

## Physics in the FY 2003 Budget

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### HIGHLIGHTS

- Most of the programs within the Department of Energy's Office of Science that fund physics R&D would receive increases, although not all would keep pace with inflation.
- National Science Foundation (NSF) funding for the Physics Subactivity would decline 1.3 percent in FY 2003.
- The NSF budget for the Materials Research Subactivity would remain relatively flat, declining 0.1 percent.
- R&D funding for the Physics Laboratory at the National Institute of Standards and Technology (NIST) would increase 16.9 percent, and for R&D at the Materials Science and Engineering Laboratory by a proposed 18.7 percent.

Physics research is the foundation for millions of American jobs in a diverse range of industries. The multibillion-dollar laser industry was developed from research conducted in the 1950s with \$30,000 in government funds. Federal funding for liquid crystal research that began in the 1960s provided the basis for the computer display industry that has annual sales of more than \$10 billion. Research supported by the federal government in the last half of the 20th century in plasma physics, semiconductors, and magnetic materials led to the development of computers and the information age. The government's support of solid state, atomic, and nuclear physics research since the 1940s made possible advanced medical imaging technologies that generate billions of dollars in products and services every year.

Physics research has strengthened our nation's defenses. Initial research in the 1940s led to technologies to detect explosives and land mines. Gamma-ray imaging that was developed by physicists and astronomers is used to locate and identify radioactive materials. Composite materials and coatings help military aircraft evade radar and heat-seeking detectors.

Federal funding for physics research declined during the last decade. The recent National Research Council report, *Trends in Federal Support of Research and Graduate Education*, indicated that federal funding for physics research, expressed in constant dollars, declined 24.6 percent from FY 1993 to FY 1999.

The Department of Energy (DOE), National Science Foundation (NSF), Department of Defense (DOD), and National Institute of Standards and Technology (NIST) provide significant support for physics research. See Chapter 6 for an analysis of the Department of Defense R&D budget request.

#### **DEPARTMENT OF ENERGY (DOE)**

DOE's Office of Science is the largest federal supporter of physics R&D. It is responsible for ten DOE civilian national laboratories, and the operation of numerous world-class, state-of-the-art scientific user facilities for university, laboratory, and industry researchers. Over the next five years, the office will design or complete several new facilities, including the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory in Tennessee. When operational, the SNS will restore the U.S. to a position of world leadership in neutron scattering research. (for more information on DOE, please see Chapter 9).

**High Energy Physics:** DOE provides more than 90 percent of the federal funding for high energy physics (HEP), with major facilities in Illinois, California, and New York. Until Europe's Large Hadron Collider (LHC) begins operations, scheduled for 2006, the U.S. will remain the world leader in HEP research, which focuses on the nature of matter and energy.

Under the FY 2003 request, the budget for HEP R&D would increase 1.7 percent, or \$12 million, from \$713 million to \$725 million (see Table II-11). The request gives priority to what DOE calls two "windows of

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opportunity.” The search for the elusive Higgs Boson, expected to be the source of mass, will be the primary emphasis at Fermilab in Illinois for the next few years. The other priority will be research at California’s Stanford Linear Accelerator Center, which may explain the preponderance of matter over antimatter in the universe. Another major activity in FY 2003 would be the participation by DOE and NSF in construction of the LHC in Europe. When construction is completed, the U.S. will become an active participant in research at the LHC.

***Nuclear Physics:*** The Nuclear Physics program explores atomic nuclei and nuclear matter. In FY 2003, the highest priority will be given to enhancing operations and increasing operating time at the program’s user facilities, in particular at major new facilities in New York and Virginia.

The FY 2003 request would increase Nuclear Physics R&D by 6.5 percent, or \$23 million, from \$359 million to \$382 million (see Table II-11). Now that the Relativistic Heavy Ion Collider (RHIC) facility at Brookhaven National Laboratory in New York is operational, a major emphasis for FY 2003 will be attempts to synthesize, in a laboratory, the state of matter that existed shortly after the Big Bang.

***Fusion Energy Sciences:*** This program leads the U.S. effort to advance the science and technology of fusion, which holds the potential for abundant, environmentally safe and affordable energy. This program supports facilities in New Jersey, Massachusetts and California. The next major milestone in fusion research will be the study of the physics of a self-sustaining fusion reaction with a burning plasma experiment.

Fusion R&D in the FY 2003 request would increase by 4.0 percent, or \$10 million, from \$247 million to \$257 million, enabling increased operating times for all major facilities (see Table II-11). At Princeton’s Plasma Physics Laboratory, completion of decontamination and decommissioning activities for one facility will enable funds to be used for design and fabrication of a National Compact Stellerator Experiment.

***Basic Energy Sciences:*** DOE’s Basic Energy Sciences (BES) program provides the research foundations for DOE’s missions in energy, environment, and national security. BES supports facilities in Illinois, California, New York, Tennessee and New Mexico, as well as research at universities, federal and industrial laboratories. The FY 2003 request

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would allow BES to expand its research in areas of nanoscale science, engineering and technology, and begin construction of Nanoscale Science Research Centers.

Funding for BES R&D would increase by 2.0 percent, or \$20 million, under the Administration's request, from \$1.00 billion to \$1.02 billion (see Table II-11). BES is responsible for construction of the Spallation Neutron Source in Tennessee. This neutron scattering facility will serve up to 2,000 researchers a year and, upon completion, will return the U.S. to world leadership in neutron scattering research. SNS funding is scheduled to start decreasing in FY 2003, making more funds available for other priorities, including increased operation of user facilities, and design and construction of the Nanoscale Science Research Centers.

***Biological and Environmental Research:*** This program supports research across a range of scientific areas including environmental remediation, global change, genomics, and medicine. Under the FY 2003 request, R&D within this program would experience a decrease of 11.6 percent, or \$66 million, from \$570 million to \$504 million, largely due to the completion of a number of earmarked projects. The Genomes to Life project would receive increased funding for additional research on energy and environmental uses of microbes. The interagency Human Genome and Climate Change Research programs would also receive slight funding increases, including \$2.9 million for the new Climate Change Research Initiative (CCRI; see Chapter 15 for more information).

**NATIONAL SCIENCE FOUNDATION (NSF)**

Physics R&D is supported by several NSF programs, at a significantly lower level than that provided by DOE. NSF provides support through the Physics Subactivity and Materials Research Subactivity and through the Major Research Equipment account. (For more information on NSF, please see Chapter 7; see Table II-7 for NSF funding details).

***Physics Subactivity:*** From 30 to 100 percent of university-based research in physics subdisciplines is provided by this subactivity. The magnitude of research support ranges from single investigators to major user groups.

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Major user facilities are also funded by the Physics Subactivity. Research in elementary particle physics is conducted at the Cornell Electron Storage Ring (New York), in nuclear physics at the Michigan State University National Superconducting Cyclotron Facility, and in gravitational physics at the Laser Interferometer Gravitational-Wave Observatory (Louisiana and Washington) which will become fully operational in FY 2003. Physics Frontiers Centers conduct research in cosmological physics, gravitational physics, coherent ultrafast optical science, particle and nuclear physics. The application of atomic, molecular, and optical research to biological systems is being advanced at a new Science and Technology Center in biophotonics.

NSF would reduce the budget for the Physics Subactivity in FY 2003. Support would decline 1.3 percent, or \$3 million, from \$196 million to \$193 million. Funding for lower priority research areas would be reduced to provide an additional \$1 million for the Physics Frontiers Center program. The facility budget would remain approximately level, with some sites receiving additional money while funding for other sites would be terminated. The NSF budget document notes that \$60 million of the request is for research in high energy physics, including \$2 million for research on neutrino collectors.

***Materials Research Subactivity:*** Research in areas such as condensed matter physics is supported by the Materials Research Subactivity. More than half of this subactivity's portfolio will be allocated to individual investigators and research groups. The remainder provides funding for 29 Materials Research Science and Engineering Centers, experimental facilities and other user facilities.

NSF requests approximately level funding for this subactivity in FY 2003. Funding would decline 0.1 percent from \$220 million to \$219 million. For FY 2003, the subactivity seeks an increase of 8.6 percent in Nanoscale Science and Engineering, with the proposed budget increasing to \$71 million. Support for Information Technology Research would also increase, and two new Collaboratives for Material Research and Education for minority-serving institutions would be established. The budget document states that support will be reduced for lower priority areas.

***Major Research Equipment:*** Two facilities are of direct interest to the physics community. For FY 2003, NSF requests \$9.7 million for two

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detectors at the Large Hadron Collider that is under construction in Geneva, Switzerland. This funding will complete the NSF contribution to this facility, which is to total \$81 million between FY 1999 and FY 2003. DOE is scheduled to provide a total of \$450 million. The budget document states, "U.S. cost performance has been excellent, with material contracts typically below estimates, and labor costs tracking close to plan."

In FY 2002, NSF received \$15.0 million for research, design and development of the IceCube Neutrino Detector Observatory. NSF requests no funding for this project this year. The budget document explains that the National Academy of Sciences will review the scientific merit of this and other proposed U.S. neutrino collectors. A decision will then be made whether NSF should seek construction funding for this project in FY 2004. The estimated cost of IceCube is \$240 million. International partners would be sought.

**NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)**

The Department of Commerce's National Institute of Standards and Technology has two laboratories whose missions are focused on physics R&D: the Physics Laboratory and the Materials Science and Engineering Laboratory. Both would receive substantial increases in FY 2003 (see Table II-14).

The Physics Laboratory supports measurement services and research in electronic, optics, and radiation technologies. It serves academic institutions, industry, and government. The Physics Laboratory R&D budget would receive an increase of 16.9 percent, or \$5 million, from \$31 million to \$36 million.

The Materials Science and Engineering Laboratory FY 2003 R&D budget would increase 18.7 percent, or \$11 million, from \$56 million to \$67 million. This laboratory plays a leading role in materials measurement and standards infrastructure. It houses the NIST Center for Neutron Research, the only facility in the United States for cold neutron research. (For more on NIST, please see Chapter 12.)