

Part III:
Disciplinary Analyses

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Physics in the FY 2001 Budget

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HIGHLIGHTS

- Within the Department of Energy (DOE) request, FY 2001 funding would more than double for continued construction and R&D on a major new research facility, the Spallation Neutron Source.
- Fusion and High Energy Physics funding within DOE would not keep pace with inflation in FY 2001, while Nuclear Physics research would receive a modest increase.
- FY 2001 is the first budget request to reflect the restructuring of DOE's national security programs into a new National Nuclear Security Administration (NNSA).
- The National Science Foundation (NSF) budget for the Physics Subactivity would increase 18.0 percent in FY 2001.
- NSF's Materials Research Subactivity would increase 15.4 percent in FY 2001.
- NSF requests \$16 million for continued construction of two detectors for the Large Hadron Collider, scheduled for completion in FY 2005.
- The FY 2001 budget for the Physics Laboratory at the National Institute of Standards and Technology would increase 34.2 percent, while the Materials Science and Engineering Laboratory budget would increase 14.1 percent.

Physics research has generated billion-dollar industries that employ millions of Americans, and has improved living standards worldwide. Technologies such as medical diagnostic equipment, the Global Positioning System, fuel efficient automobiles, compact disks, liquid crystal displays, fiber optics, stealth technology, the Internet, lasers, and new materials have their origins in physics research supported by the federal government. Federal support of physics R&D has been crucial in the often decades-long process leading to eventual product commercialization. The federal government is now poised to play a major role in physics and materials research in the emerging field of nanotechnology. A recent report predicts that “the impact of nanotechnology on the health, wealth, and lives of people could be at least as significant as the combined influences of microelectronics, medical imaging, computer-aided engineering, and man-made polymers developed in this century.”

A variety of federal departments and agencies support physics and materials research. Prominent among them are the Department of Energy, the National Science Foundation, the National Institute of Standards and Technology, and the Department of Defense. Support ranges from grants made to individual investigators to participation in the construction of billion-dollar international facilities. The Administration’s FY 2001 request for programs in physics research varies from essentially level funding to double-digit increases.

DEPARTMENT OF ENERGY (DOE)

The Department of Energy is the leading provider of federal funds for physical sciences research, and the primary supporter of R&D facilities, with missions in science, national security, energy supply, and environmental restoration. DOE’s Office of Science conducts long-term, fundamental civilian research to better understand the nature of matter and energy, develop new energy technologies, and address the impacts of energy production, development, and use. Physics-related R&D is performed within the High Energy Physics, Nuclear Physics, Basic Energy Sciences, Fusion Energy Sciences, and Biological and Environmental Research programs. Under the FY 2001 request, increased funding for a major construction project within Basic Energy Sciences (BES), the Spallation Neutron Source, would help boost the

PHYSICS IN THE FY 2001 BUDGET

BES budget, while funding for most other physics-related programs would remain essentially flat or increase only slightly. (See Table II-11 for details of R&D in the DOE budget.)

Basic Energy Sciences (BES): BES supports world-class research reactors, accelerators, and x-ray and ultraviolet sources, to perform research relevant to energy production, use, efficiency, and impacts. The BES budget would grow significantly under the FY 2001 request, driven largely by the increase requested for the Spallation Neutron Source (SNS), under construction at Oak Ridge, Tennessee. This state-of-the-art neutron scattering facility will explore the structure of matter, and may lead to better fibers, plastics, drugs, and catalysts. Within BES, a 138.3 percent increase, to \$281 million, is requested for construction and R&D on the SNS. In FY 2000, Congress gave the project \$118 million, significantly less than requested.

Also within BES, enhanced funding is requested for initiatives in Nanoscale Science, and Robotics and Intelligent Machines. The FY 2001 request for BES is \$1.0 billion, an increase of \$236 million, or 30.6 percent, from FY 2000 funding of \$772 million.

High Energy Physics (HEP): Research within HEP investigates the nature of energy and matter, and searches for neutrinos and cosmic dark matter. The FY 2001 request for HEP would grow less than inflation, and focus on research at two facilities that recently came on-line: the B-Factor at the Stanford Linear Accelerator Center in California and the Main Injector at Fermilab in Illinois. Work to upgrade two major detectors at Fermilab is nearing completion.

Another major HEP activity is U.S. involvement in the Large Hadron Collider (LHC) at CERN in Geneva, Switzerland, which will enable U.S. physicists to participate in what DOE calls “the foremost high energy physics facility of the next decade.” DOE is working in partnership with NSF and with CERN, a large European physics organization. DOE’s contribution to the LHC will support fabrication of two detectors and contribute to facility funding for the project, which will study collisions of atomic particles to enhance understanding of the atom and the origin of mass. Peak funding for LHC participation continues in FY 2001, level with the FY 2000 amount of \$70 million.

Jones and Leath

The FY 2001 R&D request for HEP is \$704 million, an increase of \$11 million, or 1.7 percent, from FY 2000 funding of \$693 million.

Nuclear Physics: Funding would increase for the Nuclear Physics program, which seeks to enhance understanding of atomic nuclei and the forces holding them together. The FY 2001 request will support operation of facilities in New York, Virginia, Tennessee, and Massachusetts. A highlight of the request is initial operation of the BLAST detector at MIT's Bates Laboratory by the end of FY 2001. The FY 2001 request for Nuclear Physics R&D is \$364 million. This represents an increase of \$16 million, or 4.7 percent, from FY 2000 funding of \$348 million.

Fusion Energy Sciences: FY 2001 funding would remain essentially flat for the Fusion program, which in recent years has been downsized and restructured to focus on advancing plasma science and developing a knowledge base for a future fusion energy source. The FY 2001 request for Fusion Energy Sciences R&D is \$244 million, a decrease of \$1 million, or 0.2 percent, from FY 2000 funding of \$245 million.

Biological and Environmental Research (BER): Research within this program addresses understanding and mitigation strategies for adverse environmental and health effects due to energy production and use. The minor requested increase would support activities in boron neutron capture therapy, bioremediation, human genome sequencing, and climate change research. The FY 2001 request for R&D within BER is \$444 million, an increase of \$11 million, or 2.6 percent, from the FY 2000 amount of \$433 million.

Defense-related Inertial Confinement Fusion: In March, DOE's defense missions were moved into the semi-autonomous National Nuclear Security Administration (NNSA). DOE's stockpile stewardship activities, which utilize computer modeling and simulation to maintain the nation's nuclear weapons without testing, fall under this new agency.

Within this agency, recent revelations of cost and schedule overruns in construction of the National Ignition Facility (NIF) caused DOE to develop a new project baseline. The FY 2001 request for NIF construction R&D is \$74 million. DOE requests \$121 million for defense-related inertial confinement fusion R&D.

PHYSICS IN THE FY 2001 BUDGET

NATIONAL SCIENCE FOUNDATION (NSF)

The National Science Foundation is a major supporter of university-based physics research. Although NSF's support of physics and materials research is but a fraction of DOE's, the foundation provides the majority of support for university research in some sub-disciplines. (For details of R&D in the NSF budget, please see Table II-7.)

Physics Subactivity: The Administration requests an increase of \$30 million, or 18.0 percent, in the Physics Subactivity budget. If approved, the budget would increase from \$168 million to \$199 million in FY 2001. NSF provides between 30 and almost 100 percent of university-based support in various physics sub-disciplines, as well as funding for interdisciplinary research.

The Physics Subactivity budget is divided into two categories. Physics Research Project Support would increase by 33.8 percent to \$143 million and would enhance funding, NSF states, for "particle and nuclear astrophysics, atom-level manipulation, atom lasers, quantum information science" and for R&D on the next generation of accelerators and detectors. NSF requests \$5 million to initiate a Physics Frontier Centers program "aimed at providing critical resources and needed infrastructure to exceptionally promising new areas of physics." The Facilities budget would decline almost \$6 million, or 9.3 percent, to \$56 million because of the scheduled completion of projects at two facilities. NSF supports user facilities in New York, Michigan, Indiana, Louisiana, and Washington state.

Materials Research Subactivity: The Materials Research Subactivity budget would increase \$29 million, or 15.4 percent, from \$191 million to \$221 million in FY 2001. According to NSF, research in this Subactivity "extends from investigations of phenomena in condensed matter physics and solid state chemistry to research on functional materials including metals; ceramics; polymers; biomaterials; and electronic, photonic and magnetic materials." Approximately 50 percent of federally-sponsored university-based research in materials is supported by this Subactivity.

This Subactivity is divided into three components. Materials Research Project Support would increase by 22.2 percent to \$126 million.

Nanoscale research in areas such as information technology and biomolecular materials would be strengthened in the new budget. An increase of 10.4 percent to \$59 million would allow up to four new Materials Research Science and Engineering Centers to be established. The centers would be selected through open competition, and would focus on areas such as nanoscale science and engineering, the interface between materials and biology, and information technology. National Facilities and Instrumentation would increase 2.9 percent to \$35 million, to develop new user facility instruments.

Major Research Equipment: The Physics Subactivity provides oversight for the foundation's participation in the Large Hadron Collider, with funding provided by the Major Research Equipment budget. NSF and the Department of Energy are providing construction funding for two detectors that will be installed at the CERN laboratory in Switzerland. NSF requests \$16 million in FY 2001 for construction of these two detectors. Completion of the LHC is scheduled for FY 2005.

National Institute of Standards and Technology (NIST)

Physics research is supported by the National Institute of Standards and Technology (NIST). NIST's Measurement and Standards Laboratories (MSL) support measurement capabilities and techniques, instruments, standards, evaluated reference data, and test methods that are used by industry and the science and technology community. As an example, the NIST Center for Neutron Research's instruments, which reveal the inner structure and dynamics of almost any material, are used annually by more than 50 U.S. companies, 90 universities, and 30 other government agencies. NIST proposes to commission "a nanoscale physics facility for characterizing the properties of quantum-electronic devices for use in next-generation integrated circuits."

Physics research is performed in many of NIST's seven Measurement and Standards Laboratories. The budget for the Physics Laboratory would increase by 34.2 percent in FY 2001 to \$36 million. The Materials Science and Engineering Laboratory budget would increase by 14.1 percent to \$47 million (see Table II-14).