cooperative agreement with Associated Western Universities to administer research appointments at National Laboratories and universities, for undergraduate students and faculty, as part of the Office of Science funded Education Programs.

Stanford Linear Accelerator Center

Stanford Linear Accelerator Center (SLAC) is a program-dedicated laboratory (High Energy Physics) located on 426 acres in Menlo Park, California. SLAC is a national basic research laboratory, probing the structure of matter at the atomic scale with x-rays and at much smaller scales with electron and positron beams. SLAC scientists perform experimental and theoretical research in elementary particle physics using electron beams, plus a broad program of research in atomic and solid state physics, chemistry, biology, and medicine using synchrotron radiation. There are also active programs in the development of accelerators and detectors for high-energy physics research and of new sources and instrumentation for synchrotron radiation research. Workforce development for scientists, technicians, engineers, and mathematics along with teachers of these disciplines are conducted at the National Laboratories through research internships and fellowships that fully immerse the participants in state-of-the-art technologies with the added benefit of a mentor-intensive relationship that helps guide them through their stay at the laboratory and fosters their continuing in STEM and science-teaching careers.

Thomas Jefferson National Accelerator Facility

Thomas Jefferson National Accelerator Facility (TJNAF) is a program-dedicated laboratory (Nuclear Physics) located on 273 acres in Newport News, Virginia. TJNAF is a basic research laboratory built to probe the nucleus of the atom to learn more about the quark structure of matter. The Laboratory gives scientists a unique and unprecedented probe to study quarks, the particles that make up protons and neutrons in an atom's nucleus. Workforce development for scientists, technicians, engineers, and mathematics along with teachers of these disciplines are conducted at the National Laboratories through research internships and fellowships that fully immerse the participants in state-of-the-art technologies with the added benefit of a mentor-intensive relationship that helps guide them through their stay at the laboratory and fosters their continuing in STEM and science-teaching careers.

Undergraduate Internships

Mission Supporting Goals and Measures

The Undergraduate Internships subprogram contains three activities:

The "Science Undergraduate Laboratory Internship" activity (formerly known as Energy Research Undergraduate Laboratory Fellowship [ERULF]) is designed to provide workforce development through research experiences at DOE laboratories for highly motivated undergraduate students from any two or four year accredited college or university. These internship opportunities complement the students' academic training and introduce them to the unique intellectual and physical resources present at the DOE laboratories. Appointments are available during the spring, summer, and fall terms. These research opportunities have also been extended, in collaboration with the National Science Foundation (NSF), to undergraduate students in NSF programs, careers in science, mathematics or technology.

The "Community College Institute (CCI) of Science and Technology" provides a 10-week workforce development program through research experiences at several DOE National Laboratories for highly motivated community college students. The CCI is targeted at underserved community college students who have not had an opportunity to work in an advanced science-research environment. It incorporates both an individually mentored research component and a set of enrichment activities that include: lectures, classroom activities, career guidance/planning, and field trips. Appointments are available during the summer. This activity has also been extended, in collaboration with the National Science Foundation (NSF), to community college students and faculty in NSF funded programs that might not otherwise have an advanced research opportunity.

"Pre-Service Teachers" (PST) is for undergraduate students who have decided on a teaching career in science, technology, engineering or mathematics. Students work with scientists or engineers on projects related to the laboratories' research programs. They also have the mentorship of a Master Teacher who is currently working in K-12 education as a teacher and is familiar with the research environment of a specific National Laboratory. Appointments are available during the summer. This activity began in collaboration with the National Science Foundation (NSF) and has been extended to all pre-service teachers.

PROGRAM ACCOMPLISHMENTS

- An innovative, interactive Internet system has been developed and implemented for all Office of Science national workforce development programs, to receive and process hundreds of student and teacher/faculty applications for summer, fall, and spring semester research appointments at participating DOE laboratories. The automated system is virtually paperless and provides an excellent example of how the Internet can be used to streamline the operation of the Department's research participation programs. The on-line application system is linked with an SC laboratory central processing center called Education Link.

  This system enhances communication with the participants regarding their internships, contains pre- and post-surveys that quantify student knowledge, performance and improvement, allows SC to measure program effectiveness, track students in their academic and career path, and be a hosting site for publishing student papers, abstracts and all activity guidelines.

- Through special recruitment efforts, the Science Undergraduate Laboratory Internship (formerly ERULF, now SULI) has attracted a diverse group of students using the electronic application. Nearly 20 percent of those submitting applications were from under-represented groups. Approximately 40 percent of the applicants were females, and more than 25 percent were from low-income families. In the summer of 1999, more than 400 appointments were made through the new application process and in the summers of 2000, 2001 and 2002 more than 500 appointments were made each year through the new application process.
- An undergraduate student journal was created and publishes full-length peer-reviewed research papers and abstracts of students in the activity. A second edition was published in 2002, with 15 full-length papers and 350 abstracts. The students who published full-length papers presented their work at a poster session at the American Association for the Advancement of Science (AAAS) national meeting in Boston. One of the students won a poster award at the AAAS meeting.
- Two Program Guidebooks were written for the student participants: 1) SULI and the Community College Initiative (CCI) guidebook provides formats and instructions for the written requirements, including scientific abstract, research paper, oral presentation, and poster; and 2) Pre-Service (PST) guidebook also includes instructions for an education module.
- The DOE Community College Institute of Science and Technology is no longer a pilot and is open to students from all community colleges. In the summer of 2002, more than 125 community college students attended a 10-week mentor-intensive scientific research experience at several DOE National Laboratories. Almost 60 percent of the participating students came from underrepresented groups in STEM disciplines; many were “non-traditional” students.

Subprogram Goals

Expand the number and diversity of participants in the Science Undergraduate Laboratory Internships, the Community College Institute (CCI) for Science and Technology, and Pre-Service Teacher (PST) programs, by establishing partnerships with other federal agencies and professional educational organizations. Also, evaluate the programs to assess the overall quality and relevance of the intern experience and track the students to determine the impact of these programs on advanced education and career goals.

Performance Indicator

Number of applicants; quality of mentorship; tracking of academic and career choices.

Annual Performance Results and Targets

FY 2002 Targets/Results	FY 2003 Targets	FY 2004 Targets
More than 1,600 applicants for the Undergraduate Internships were received (60% increase in applications). 470 students were selected for summer 2002. [Met Goal]	Increase the number and/or diversity of the applicants by 20% over FY 2002 level.	Increase the number and/or diversity of the applicants by 10%, leading to a more select group of students entering the program.
90% of students submitted acceptable abstracts. [Met Goal]	90% of approximately 500 students will submit acceptable abstracts.	90% of approximately 500 students will submit research abstracts judged as high quality by independent review.

FY 2002 Targets/Results	FY 2003 Targets	FY 2004 Targets
Develop tracking mechanisms to follow employment and career choices of participants at National laboratories and associated institutions. [Goal not met]	Complete the development of the tracking mechanisms and establish a baseline to begin following employment and career choices of participating students.	Track career choices of at least 30% of participating students, which will baseline long-term benefits of the program.
On-site review of workforce development programs at each laboratory by independent evaluators.	Evaluate quality of workforce development programs through independent evaluators.	SC Institutional Plan on-site reviews will include Workforce Development programs. Evaluate quality of workforce development programs through independent evaluators.

Funding Schedule

	(dollars in thousands)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
Science Undergraduate Laboratory Internship	2,206	3,050	2,653	-397	-13.0%
Community College Institute of Science and Technology	695	625	605	-20	-3.2%
Pre-Service Teachers	264	400	510	+110	+27.5%
Total, Undergraduate Internships	3,165	4,075	3,768	-307	-7.5%

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Science Undergraduate Laboratory Internship	**2,206**	**3,050**	**2,653**

The Science Undergraduate Laboratory Internship (formerly ERULF) supports a diverse group of students at our National Laboratories in individually mentored research experiences. Through these unique and highly focused experiences these students will comprise a repository of talent to help the DOE meet its science mission goals. The paradigms of the activity are: 1) students apply on a competitive basis and are matched with mentors working in the students' fields of interest; 2) students spend an intensive 10-16 weeks working under the individual mentorship of resident scientists; 3) students must each produce an abstract and formal research report; 4) students attend seminars that broaden their view of career options and help them understand how to become members of the scientific community; and 5) activity goals and outcomes are measured based on students' research papers, students' abstracts, surveys and outside evaluation. An undergraduate student journal was created that publishes selected full research papers and all abstracts of students in the activity. Students who publish in this journal present their research at the annual AAAS meeting. The National Science Foundation (NSF) began a collaboration with this activity as of FY 2001. The activity will ensure a steady flow of students with technical expertise into the Nation's pipeline of workers in both academia and industry. A system is being created to track students in their academic career paths.

	FY 2002	FY 2003	FY 2004
	(dollars in thousands)		
Community College Institute of Science and Technology	**695**	**625**	**605**

The Community College Institute (CCI) of Science and Technology was originally a collaborative effort between DOE and its National Laboratories with the American Association of Community Colleges and specified member institutions. Through a recent Memorandum of Understanding with the NSF, undergraduate students in NSF programs (e.g., Lewis Stokes Alliance for Minority Participation and Advanced Technology Education program) are also participating in this activity and in FY 2002 the CCI was made available to students from all community colleges. This activity is designed to address shortages, particularly at the technician and paraprofessional levels and will help develop the workforce needed to continue building the Nation's capacity in critical areas for the next century. Since community colleges account for more than half of the entire nation's undergraduate enrollment, this is a great avenue to find and develop talented scientists and engineers. The Institute provides a ten-week mentored research internship at a DOE National Laboratory for highly motivated community college students. The paradigms of the activity are: 1) students apply on a competitive basis and are matched with mentors working in the students' field of interest; 2) students spend an intensive 10 weeks working under the individual mentorship of resident scientists; 3) students must each produce an abstract and formal research report; 4) students attend professional enrichment activities, workshops and seminars that broaden their view of career options, help them understand how to become members of the scientific community, and enhance their communication and other professional skills; and 5) activity goals and outcomes are measured based on students' research papers, students' abstracts, surveys and outside evaluation. An undergraduate student journal was created that publishes selected full research papers and all abstracts of students in this activity. The National Science Foundation entered into a collaboration with this activity in FY 2001. This allows NSF's undergraduate programs to include a community college internship in their opportunities they provide to students.

	FY 2002	FY 2003	FY 2004
Pre-Service Teachers	**264**	**400**	**510**

The Pre-Service Teachers activity is for students who are preparing for a teaching career in a STEM discipline. This effort is aimed at addressing the national need to improve content knowledge of STEM teachers prior to entering the teaching workforce. The paradigms of the activity are: 1) students apply on a competitive basis and are matched with mentors working the student's field of interest; 2) students spend an intensive 10 weeks working under the mentorship of master teachers and laboratory scientists to help maximize the building of content, knowledge, and skills through the research experience; 3) students must produce an abstract and an educational module related to their research and may also produce a research paper or poster or oral presentation; 4) students attend professional enrichment activities, workshops and seminars that help students apply what they learn to their academic program and the classroom, and also to help them understand how to become members of the scientific community, and enhance their communication and other professional skills; and 5) activity goals and outcomes are measured based on students' abstracts, education modules, surveys and outside evaluation.

	FY 2002	FY 2003	FY 2004
Total, Undergraduate Internships	**3,165**	**4,075**	**3,768**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
■ The number of Science Undergraduate Laboratory Internship decreases by 66 students.	-397
■ The number of students in the Community College Institute of Science and Technology decreases by 4.	-20
■ The number of students participating in the Pre-Service Teachers activity will increase by 20.	+110
Total Funding Change, Undergraduate Internships	-307

Graduate/Faculty Fellowships

Mission Supporting Goals and Measures

The Graduate/Faculty Fellowships subprogram contains four activities:

In response to the national need for science teachers who have strong content knowledge, the Department is proposing a Laboratory Science Teacher Professional Development pilot fellowship at Argonne National Laboratory for K-14 teachers that will provide a mentor-intensive scientific professional development activity to improve their classroom performance and the achievement of their students.

The Faculty and Student Teams program provides research opportunities at a DOE National Laboratory to faculty and undergraduate students from colleges and universities with limited prior research capabilities and those institutions serving populations, women, and minorities underrepresented in the fields of science, engineering, technology and community college faculty, enabling a broader and lasting impact on undergraduate programs. These opportunities are also extended to faculty from NSF funded institutions.

The “Albert Einstein Distinguished Educator Fellowship” activity supports outstanding K-12 science and mathematics teachers, who provide insight, extensive knowledge, and practical experience to the Legislative and Executive branches. This activity is in compliance with the Albert Einstein Distinguished Educator Act of 1994 (signed into law in November 1994). The law gives DOE responsibility for administering the activity of distinguished educator fellowships for elementary and secondary school mathematics and science teachers.

The used “Energy Related Laboratory Equipment” (ERLE) activity was established by the United States Department of Energy (DOE) to grant available excess equipment to institutions of higher education for energy-related research.

PROGRAM ACCOMPLISHMENTS

- An innovative, interactive Internet system has been developed and implemented for all Office of Science national workforce development programs, to receive and process hundreds of student and teacher/faculty applications for summer, fall, and spring semester research appointments at participating DOE laboratories. The automated system is virtually paperless and provides an excellent example of how the Internet can be used to streamline the operation of the Department’s research participation programs. The on-line application system is linked with an SC laboratory central processing center called Education Link.

  This system enhances communication with the participants regarding their internships, contains pre- and post-surveys that quantify student knowledge, performance and improvement, allows SC to measure program effectiveness and track students in their academic and career path, and be a hosting site for publishing student papers, abstracts and all activity guidelines.

- The Albert Einstein Distinguished Educator Fellowship Activity placed four outstanding K-12 science, math, and technology teachers in Congressional offices and two at DOE, as directed by legislation. The National Aeronautics and Space Administration, the National Science Foundation, and the National Institute of Standards and Technology contributed funds to place seven additional Einstein Fellows in those agencies.

- A pilot Faculty and Student Team (FaST) activity was hosted at three Office of Science laboratories – Argonne National Laboratory, Lawrence Berkeley National Laboratory, and Pacific Northwest National Laboratory-- in collaboration with the National Science Foundation. Faculty and students from colleges and universities with limited prior research capabilities and those institutions serving populations, women, and minorities underrepresented in the fields of science, engineering, and technology were part of a research team at a National Laboratory. Over a ten week summer visit to the laboratory the faculty were introduced to new and advanced scientific techniques that will help them prepare their students for careers in science, engineering, computer sciences and technology and for their own professional development.

Subprogram Goals

Develop grade level K-14 STEM teachers as leaders in their profession and as members of the extended scientific and technical community. Develop a tracking system to determine quality of the activity and long term impact on physical science courses being offered; inquiry based instruction in the classroom that is at grade level and matched to local standards and benchmarks; use of technology; and leadership roles in education activities.

Performance Indicator

Number of leadership roles and quality of classroom teaching techniques.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
	Develop the Laboratory Science Teacher Professional Development initiative to support professional development of K-14 STEM teachers.	Implement the Laboratory Science Teacher Professional Development initiative pilot at Argonne National Laboratory and provide follow-up support to participants. Track teachers with respect to their leadership roles and changes in their classroom teaching techniques.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Laboratory Science Teacher Professional Development	0	0	1,000	+1,000	+100.0%
Faculty and Student Teams	50	150	210	+60	+40.0%
Albert Einstein Distinguished Educator Fellowship	443	500	600	+100	+20.0%
Energy Related Laboratory Equipment	75	75	90	+15	+20.0%
Total, Graduate/Faculty Fellowships	568	725	1,900	+1,175	+162.1%

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Laboratory Science Teacher Professional Development	**0**	**0**	**1,000**

The *National Commission on Mathematics and Science Teaching* and numerous other studies indicate that *professional staff development is one of the most effective ways of improving the achievement of K-14 students.* The National Laboratories can play a significant role in providing carefully designed *mentor-intensive training for science and math teachers* that will allow them to more effectively teach, *attract their students' interests to science, mathematics and technology careers*, and improve student achievement. The paradigms of the pilot "*Laboratory Science Teacher Professional Development*" activity are: 1) Teachers apply on a competitive basis and are matched with mentors working in their subject fields of instruction; 2) in the first year *about 60 teachers spend an intensive 4 to 8 weeks at a National laboratory* working under the mentorship of master teachers and laboratory mentor scientists to help build content knowledge research skills and a lasting connection with the scientific community through the research experience. *Master teachers*, who are expert K-14 teachers and adept in both scientific research experience at a National Laboratory and scientific writing, *will act as liaisons between the mentor scientists and the teacher researchers to help the teachers transfer the research experience to their classroom environments*; 3) follow-on support is considered critical. Master teachers and other teacher participants receive an $800/week stipend, travel and housing expenses. All teachers completing the initial immersion experience will be provided monetary support, which consists of approximately $3,000 to *purchase materials and scientific equipment*, to help them transfer their research experience to their classroom. Follow-on support also will include: Returning to the laboratory in the first year for *additional training sessions* of approximately 1 week long; and *long-term support* in following years through communication with other participants and laboratory scientists, more *return trips* to the National Laboratory, and support to *present their experience at teaching conferences and publications*; and 4) *outside evaluation* of program effectiveness including visits to participant teachers' schools and long term impact of the program on student achievement. Success of the pilot is based on two separate outcomes: 1) proper placement of a participant with a suitable mentor; and 2) the effect the program has on the teachers during the academic year. In FY 2004, a pilot program will be initiated at Argonne National Laboratory.

Faculty and Student Teams	**50**	**150**	**210**

Faculty and Student Teams (FaST) at Department of Energy, Office of Science Laboratories are being piloted in partnership with the National Science Foundation. Faculty from colleges and universities with limited prior research capabilities and those institutions serving populations, women, and minorities underrepresented in the fields of science, engineering, and technology are encouraged to take advantage of the FaST opportunity to prepare students for careers in science, engineering, computer sciences and technology and for their own professional development.

	FY 2002	FY 2003	FY 2004
	(dollars in thousands)		
Albert Einstein Distinguished Educator Fellowship...	**443**	**500**	**600**

The Albert Einstein Fellowship Awards for outstanding K-12 science, mathematics, and technology teachers continues to be a strong pillar of the program for bringing real classroom and education expertise to our education and outreach activities. Albert Einstein Fellows bring to Congress, DOE and other Federal agencies extensive knowledge and experience of classroom teachers. They provide practical insights and "real world" perspectives to policy makers and program managers.

Energy Related Laboratory Equipment	**75**	**75**	**90**

The used "Energy Related Laboratory Equipment" (ERLE) grant activity was established by the United States Department of Energy (DOE) to grant available excess equipment to institutions of higher education for energy-related research.

Total, Graduate/Faculty Fellowships	**568**	**725**	**1,900**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
■ Initiate the Laboratory Science Teacher Professional Development pilot at Argonne National Laboratory for approximately 60 science, technology, engineering and mathematics (STEM) teachers in grades K-14.	+1,000
■ This allows an increase of 3 Faculty and Student Teams to participate in a 10 week mentored research experience at a DOE National Laboratory.	+60
■ Increase the number of Fellows, their stipends and administrative expenses for the Albert Einstein Distinguished Educator Fellowship	+100
■ Increase the used Energy Related Laboratory Equipment activity to upgrade and maintain the web-based on-line system.	+15
Total Funding Change, Graduate/Faculty Fellowships	+1,175

Pre-College Activities

Mission Supporting Goals and Measures

The Pre-College Activities subprogram contains two activities:

The "National Science Bowl®" activity is a highly visible educational event and academic competition among teams of high school students who attend science and technology seminars and compete in a verbal forum to solve technical problems and answer questions in all branches of science and math. This activity is a highly publicized academic event among high school students who answer questions on scientific topics in astronomy, biology, chemistry, mathematics, physics, earth, and general science. Since its inception, more than 80,000 high school students have participated in regional tournaments leading up to the national finals.

The Middle School Science Bowl will attract students at the most critical stage of their academic development. The emphasis at this grade level will be on discovery and hands-on activities such as designing, building and racing model solar cars.

PROGRAM ACCOMPLISHMENTS

- Three additional regional competitions were held in conjunction with DOE's National Science Bowl®. More than 12,000 high school students participated in the 64 regional science bowl tournaments.
- A pilot Middle School Science Bowl was added in FY 2002, bringing eight teams to Washington DC for the National event. The event had two main activities: 1) a science and mathematics academic question and answer forum; and 2) a hands-on activity where each team designed, built and raced a scale-model solar car.
- Saturday morning science seminars were added to the National Science Bowl weekend, introducing students to many contemporary issues and findings in scientific research. A Nobel laureate from the National Institute of Standards and Technology (NIST) also spoke to all the students on Saturday morning.
- National Science Bowl awards were expanded to include a wide variety of academic awards to the top 18 teams and a Civility Award sponsored by IBM.

Subprogram Goals

Broaden the educational impact and outreach of the "Science Bowl" competition by increasing the number of scientific seminars; improve and expand the middle school component of the science bowl, and increase the number of participating schools in both the National Science Bowl and the Middle School Science Bowl.

Performance Indicator

Number of participants, quality of science seminars and other educational enrichment activities.

Annual Performance Results and Targets

FY 2002 Targets/Results	FY 2003 Targets	FY 2004 Targets
Pilot a Middle School Science Bowl; Nobel Laureate speaker at National Science Bowl.	Increase the number of students participating at regional events; and increase number of scientists giving seminars at Science Bowl.	Increase the number of students participating at regional events; and increase number of scientists giving seminars at Science Bowl.
Extend the science education of the Science Bowl beyond the current academic, question and answer event, to a broader experience by including a hands-on engineering event where students build and compete in a model solar car competition.	Enhance the hands-on elements of Science Bowl by having students build and compete in a model fuel cell car competition.	Collaborate with industry partner to increase the number of students and regional events for the model fuel cell car competitions.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
National Science Bowl	727	660	702	+42	+6.4%
Middle School Science Bowl	0	0	100	+100	+100.0%
Total, Pre-College Activities	727	660	802	+142	+21.5%

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
National Science Bowl	**727**	**660**	**702**

SC will manage and support the National Science Bowl® for high school students from across the country for DOE. Since its inception, more than 80,000 high school students have participated in this event. The National Science Bowl® is a highly publicized academic competition among teams of high school students who answer questions on scientific topics in astronomy, biology, chemistry, mathematics, physics, earth, computer, and general science. In 1991, DOE developed the National Science Bowl® to encourage high school students from across the Nation to excel in mathematics and science and to pursue careers in those fields. The National Science Bowl® provides the students and teachers a forum to receive national recognition for their talent and hard work. An entire day of Saturday seminars in the latest scientific topics and the hydrogen fuel cell challenge has been added to the National Science Bowl® weekend. Students participating in the National Science Bowl ® will be tracked to see the long-term impact on their academic and career choices.

	FY 2002	FY 2003	FY 2004
Middle School Science Bowl	**0**	**0**	**100**

It is well recognized that the middle school years are the most productive time to exert an effort to attract students to science and math subjects. *There are two competitions at the Middle School Science Bowl –*

	FY 2002	FY 2003	FY 2004
(dollars in thousands)			

an academic mathematics and science competition and a model solar car competition. The academic competition is a fast-paced question and answer contest where students answer questions about earth science, life science, physical science, mathematics, and general science. The model solar car competition challenges students to design, build, and race model solar cars. Students who win in regional events will then enjoy a trip to a National Laboratory and participate in a final three day event that will be designed to capture their interest and reward them for their hard work.

	FY 2002	FY 2003	FY 2004
Total, Pre-College Activities	**727**	**660**	**802**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
▪ This is to increase the number of National Science Bowl teams and to also provide a whole day of scientific seminars and workshops for the students.	+42
▪ Initiate the Middle School Science Bowl activity, which will include an academic mathematics and science competition and a model solar car competition	+100
Total Funding Change, Pre-College Activities	+142