14

Physics in the FY 2004 Budget

Richard M. Jones and Audrey T. Leath,
American Institute of Physics

HIGHLIGHTS

- The R&D supported by the Department of Energy's (DOE) Office of Science would drop 0.3 percent from the FY 2003 level, continuing a decade-long trend of flat or declining funding for the office.

- The U.S. recently announced that it is rejoining the International Thermonuclear Experimental Reactor (ITER), a collaborative project to demonstrate fusion technologies.

- The budgets for the National Science Foundation's (NSF) Physics Subactivity and Materials Research Subactivity would each increase approximately six percent from the FY 2003 level.

- The budget for physics research at the National Institutes of Standards and Technology (NIST) laboratories would increase 41.9 percent.

Federally-sponsored research and development (R&D) is the foundation of millions of jobs and a better way of life for Americans. Federal research in the 1930s led to the development of particle physics therapies for the treatment of cancer. Physics research in that same decade enabled the later development of synthetic blood vessels and tissues for reconstruction. Gamma-ray imaging used to prevent the smuggling of nuclear materials was first developed by physicists and astronomers doing basic research. Research conducted in the 1950s led to the development of the laser, now used in countless devices.

Major support for physics research is provided by the Department of Energy (DOE), the National Science Foundation (NSF), the National Institute of Standards and Technology (NIST), the Department of

Defense (DOD), and the National Aeronautics and Space Administration (NASA; see Chapters 6 and 10 for analyses of the DOD and NASA requests.) The FY 2004 Administration budget was submitted at a time when federal funding for the physical sciences was under increasing scrutiny. In 2002, a panel of the President's Council of Advisors on Science and Technology reviewed the funding of the physical sciences. A letter released earlier this year summarized one of the panel's major findings: *"All evidence points to a need to improve funding levels for physical sciences and engineering. Continuation of present patterns will lead to an inability to sustain our nation's technical and scientific leadership. We recommend that beginning with the FY04 budget and carrying through the next four fiscal years, funding for physical sciences and engineering across the relevant agencies be adjusted upward to bring them collectively to parity with the life sciences."*

DEPARTMENT OF ENERGY (DOE)

Through its Office of Science, DOE is the largest funder of physics R&D in the federal government. It supports 10 civilian national laboratories, and world-class scientific user facilities that are used by more than 18,000 academic, industry and government researchers for investigations into the nature of matter and energy. In addition to its domestic facilities, DOE participates, jointly with NSF, in the international Large Hadron Collider (LHC) now under construction. The U.S. recently announced that it is rejoining the International Thermonuclear Experimental Reactor (ITER) project, which, when built, will demonstrate fusion technologies. (See Table II-11 for details of R&D in the DOE budget.)

High Energy Physics: The High Energy Physics (HEP) program explores the basic constituents of matter and the forces that bind them together. HEP research is conducted primarily at Fermilab in Illinois and at the Stanford Linear Accelerator Center (SLAC) in California. Additionally, the HEP program supports DOE's participation in the LHC at the European Center for Nuclear Research (CERN) in Switzerland. The HEP program also supports research into black holes, dark energy, and other non-accelerator physics.

The FY 2004 request of $738 million for HEP R&D represents an increase of 2.2 percent, or $16 million, over FY 2003 funding of $722 million. HEP priorities for FY 2004 continue to be the search for the Higgs Boson at Fermilab, and research at SLAC into why matter

dominates over antimatter in the universe. In addition, the non-accelerator research program would be enhanced, and construction funding would be cut as construction winds down on the Neutrinos at the Main Injector project.

Nuclear Physics: DOE's Nuclear Physics program conducts research into atomic nuclei and nuclear matter. The program's two flagship user facilities are the Continuous Electron Beam Accelerator Facility in Virginia, and the Relativistic Heavy Ion Collider (RHIC) in New York.

The FY 2004 request of $389 million for Nuclear Physics R&D would represent an increase of 2.0 percent, or $8 million, over FY 2003 funding of $382 million. Funding for nuclear theory R&D would be enhanced, as would the operating time at RHIC. To support other facility operations, the 88-inch Cyclotron in California would be shut down. R&D funding would continue on a proposed Rare Isotope Accelerator.

Fusion Energy Sciences: The Fusion Energy Sciences (FES) program seeks to understand and control the process of fusion. This year, DOE rejoined the international negotiations for construction of ITER. The FES program would also continue to support facilities in California, New Jersey, and Massachusetts.

The FY 2004 request for FES R&D is $257 million, an increase of 3.6 percent, or $9 million, over the FY 2003 level of $248 million. Within its existing programs, DOE has identified $12 million supporting preparations for participation in ITER. The FY 2004 request would continue to support the design and fabrication of a National Compact Stellerator Experiment in New Jersey, and would establish up to two Centers of Excellence in Theory and General Plasma Science.

Basic Energy Sciences: The Basic Energy Sciences (BES) program funds R&D in support of DOE's energy, environment and national security missions. BES has two subprograms, Materials Sciences and Engineering; and Chemical Sciences, Geosciences, and Engineering Biosciences, with facilities in Illinois, California, New York, Tennessee, and New Mexico. The Spallation Neutron Source (SNS), under construction in Tennessee, will be the world's most powerful neutron scattering facility when completed in FY 2006.

The FY 2004 request for BES R&D is $1,009 million, a decrease of 1.4 percent, or $15 million, from the FY 2003 appropriation of $1,023 million. FY 2002 funding was $980 million. Construction funding for the SNS declines significantly in FY 2004 as the project moves toward completion. This savings will make additional funding available for other BES programs, including increased funding for scientific user facilities, support for five Nanoscale Science Research Centers, and design of a next-generation Linac Coherent Light Source.

Biological and Environmental Research: The Biological and Environmental Research (BER) program supports research in four subprograms: Life Sciences, Climate Change Research, Environmental Remediation, and Medical Applications and Measurement Science.

The FY 2004 request for BER R&D is $500 million, a decrease of 5.1 percent, or $27 million, from the FY 2003 appropriation of $527 million. FY 2002 funding was $554 million. Medical R&D would drop substantially, partly due to the completion of human DNA sequencing. The Genomes to Life program would be increased for more R&D into molecular machines for energy and environmental applications, and the Climate Change Research program would see an increase for research into the response of ecosystems to environmental change. (For more on the DOE budget, please see Chapter 9.)

NATIONAL SCIENCE FOUNDATION (NSF)

NSF is a major source of research funding for university-based physics research. Major support is provided through the Physics Subactivity and the Materials Research Subactivity, both of which would receive increases of about six percent in the FY 2004 request (see Table II-7 for details of the NSF budget). NSF also supports physics research through the Major Research Equipment and Facilities Construction account. "This investment will spur the vigorous research in these fields that has helped in the past to power advances in medicine, energy, agriculture, and the environment," said NSF Director Rita Colwell when describing the request for physical sciences funding.

Physics Subactivity: NSF supports physics research in fields such as atomic, optical, molecular, plasma, gravitational, nuclear, particle and theoretical physics, and nuclear astrophysics. For some fields, the

foundation provides almost all university-based funding. Important interdisciplinary research is also funded through the Physics Subactivity.

The Physics Subactivity provides grants ranging in size from individual investigators to major user groups. Important physics research is conducted at NSF user facilities at the Cornell Electron Storage Ring in New York, the Michigan State University National Superconducting Cyclotron Laboratory, and the Laser Interferometer Gravitational Wave Observatory (LIGO) in Louisiana, and Washington state. The Subactivity oversees construction of major instruments for advanced physics research. Funding has been completed for two such projects: the U.S. detectors for the LHC and LIGO.

FY 2004 funding for the Physics Subactivity would increase 6.1 percent, or $12 million, to $218 million. Current year funding is $205 million. The request states that there will be "some emphasis on particle and nuclear astrophysics, computational and information-intensive physics, quantum information science, biological physics and on advanced R&D towards next generation particle accelerators and gravitational wave detectors." Almost $4 million would be allocated to a new Science and Technology Center in biophotonics. The request would support full operations of the superconducting cyclotron in Michigan and full operations of NSF's new LIGO detectors. The budget request proposes to increase funding for the electron storage ring in New York, and the early operation of the two new LHC detectors.

Materials Research Subactivity: NSF also supports physics research through its Materials Research Subactivity. Investigations of materials, and the processes by which their characteristics can be improved, are funded through this Subactivity, with about half of all materials basic research at universities provided by this budget. Funding is also provided for 29 Materials Research Science and Engineering Centers, several user facilities such as a high magnetic field laboratory in Florida and other facilities for x-ray synchrotron radiation and neutron scattering.

FY 2004 funding for the Materials Research Subactivity would increase 5.8 percent, or $13 million, to $246 million. Current year funding is $233 million. FY 2002 funding was $219 million. The request explains that $5 million of this requested increase will be provided for nanoscale science and engineering, which will include partial funding for up to five new nanoscale science and engineering centers and for new awards in the core

research program. The FY 2004 budget for nanoscale science and engineering through this Subactivity would total $76 million.

The budget increase would provide an additional $10 million for awards to individual investigators and focused research groups for research into fundamental physics and the chemistry of materials. While funding for the National High Magnetic Field Laboratory would remain constant, the budget would be increased for operations at this Subactivity's other user facilities, and to plan future development of mid-scale research facilities. The request would also provide funding for the planning of instrumentation at DOE's Spallation Neutron Source.

Major Research Equipment and Facilities Construction: Construction funding for two major physics research facilities, the LHC and LIGO, is complete. NSF is requesting $60 million for FY 2004 to start construction of the IceCube Neutrino Observatory at the South Pole. This facility is being funded by a collaboration of 11 institutions in the United States and Europe, as well as DOE. The observatory would be built under the ice at the South Pole, and would study the universe through high-energy neutrinos. The project was started with FY 2002 funding, and has been on schedule and budget. Full operations of this observatory would begin in FY 2011. (For more on NSF, see Chapter 7).

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST supports physics research through many of its programs. The Physics Laboratory and the Materials Science and Engineering Laboratory are the focus of much of this work. There are seven NIST Measurement and Standards Laboratories.

The Physics Laboratory funds both directed research and research into physical standards and measurement methods. The Materials Science and Engineering Laboratory supports work on materials measurement and standards, and houses the only U.S. cold neutron research facility.

NIST calculates that FY 2004 funding for physics research conducted by its various laboratories would increase 41.9 percent, or $16 million, to $54 million. Current year funding is $38 million. FY 2002 funding was $34 million. FY 2004 funding for materials science and engineering research would increase 1.7 percent, or $1 million, to $66 million. FY 2003 funding is $65 million. FY 2002 funding was $59 million.