Maintaining U.S. Preeminence in Science: University Support

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Office of Science

Department of Energy
Office of Science
Washington, DC 20585

Office of the Director

Maintaining U.S. Preeminence in Science: University Support

5,400 Ph.D's, 3,200 Graduate Students, and 830 Technicians and Support Staff

January 2006

It is my pleasure and privilege to introduce you to one of the premier research organizations in the world – and an important force for quality, excellence, and leadership in U.S. higher education.

The Department of Energy's Office of Science is the single largest supporter of basic research in the physical sciences in the U.S. We sponsor fundamental research programs in basic energy sciences, materials and chemical sciences, nanoscale science, climate change, genomics, life sciences, fusion energy sciences, high energy physics, nuclear physics, and advanced scientific computing.

The DOE Office of Science supports a diverse portfolio of research at more than 300 colleges and universities nationwide. This year, we are funding the work of about 21,500 scientists, including approximately 5,400 Ph.D.'s, 3,200 graduate students, and 800 technicians and support staff at this Nation's institutions of higher learning.

The Office of Science is the steward of 10 world-class laboratories with unmatched capabilities for solving complex interdisciplinary scientific problems, and we fund research at DOE's seven other national labs as well. The DOE national laboratory system is the most comprehensive research system of its kind in the world – and the backbone of American science.

The DOE Office of Science also builds and operates the world's finest suite of scientific facilities and instruments, used annually by more than 19,000 researchers to extend the frontiers of all areas of science.

In sum, the DOE Office of Science's mission is to deliver the remarkable discoveries and scientific tools that will transform our understanding of energy and matter and advance the energy, economic and national security of the United States.

The DOE Office of Science also has played an important role in training America's scientists and engineers for more than 50 years. Today we offer a range of workforce development programs for teachers and scientists for scientific discovery, helping to ensure that this Nation will have the scientific workforce we will need in the twenty-first century.

As President Bush has remarked, "Science and technology have never been more essential to the defense of the Nation and the health of our economy."

Today there is a growing recognition that the standard of living we enjoy and the security of our Nation rests on the quality of science and technology education we provide America's students from elementary through graduate school.

At the DOE Office of Science, we are proud of our historic contributions to the United States' economic and scientific pre-eminence. To ensure our Nation's future competitiveness, the Office of Science is committed to meeting its responsibility to help increase America's talent pool in science, technology, engineering, and mathematics for years to come.

Raymond L. Orbach

Dr. Raymond L. Orbach
Director, Office of Science
U.S. Department of Energy

The Academic Community: Research Support

The Department of Energy and its predecessor agencies have long engaged universities to perform research and to manage research programs at DOE-owned facilities and at universities.

The DOE Office of Science builds and operates the world's finest suite of scientific facilities and instruments that researchers depend on to extend the frontiers of science. Each year, these facilities are used by more than 19,000 researchers and their students from universities, other federal science agencies, and private industry. In certain scientific disciplines, the most creative research and instruction of students can only be done at these large facilities, which include particle accelerators, synchrotron light sources, neutron scattering facilities, supercomputers, genome sequencing facilities, the environmental molecular sciences laboratory, climate science facilities, and high speed networks.

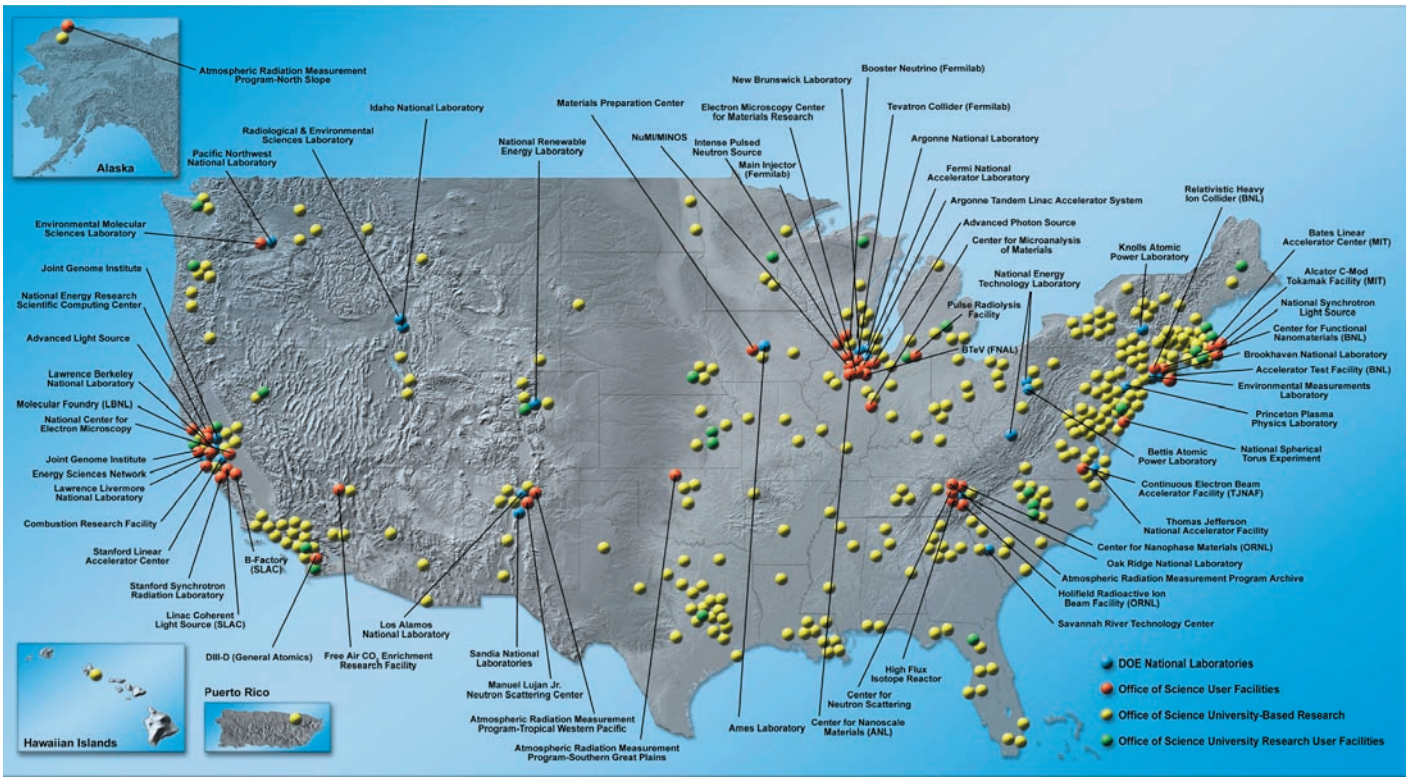
Nine of the 10 national laboratories managed by the Office of Science – and a majority of the Department of Energy's 17 laboratories – are managed either by a university, a consortium of universities, or a university in partnership with a non-profit enterprise. These include the Office of Science multi-program laboratories – Argonne, Brookhaven, Lawrence Berkeley, and Oak Ridge – as well as program-dedicated laboratories such as Ames, Fermi, Thomas Jefferson, Princeton, and Stanford. Many of these laboratories are co-located with or near major universities, and many of the laboratories were established to serve the university community with large-scale scientific facilities that did not fit within the university site or management structure.

All of the DOE Office of Science's research is competitively selected and peer reviewed. Many university professors and officials serve on review and advisory committees for DOE's Office of Science and its national laboratories. This helps bolster DOE's uncompromising commitment to scientific excellence and integrity.

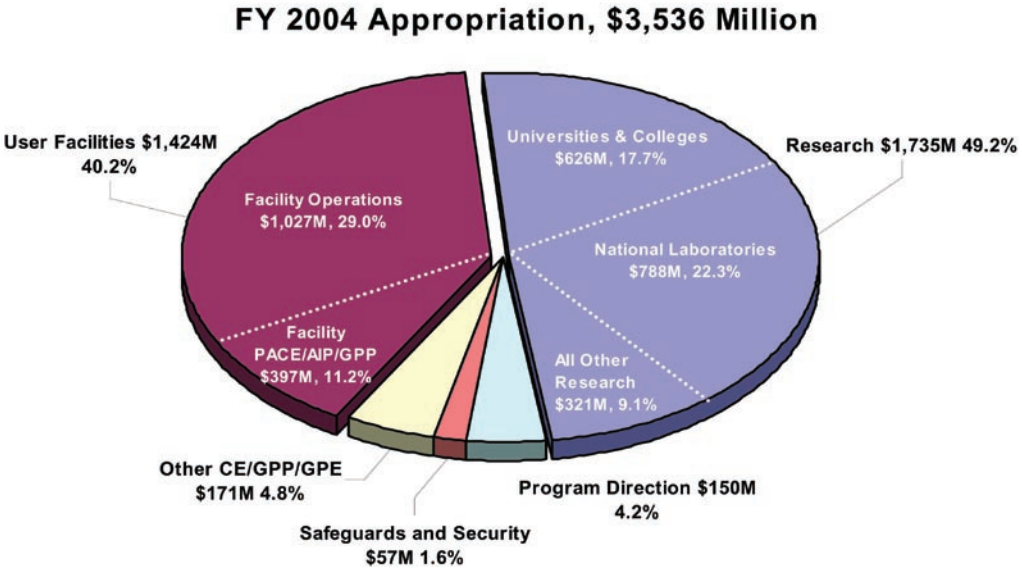
The DOE Office of Science balances its signature support for large-scale science and interdisciplinary teams with investments in research projects conducted by leading university and laboratory investigators. The Office of Science is a principal supporter of graduate students and postdoctoral researchers early in their careers at the Nation's colleges and universities.

The Office of Science sponsors undergraduate student internships at national laboratories and fellowships for distinguished science, technology, engineering, and mathematics educators. Faculty sabbatical fellowships also are available for faculty from minority serving institutions to collaborate on research projects at national laboratories.

A significant portion of the DOE Office of Science basic research budget goes to universities through grants to academic researchers, as this map highlights:



In the 2004 fiscal year, $626M in funding – more than one third of the DOE Office of Science research budget that year – was awarded to researchers in all 50 states:



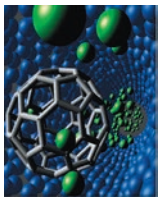
Detailed information about the Office of Science's FY 2004 research investments nationwide is available under "Research Universities" on the Office of Science web site, or directly at http://www.science.doe.gov/SC_Funding/. Following is a state-by-state accounting:

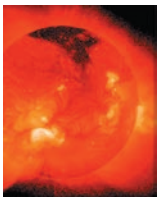
State	FY04 Funding for Universities*^	Universities or Colleges
Alabama	$5,643,000	7
Alaska	$231,000	1
Arizona	$7,477,000	3
Arkansas	$534,000	2
California	$107,628,000	29
Colorado	$12,247,000	5
Connecticut	$10,830,000	3
Delaware	$3,683,000	3
District of Columbia	$1,274,000	5
Florida	$9,668,000	13
Georgia	$12,142,000	10
Hawaii	$1,818,000	1
Idaho	$1,091,000	2
Illinois	$30,446,000	10
Indiana	$18,523,000	8
Iowa	$7,503,000	4
Kansas	$5,327,000	2
Kentucky	$1,263,000	2
Louisiana	$4,925,000	8
Maine	$100,000	1
Maryland	$13,719,000	6
Massachusetts	$84,728,000	17
Michigan	$24,695,000	6
Minnesota	$6,693,000	4
Mississippi	$2,647,000	2
Missouri	$5,110,000	4

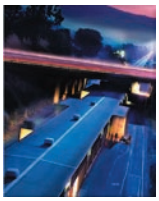
State	FY04 Funding for Universities*^	Universities or Colleges
Montana	$991,000	2
Nebraska	$1,740,000	3
Nevada	$9,541,000	5
New Hampshire	$1,297,000	2
New Jersey	$11,713,000	10
New Mexico	$14,646,000	5
New York	$46,737,000	26
North Carolina	$14,452,000	12
North Dakota	$527,000	2
Ohio	$10,816,000	10
Oklahoma	$1,920,000	3
Oregon	$6,167,000	5
Pennsylvania	$22,506,000	9
Puerto Rico	$793,000	2
Rhode Island	$2,691,000	2
South Carolina	$3,972,000	6
South Dakota	$150,000	1
Tennessee	$7,775,000	9
Texas	$24,721,000	21
Utah	$5,425,000	3
Vermont	$1,036,000	1
Virginia	$6,903,000	9
Washington	$19,388,000	2
West Virginia	$267,000	1
Wisconsin	$25,103,000	5
Wyoming	$293,000	1
Total	$621,515,000	315

* Amounts rounded to the nearest $1,000.
^ Excludes approximately $4.5M in Capital Equipment and General Plant Projects.

The Office of Science's Role in Research and Education







$626M in nearly 3,000 University Research Grants at 315 Colleges and Universities
5,400 Ph.D.'s, 3,200 Graduate Students, and 830 Technicians and Support Staff
Total Office of Science Budget: FY 2004 – $3,523M; FY 2005 – $3,636M; FY 2006 – $3,596M

The Department of Energy's Office of Science fills a critical role in the country's scientific endeavor. Our work is complementary to that of other government research agencies, but the Office of Science distinguishes itself by our emphasis on research that:

- is driven by Department of Energy missions,
- takes the long view,
- is open and interdisciplinary,
- requires the use of large-scale facilities, and
- takes risks commensurate with high pay-offs.

Science education poses special challenges, because in science – more perhaps than in many fields of learning – the mission of research and the mission of education are inextricably linked. There is no more powerful spur to interest in science, and in pursuing a scientific or engineering career, than hands-on experience of cutting-edge research in a well equipped laboratory.

The Office of Science plays a vital role in U.S. higher education by providing direct support and access to research facilities for thousands of university students and researchers in mathematics and the physical and biological sciences. As a result, the Office of Science provides nearly one billion dollars of support for university research and education through direct grants to university-based researchers and over one billion dollars through support for the construction and operation of major scientific facilities and collaborative experiments. The Office of Science also supports programs that each year bring hundreds of undergraduate students and faculty from under-represented institutions to the national labs for research experience, workshops, and training.

The missions of the Department present unique technical challenges that require innovative, high-risk research; complex, large-scale scientific research facilities; and long-term commitments to critical subfields. Over the years, DOE's Office of Science, with its predecessor agencies, has been the anchor of the Nation's scientific infrastructure, generating many important scientific discoveries – from the Standard Model of Particles and Interactions in high energy and nuclear physics to the map of the human genome, initiated by DOE and completed in partnership with NIH, private industry, and international partners. These discoveries have advanced science, inspiring the students who are helping to solve the Nation's energy, environment, and national security challenges.

Going back to the earliest days of the Manhattan Project, the Department of Energy and its predecessor agencies have blended cutting-edge research and innovative problem-solving to keep the United States in the forefront of scientific discovery for decades. As testimony to the high quality and impact of the research DOE underwrites, the Department of Energy has sponsored 42 Nobel Laureates since DOE's inception in 1977 – and a total of 82 Nobel Laureates have been associated with DOE and its predecessor agencies since 1934. (Information about these DOE Nobel Laureates is at http://www.science.doe.gov/sub/accomplishments/heroes/heroes.htm.)

The DOE Office of Science helps maintain the Nation's scientific infrastructure and ensure U.S. world leadership across a broad range of scientific disciplines. The Office of Science manages this research portfolio through seven interdisciplinary program offices, which affiliate with America's research universities in important ways.

Advanced Scientific Computing Research

Deliver Computing for the Frontiers of Science

- *Computer science and software research*
- *Extending science through computation and collaboration*
- *Supercomputing technologies for science*
- *Computational and network infrastructure and tools*

$28M in 140 University Research Grants
675 Ph.D.'s and 354 Graduate Students
Program Budget: FY 2004 – $197M; FY 2005 – $226M; FY 2006 – $235M

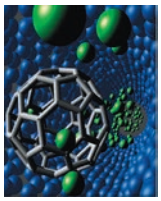
Computational science is increasingly important to progress in almost every scientific discipline and to our most challenging feats of engineering. The mission of the Office of Science's Advanced Scientific Computing Research (ASCR) program is to deliver forefront computational and networking capabilities nationwide that enable discoveries at the frontiers of science, including DOE and the Office of Science mission areas of modeling and simulation of advanced energy systems, biotechnology, nanotechnology, the environment, the fundamental structure of matter, the production of heavy elements in supernovae explosions, and the functions of enzymes in living cells. University researchers draw upon the computational resources of the Office of Science facilities and at the same time play a critical role in the Office of Science research efforts and in the training of the next generation of scientists specializing in a broad spectrum of disciplines.

ASCR supports cross-cutting research that includes applied mathematics research to produce the fundamental mathematical methods to model complex physical and biological systems; computer science research to enable scientists to efficiently perform scientific computations on the highest performance computers available and to store, manage, analyze, and visualize the massive amounts of resulting data; and networking research to link the data producers with the scientists who need the data.

ASCR is an important sponsor of civilian research in applied mathematics and supports the National Energy Research Scientific Computing Center (NERSC), one of the Nation's premier unclassified computing centers, at Lawrence Berkeley National Laboratory. Approximately 2,000 researchers from universities, national labs, federal agencies, and U.S. companies use the high-performance state-of-the-art computing resources of the NERSC annually. Other facilities and programs supported by ASCR and available to scientists include the Oak Ridge National Laboratory's Center for Computational Sciences (CCS), which provides high-end capability computer services, and the Research and Evaluation Prototype Program, which focuses on the evaluation of leading-edge research computers.

ASCR funds four specific education-related activities, including the Computational Science Graduate Fellowship Program, which has funded over 200 graduate students since it was established in the early 1990s; the Early Career Principal Investigator Program, which provides three-year grants of $100,000 per year to new, young faculty at universities; three university-based computational biology institutes that are developing young investigator communities in computational biology at the graduate and undergraduate level; and a new initiative to establish university-based computational science institutes as part of the Scientific Discovery through Advanced Computing (SciDAC) program.

Recent accomplishments of ASCR researchers include the development of computational models that successfully simulate supernovae collapse in three dimensions; the development of efficient earth system models that aid in understanding ocean-atmosphere interactions and the origins of decadal and centennial climate variability; algorithms that improve the performance of fluid flow simulations; and new modeling paradigms for the design of efficient electricity markets.



Basic Energy Sciences

Advance the Basic Sciences for Energy Independence

- *Materials sciences and engineering research*
- *Chemical sciences, geosciences, and physical biosciences research*
- *Nanoscale science, engineering, and technology research*
- *Scientific user facilities to understand materials and perform nanoscale science*

$150M in 1,100 University Research Grants
3,650 Ph.D.'s, 1,050 Postdoctoral Associates, and 1,690 Graduate Students
Program Budget: FY 2004 – $991M; FY 2005 – $1,084M; FY 2006 – $1,135M

The Office of Science's Basic Energy Sciences (BES) program is one of the Nation's largest sponsors of research in the natural sciences and is uniquely responsible for supporting fundamental research in materials sciences, chemistry, geosciences, and aspects of biosciences impacting energy resources, production, conversion, efficiency, and the mitigation of the adverse impacts of energy production and use. Not only does the BES program ask its communities of scientists to provide the scientific foundations to overcome short-term "showstoppers" in energy technologies, BES also asks researchers to reach far beyond today's problems in order to provide the basis for long-term solutions to what is probably society's greatest challenge – a secure, abundant, and clean energy supply. BES supports a large extramural research program, with approximately 35% of the program's research activities sited at academic institutions.

BES research programs include fundamental research in materials sciences, chemistry, geosciences, and aspects of biosciences. BES provides the sole support or is a primary supporter of the Nation's research efforts in heavy element chemistry, catalysis, photochemistry, and radiation chemistry; it is a major source of funding for research in all aspects of chemistry and materials sciences and is a primary sponsor of nanoscale science research.

BES supports work to provide the foundations for effective solar energy utilization, a future hydrogen economy, more efficient energy systems, and many more topics related to today's energy technologies. BES also supports work to understand the grand challenge science questions whose solutions will underpin future energy technologies. These include the study of the fundamental phases of matter and phase transitions; quasiparticles; interactions of strong and weak forces in molecular bonding; "communication" among electrons, atoms, molecules, cells, and organisms; the harnessing of properties of elementary particles, atoms, and molecules to create fundamentally new ways to store, manipulate, and transmit information; and organizing principles at the nanoscopic and mesoscopic scales, intermediate between atomic and macroscopic dimensions.

The BES program also supports world-class scientific user facilities, providing outstanding capabilities for imaging and characterizing materials of all kinds, from metals, alloys, and ceramics to fragile biological samples. The BES synchrotron radiation light sources, the neutron scattering facilities, and the electron beam characterization centers represent the largest and best collection of such facilities supported by a single organization in the world. Annually, 8,000 researchers from universities, national laboratories, and industrial laboratories perform experiments at these facilities. Spurred by results of past investments and by innovations in accelerator concepts, the BES program continues its pioneering role in the development of new generations of scientific research instruments and facilities. Key among these are the Spallation Neutron Source, which will be the world's most intense pulsed neutron source allowing researchers to study materials that were never before accessible (to commence operations in 2006), and five Nanoscale Science Research Centers, which will operate in concert with the scattering facilities.

The BES research program promotes development of the R&D workforce through support of undergraduate researchers, graduate students working toward a doctoral degree, and postdoctoral associates developing their research and management skills.

Biological and Environmental Research

Harness the Power of Our Living World

- *Genomics and low dose radiation research*
- *Climate change research*
- *Environmental remediation sciences*
- *Medical sciences*

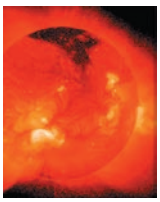
$179M in 883 University Research Grants
1,517 Ph.D.'s, 372 Postdoctoral Associates, and 488 Graduate Students
Program Budget: FY 2004 – $624M; FY 2005 – $567M; FY 2006 – $580M

With the 21st Century dawns what many believe will be the "biological century." Whereas during the past 100 years the most spectacular and revolutionary scientific discoveries were in physics and chemistry, today we are on the threshold of discoveries in biology that will be as relevant to DOE's missions – energy supply, national security, environmental protection – and as revolutionary, as any that came before. For over 50 years, the Office of Science's Biological and Environmental Research (BER) program has been advancing environmental and biomedical knowledge that supports these vital national missions. Today, BER focuses its program through competitive and peer-reviewed research projects in climate change, environmental remediation, genomics, proteomics, radiation biology, and medical sciences. This year, BER will support more than 1,000 research projects, five specialized user facilities, and stations at BES neutron and light sources. This enables the research of more than 2,500 researchers and 1,400 graduate students and postdoctoral associates at over 200 public and private research institutions in 40 states.

BER has funded the vast majority of federal research in nuclear medicine, the environmental remediation of metals and radionuclides, the systems biology of environmental microbes, and the use of high-end supercomputing to understand our climate. Approximately half of BER's research funds directly or indirectly support university-based activities (roughly 700 university grants averaging $250,000 are made annually), and university scientists are the major users of BER facilities and other enabling research infrastructure.

BER has played a leading role in pushing the incorporation of the physical and computational sciences – DOE's historical scientific base – into the biological and environmental sciences. Sequencing the human genome required the best of biology, physics, and large-scale computing to work together on a very large, high-risk project, and was a quintessentially BER activity.

BER-sponsored programs, and facilities such as the Environmental Molecular Sciences Laboratory and the DOE Joint Genome Institute's Production Genomics Facility, provide unique opportunities for researchers from universities across the country to pursue questions at the intersection of multiple disciplines: computing, biology, physics, chemistry, and materials science. BER's focus on multi-disciplinary research in areas of importance to the DOE mission not only encourages investigation into some of the most exciting and important questions of the day, but also provides incentives for students to pursue their education in fields necessary for the good of the country. Thus, BER's Atmospheric Radiation Measurement user facilities were launched in the 1990s not just to address the principal uncertainty in climate change prediction, but also to inject new vigor into the field. It is also safe to say that almost all academic and research centers in the country involved in radiation biology and nuclear medicine – two historic areas of DOE investigation since its original charter 59 years ago – have leading scientists whose education and training have been nurtured by BER.



Fusion Energy Sciences

Bring the Power of the Stars to Earth

- *Harnessing fusion energy through basic research in plasma and fusion sciences*
- *ITER, the international burning plasma experiment*

$75M in 208 University Research Grants
722 Ph.D.'s, 126 Postdoctoral Associates, and 264 Graduate Students
Program Budget: FY 2004 – $256M; FY 2005 – $267M; FY 2006 – $288M

The mission of the Office of Science's Fusion Energy Sciences (FES) program is to answer the key scientific questions and overcome the technical challenges to harness the power that fuels a star, realizing by the middle of this century a landmark scientific achievement by bringing safe, economic, and environmentally benign fusion power to the electric grid.

The FES program supports advances in plasma science, fusion science, and fusion technology—the knowledge base needed for an economically and environmentally attractive fusion energy source. FES is pursuing this goal through an integrated program of research based in U.S. universities, industry, and national laboratories, augmented by a broad program of international collaboration.

The U.S., through FES, is a member of ITER (formerly known as the International Thermonuclear Experimental Reactor), the world's largest fusion project. ITER is an international collaboration to build the first fusion science experiment capable of producing a sustained fusion reaction, called a "burning plasma." It is the next essential and critical step on the path toward demonstrating the scientific and technological feasibility of fusion energy. FES funds other fusion facilities, designed to advance the state of knowledge in fusion energy and to test alternative concepts. These include: the National Spherical Torus Experiment (NSTX) at the Princeton Plasma Physics Laboratory (PPPL) in Princeton, New Jersey; the National Compact Stellarator Experiment (NCSX), also located at PPPL; DIII-D at General Atomics in San Diego, California; and Alcator C-Mod, at the Massachusetts Institute of Technology in Boston, Massachusetts.

A science-based approach to fusion offers the fastest path to commercial fusion energy and is advancing our knowledge of plasma physics and associated technologies, yielding near-term benefits in a broad range of scientific disciplines. Examples of these accomplishments include plasma processing of semiconductor chips for computers and other electronic devices, advanced video displays, innovative material coatings, the efficient destruction of chemical and radioactive wastes, and more efficient space propulsion.

The FES program funds research activities involving over 1,100 researchers and students at 65 academic and private sector institutions located in 30 states and at 11 DOE and Federal laboratories in eight states. These include 144 faculty members, seven of whom are Junior Faculty awardees; 327 graduate students, including 12 who are Oak Ridge Institute of Science and Education (ORISE) fellows; 103 postdoctoral associates, including six ORISE fellows; and about 95 undergraduates.

High Energy Physics

Explore the Fundamental Interactions of Energy, Matter, Time, and Space

- *Explore unification of the forces and particles of nature*
- *Understand the cosmos and the destiny of the universe*
- *Develop the tools for scientific revolutions to come*

$121M in 140 University Research Grants
1,255 Ph.D.'s, 565 Postdoctoral Associates, and 610 Graduate Students
Program Budget: FY 2004 – $716M; FY 2005 – $723M; FY 2006 – $717M

The Office of Science's High Energy Physics (HEP) program provides the majority of Federal support for research in high energy physics, which seeks to understand the fundamental nature of matter, energy, space, and time. HEP funds research at more than 100 universities and 10 national laboratories, and operates world-class research facilities serving more than 3,000 researchers each year. Areas of research include the search for a unified theory of physics beyond the Standard Model, the role of neutrinos, and the search for dark matter and dark energy, which comprise an estimated 95 percent of the mass of the universe. High energy physics, also known as particle physics, aims to uncover some of the universe's deepest mysteries.

HEP operates two of the world's most advanced particle accelerators, the Tevatron at Fermilab and the Stanford Linear Accelerator Center (SLAC). HEP is also contributing major technology and design to the Large Hadron Collider at the European Center for Nuclear Research (CERN), scheduled to begin operations in 2007. In addition, the HEP program supports research groups at Lawrence Berkeley, Lawrence Livermore, Argonne, Brookhaven, Oak Ridge, and Los Alamos National Laboratories, Princeton Plasma Physics Laboratory, and the Thomas Jefferson National Accelerator Facility.

University researchers, including graduate students and postdoctoral associates, play a critical role in this laboratory research, collaborating with laboratory-based researchers on major experiments. The HEP program also makes direct grants to universities. During FY 2004, the DOE High Energy Physics program supported approximately two-thirds of the Nation's university researchers and graduate students engaged in fundamental high energy physics research and approximately 90 percent of graduate students engaged in particle accelerator R&D. Typically, about 120 Ph.D. degrees are granted annually to students for research supported by the program. The university grants program is proposal driven, and funds the best and brightest of those ideas submitted in response to grant solicitation notices.

While the overarching goal of the HEP program is discovery, a major objective of the program is to train the next generation of particle physicists. High energy physics is highly facilities-dependent, and the ability to create, operate, and maintain such advanced scientific facilities is essential to attracting talented minds to this field. The HEP program supports graduate students working toward a doctoral degree and post-doctoral associates developing their research and management skills. About 1,200 postdoctoral associates and graduate students supported by the HEP program in FY 2004 were involved in a large variety of theoretical and experimental research, including advanced technology R&D. About one-fifth are involved in theoretical research. About 90 percent of those involved in experimental research utilize a number of scientific accelerator facilities supported by the DOE, NSF, and foreign countries; and about 10 percent participate in non-accelerator research.

Students trained in this program not only provide new scientific talent in areas of fundamental research, but also provide talent for a wide variety of technical, medical, and industrial areas that require the incisive thinking and problem-solving abilities and computing and technical skills developed through an education and experience in a fundamental research field. Scientists trained as high energy physicists can be found working in such diverse areas as hospitals (radiation therapy, medical imaging, and medical physics), national security, space exploration, software and computing, telecommunications, finance, and many other fields.

Nuclear Physics

Explore Nuclear Matter – from Quarks to Stars

- *Studies of hot, dense nuclear matter*
- *The quark structure of matter*
- *Nuclear structure/astrophysics, fundamental symmetries, and neutrinos*

$73M in 190 University Research Grants
746 Ph.D.'s, 403 Postdoctoral Associates, and 473 Graduate Students
Program Budget: FY 2004 – $380M; FY 2005 – $395M; FY 2006 – $367M

The Office of Science's Nuclear Physics (NP) program provides most of the Federal support for nuclear physics research in the United States, delivering new insights into our knowledge of the properties and interactions of atomic nuclei and nuclear matter. Over 2,000 scientists and technical staff, including 900 doctoral students and postdoctoral research associates, receive support from NP. Areas of research include the early universe, the structure of the nucleon and atomic nuclei, neutrinos, and the origin of the elements.

By building and operating research facilities that provide the opportunity to do exciting forefront science – and supporting the training of students at the undergraduate, graduate and postdoctoral levels – NP contributes to the Nation's effort to ensure quality, excellence, and leadership in higher education. Hundreds of university-based scientists, graduate students, and postdoctoral associates make use of NP's world-class scientific facilities, which include the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory; the Continuous Electron Beam Accelerator Facility (CEBAF) at Thomas Jefferson National Accelerator Facility; the Holifield Radioactive Ion Beam Facility (HRIBF) at Oak Ridge National Laboratory; and the Argonne Tandem Linac Accelerator System (ATLAS) at Argonne National Laboratory.

Through these facilities and others, NP supports and nurtures a research community that will produce discoveries that advance our understanding of the fundamental nature of nuclear matter and the forces by which matter interacts. These world-class research capabilities keep the United States at the forefront of international nuclear physics research and enable the United States to attract and maintain a high-quality, highly-motivated university research community in nuclear physics.

The competitive peer-review process ensures the quality and excellence of the over 180 research grants at 85 universities in 35 states supported by the NP program. In FY 2005, these grants supported the research activities of more than 360 Ph.D. faculty members, involving 220 postdoctoral associates, 420 graduate students, and 100 undergraduates. The national laboratories played an important educational role by supporting and mentoring about 80 graduate students and about 170 postdoctoral associates and by providing opportunities for the involvement of undergraduates at state-of-the-art technical and scientific facilities. Approximately 80 Ph.D. degrees in nuclear physics/chemistry are granted annually to graduates students supported by the NP program. These highly trained scientific and technical personnel are a valuable resource for many applied fields, including medicine, national security, and space exploration.

NP also supports five university centers of excellence (Duke University, Massachusetts Institute of Technology, Texas A&M University, Yale University and the University of Washington), several of which have accelerators for in-house research programs. NP also provides support for summer undergraduate and graduate student programs at universities and national laboratories and, through its national laboratories, for the American Physical Society (APS) Division of Nuclear Physics (DNP) Conference Experience for Undergraduates (CEU), where 60-70 undergraduates each year attend an APS DNP meeting and present their work in a posters session.

Workforce Development for Teachers and Scientists

Train the Next Generation of Scientists and Engineers to Maintain U.S. Scientific and Technological Leadership

- *Student internships at national laboratories*
- *Fellowships for distinguished science, technology, engineering, and mathematics educators*
- *The DOE National Science Bowl® for high school students and the National Middle School Science Bowl*

$3M in Undergraduate Internships, $3M in Graduate/Faculty Fellowships
700 Students and Faculty
Program Budget: FY 2004 – $6.4M; FY 2005 – $7.6M; FY 2006 – $7.1M

The Office of Science funds several science, technology, engineering, and mathematics (STEM) education programs that are modest in size but have a significant impact. These programs leverage the Department's investment in the national laboratories and foster partnerships with the Nation's colleges and universities. Approximately 700 students and faculty gain research experience each year through a variety of programs. Since the Workforce Development for Teachers and Scientists programs are focused on addressing DOE needs, evaluation is a critical element of each program.

The Workforce Development programs in higher education are focused on undergraduate research, under-represented institutions, and community colleges. The Office of Science funds five internship/fellowship programs at its national laboratories. Three of these programs support undergraduate students to spend up to 16 weeks in mentor-intensive research experiences; one attracts faculty and student teams primarily from minority serving institutions; and the last program funds STEM teachers from grades K-14 to participate in a three-year program that includes a minimum of five weeks at a national laboratory.

The programs have been specifically designed around best practices. For example, the teacher professional development programs utilize educational research including The National Board for Professional Teaching Standards, "Five Core Principles," and Loucks-Horsley and colleagues' "Fifteen Strategies of Professional Development." All of the programs are monitored and regularly evaluated by an online tracking system that compiles information from entrance and exit surveys; posts internal and external evaluations: and collects participant final reports, research papers, and research abstracts. The program continues to use independent evaluation and research to improve programs including the development and distribution of better tools for self evaluation of content knowledge, professional practice, and leadership.

Higher Education Programs

- Science Undergraduate Laboratory Internship: In FY 2005, 456 students participated.
- The Laboratory Science Teacher Professional Development: In FY 2005, seven laboratories hosted 90 teachers.
- The Faculty and Student Teams: In FY 2005, five laboratories hosted 42 FaST teams.
- Community College Institute of Science and Technology: In FY 2005, 68 students directly participated in this internship.
- Pre-Service Teachers: In FY 2005, 52 students participated in this program.
- Energy Related Laboratory Equipment, which allows higher education institutions to receive surplus equipment form DOE facilities: FY 2005 funding of $90,000.
- Faculty Sabbatical Fellowship: In FY 2005, ten faculty members from Minority Serving Institutions participated. In addition, two faculty members displaced by Hurricane Katrina were placed at DOE laboratories in Faculty Sabbatical appointments.

About the Office of Science

The Department of Energy's Office of Science is the single largest supporter of basic research in the physical sciences in the United States, providing more than 40 percent of total funding for this vital area of national importance. It oversees – and is the principal federal funding agency of – the Nation's research programs in high-energy physics, nuclear physics, and fusion energy sciences.

The Office of Science manages fundamental research programs in basic energy sciences, biological and environmental sciences, and computational science. In addition, the Office of Science is the Federal Government's largest single funder of materials and chemical sciences, and it supports unique and vital parts of U.S. research in climate change, geophysics, genomics, life sciences, and science education.

The Office of Science manages this research portfolio through six interdisciplinary program offices: Advanced Scientific Computing Research, Basic Energy Sciences, Biological and Environmental Research, Fusion Energy Sciences, High Energy Physics, and Nuclear Physics. In addition, the Office of Science sponsors a range of science education initiatives through its Workforce Development for Teachers and Scientists program.

The Office of Science makes extensive use of peer review and federal advisory committees to develop general directions for research investments, to identify priorities, and to determine the very best scientific proposals to support.

The Office of Science also manages 10 world-class laboratories, which often are called the "crown jewels" of our national research infrastructure. The national laboratory system, created over a half-century ago, is the most comprehensive research system of its kind in the world.

Five are multi-program facilities: Argonne National Laboratory, Brookhaven National Laboratory, Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, and Pacific Northwest National Laboratory. The other five are single-program laboratories: Ames Laboratory, Fermi National Accelerator Laboratory, Thomas Jefferson National Accelerator Facility, Princeton Plasma Physics Laboratory, and Stanford Linear Accelerator Center.

The Office of Science oversees the construction and operation of some of the Nation's most advanced R&D user facilities, located at national laboratories and universities. These include particle and nuclear physics accelerators, synchrotron light sources, neutron scattering facilities, supercomputers, and high-speed computer networks. Each year these facilities are used by more than 19,000 researchers from universities, other government agencies, and private industry.

The Office of Science is a principal supporter of graduate students and postdoctoral researchers early in their careers. Almost 50 percent of its research funding goes to support research at more than 300 colleges, universities, and institutes nationwide.

The Office of Science also reaches out to America's youth in grades K-12 and their teachers to help improve students' knowledge of science and mathematics and their understanding of global energy and environmental challenges.

To attract and encourage students to choose an education in the sciences and engineering, the Office of Science also manages the DOE National Science Bowl®, an educational competition for high school students involving all branches of science. Each year, over 12,000 students participate in the contest, and some 300 finalists typically prepare for months to attend the national event in Washington, DC.

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