Statement of Dr. Raymond L. Orbach
Under Secretary for Science
U.S. Department of Energy

Before the
Subcommittee on Energy and Environment
House Science and Technology Committee

Regarding FY 2008 Research
and Development Budget Proposal

March 7, 2007

Mr. Chairman and Members of the Committee, thank you for the opportunity to testify today on the Office of Science's Fiscal Year (FY) 2008 budget request. I appreciate your support for the Office of Science and basic research in the physical sciences, Mr. Chairman, and your understanding of the importance of this research to our Nation's energy security and economic competitiveness. I also want to thank the Members of the Committee for their support. I believe this budget will enable the Office of Science to deliver on its mission and enhance U.S. competitiveness through our support of transformational science, national scientific facilities, and the scientific workforce for the Nation's future.

The Office of Science requests $4,397,876,000 for the FY 2008 Science appropriation, an increase of $600,582,000 over the FY 2007 appropriated level. The FY 2008 budget request for the Office of Science represents the second year of the President's commitment to double the Federal investment in basic research in the physical sciences by the year 2016 as part of the American Competitiveness Initiative. It also represents a continued commitment to maintain U.S. leadership in science and recognition of the valuable role research in the physical sciences plays in technology innovation and global competitiveness.

With the FY 2008 budget request the Office of Science will continue to support transformational science – basic research for advanced scientific breakthroughs that will revolutionize our approach to the Nation's energy, environment, and national security challenges. The Office of Science is the Nation's steward for fields such as high energy physics, nuclear physics, heavy element chemistry, plasma physics, magnetic fusion, and catalysis. It also supports unique components of U.S. research in climate change and geophysics.

Researchers funded through the Office of Science are working on some of the most pressing scientific challenges of our age including: 1) Harnessing the power of microbial communities and plants for energy production from renewable sources, carbon sequestration, and environmental remediation; 2) Expanding the frontiers of nanotechnology to develop materials with unprecedented properties for widespread potential scientific, energy, and industrial applications; 3) Pursuing the breakthroughs in materials science, nanotechnology, biotechnology, and other fields needed to make solar energy more cost-effective; 4) Demonstrating the scientific and technological feasibility of creating and controlling a sustained burning plasma to generate energy, as the next step toward making fusion power a commercial reality; 5) Using advanced computation, simulation, and modeling to understand and predict the behavior of complex systems beyond the reach of some of our most powerful experimental probes, with potentially transformational impacts on a broad range of scientific and technological undertakings; 6) Understanding the origin of the universe and nature of dark matter and dark energy; and 7) Resolving key uncertainties and expanding the scientific foundation needed to understand, predict, and assess the potential effects of atmospheric carbon dioxide on climate and the environment.

U.S. leadership in many areas of science and technology depends in part on the continued availability of the most advanced scientific facilities for our researchers. The Office of Science builds and operates national scientific facilities and instruments that make up the world's most sophisticated suite of research capabilities. The resources available for scientific research include advanced synchrotron light sources, the new Spallation Neutron Source, state-of-the-art Nanoscale Science Research Centers, supercomputers and high-speed networks, climate and environmental monitoring capabilities, particle accelerators and detectors for high energy and nuclear physics, and genome sequencing facilities We are in the process of developing new tools such as an X-ray free electron laser light source that can image single large macromolecules and measure in real-time changes in the chemical bond as chemical and biological reactions take place, a next generation synchrotron light source for x-ray imaging and capable of nanometer resolution, and detectors and instruments for world-leading neutrino physics research. SC will also select and begin funding in FY 2007 for three Bioenergy Research Centers to conduct fundamental research on microbes and plants needed to produce biologically-based fuel

Office of Science leadership in support of the physical sciences and stewardship of large national research facilities is directly linked to our historic role in training America's scientists and engineers. In addition to funding a diverse portfolio of research at more than 300 colleges and universities nationwide, we provide direct support and access to research facilities for thousands of university students and researchers. Facilities at the national laboratories provide unique opportunities for researchers and their students from across the country to pursue questions at the intersection of physics, chemistry, biology, computing, and materials science. About half of the annual 21,000 users of the Office of Science's scientific facilities come from universities. The FY 2008 budget will support the research of approximately 25,500 faculty, postdoctoral researchers, and graduate students throughout the Nation, an increase of 3,600 from FY 2006, in addition to supporting undergraduate research internships and fellowships and research and training opportunities for K-14 science educators at the national laboratories.

The approximate $600 million increase in FY 2008 from the FY 2007 appropriated level will bring manageable increases to the Office of Science programs for long planned for activities. The FY 2008 request will allow the Office of Science to increase support for high-priority DOE mission-driven scientific research and new initiatives; maintain optimum operations at our scientific user facilities; continuing major facility construction projects; and enhance educational, research, and training opportunities for the Nation's future scientific workforce. The budget request will also support basic research that contributes to Presidential initiatives such as the Hydrogen Fuel Initiative and the Advanced Energy Initiative, the Climate Change Science and Technology Programs, and the National Nanotechnology Initiative.

The following programs are supported in the FY 2008 budget request: Basic Energy Sciences, Advanced Scientific Computing Research, Biological and Environmental Research, Fusion Energy Sciences, High Energy Physics, Nuclear Physics, Workforce Development for Teachers and Scientists, Science Laboratories Infrastructure, Science Program Direction, and Safeguards and Security.

FY 2008 PRESIDENT'S REQUEST
SUMMARY BY PROGRAM

(dollars in thousands)

	FY 2006 Approp.	FY 2007 Request	FY 2007 Approp.†	FY 2008 Request	FY 2008 Request vs.	
					Request	Approp.
Basic Energy Sciences	1,110,148	1,420,980		1,498,497	+77,517	
Advanced Scientific Computing Research	228,382	318,654		340,198	+21,544	
Biological and Environmental Research	564,077	510,263		531,897	+21,634	
High Energy Physics	698,238	775,099		782,238	+7,139	
Nuclear Physics	357,756	454,060		471,319	+17,259	
Fusion Energy Sciences	280,683	318,950		427,850	+108,900	
Science Laboratories Infrastructure	41,684	50,888		78,956	+28,068	
Science Program Direction	159,118	170,877		184,934	+14,057	
Workforce Development for Teachers and Scientists	7,120	10,952		11,000	+48	
Safeguards and Security	68,025	70,987		70,987	—	
SBIR/STTR	116,813	—		—	—	
Total, Office of Science	3,632,044	4,101,710	3,797,294	4,397,876	+296,166	+600,582

† FY 2007 program allocation plan not yet finalized.

FY 2008 SCIENCE PRIORITIES

The challenges we face today in energy and the environment are some of the most vexing and complex in our history. Our success in meeting these challenges will depend in large part on how well we maintain this country's leadership in science and technology because it is through scientific and technological innovation and a skilled workforce that these challenges will be solved.

President George W. Bush made this point in his State of the Union Message on January 23, 2007, when he stated,

"It's in our vital interest to diversify America's energy supply – the way forward is through technology… We must continue changing the way America generates electric power, by even

greater use of clean coal technology, solar and wind energy, and clean, safe nuclear power. We need to press on with battery research for plug-in and hybrid vehicles, and expand the use of clean diesel vehicles and biodiesel fuel. We must continue investing in new methods of producing ethanol – using everything from wood chips to grasses, to agricultural wastes….

"America is on the verge of technological breakthroughs that will enable us to live our lives less dependent on oil. And these technologies will help us to be better stewards of the environment, and they will help us confront the serious challenge of global climate change."

In 2006, the President announced a commitment to double the budget for basic research in the physical sciences at key agencies over ten years to maintain U.S. leadership in science and ensure continued global competitiveness. This commitment received bipartisan support in both the House of Representatives and the Senate and the FY 2008 budget request for the Office of Science represents the second year of this effort. Through the FY 2008 budget, the Office of Science will build on its record of results with sound investments to keep U.S. research and development at the forefront of global science and prepare the scientific workforce we will need in the 21st century to address our Nation's challenges.

Determining and balancing science and technology priorities across the Office of Science programs is an ongoing process. Several factors are considered in our prioritization, including scientific opportunities identified by the broader scientific community through Office of Science sponsored workshops; external review and recommendations by scientific advisory committees; DOE mission needs; and national and departmental priorities. In FY 2008, we will support the priorities in scientific research, facility operations, and construction and laboratory infrastructure established in the past few years and outlined in the Office of Science Strategic Plan and Twenty-year Facilities Outlook, in addition to national and departmental priorities and new research opportunities identified in recent workshops.

National initiatives in hydrogen fuel cell and advanced energy technologies will be supported through our contributions to basic research in hydrogen, fusion, solar energy-to-fuels, and production of ethanol and other biofuels from cellulose. We will also continue strong support for other Administration priorities such as nanotechnology, advanced scientific computation, and climate change science and technology.

The Office of Science will support three Bioenergy Research Centers in FY 2008 as part of the broader Genomics:GTL program. These centers, to be selected in FY 2007 and fully operational by the end of 2008, will conduct comprehensive, multidisciplinary research programs focused on microbes and plants to drive scientific breakthroughs necessary for the development of cost-effective biofuels and bioenergy production. The broader GTL program will also continue to support fundamental research and technology development needed to understand the complex behavior of biological systems for the development of innovative biotechnology solutions to energy production, environmental mitigation, and carbon management.

The Office of Science designs, constructs, and operates facilities and instruments that provide world-leading research tools and capabilities for U.S. researchers and will continue to support next generation tools for enabling transformational science. For example, the Spallation Neutron Source (SNS), the world's forefront neutron scattering facility, increases the number of neutrons available for cutting-edge research by a factor of ten over any existing spallation neutron source in the world. SNS was completed and began operations in 2006 and in FY 2008 full operations are supported and additional experimental capabilities continue to be added.

When it comes on line, the Linac Coherent Light Source (LCLS) at the Stanford Linear Accelerator Center (SLAC) will produce X-rays 10 billion times more intense than any existing X-ray source in the world, and will allow structural studies on individual nanoscale particles and single biomolecules. Construction of LCLS continues in FY 2008.

A next generation synchrotron light source, the National Synchrotron Light Source-II (NSLS-II), would deliver orders of magnitude improvement in spatial resolution, providing the world's finest capabilities for X-ray imaging and enabling the study of material properties and functions, particularly at the nanoscale, at a level of detail and precision never before possible. Its energy resolution would explore dynamic properties of matter as no other light source has ever accomplished. Support for continued R&D and project engineering and design (PED) are provided in FY 2008.

All five of DOE's Nanoscale Science Research Centers (NSRCs) will be operating in FY 2008. These facilities are the Nation's premier nanoscience user centers, providing resources unmatched to the scientific community for the synthesis, fabrication, and analysis of nanoparticles and nanomaterials.

We will fully fund the programs for advanced scientific computing, including: continued support for high-performance production computing at the National Energy Research Scientific Computing Center (NERSC), which will increase capacity to 100-150 teraflops in FY 2007; support for advanced capabilities for modeling and simulation of scientific problems in combustion, fusion, and complex chemical reactions at Oak Ridge National Laboratory's Leadership Computing Facility, which should deliver 250 teraflops computing capability by the end of FY 2008; and support for the upgrade to 250-500 teraflop peak capacity of the IBM Blue Gene P system at Argonne National Laboratory's Leadership Computing Facility to extend architectural diversity in leadership computing.

The Office of Science continues to be a partner in the interagency Climate Change Science Program focusing on understanding the principal uncertainties of the causes and effects of climate change, including abrupt climate change, understanding the global carbon cycle, developing predictive models for climate change over decades to centuries, and supporting basic research for biological sequestration of carbon. We also continue to support research in geosciences and environmental remediation towards the development of scientific and technological solutions to long-term environmental challenges.

The Office of Science will continue to actively lead and support the U.S. contributions to ITER, the international project to build and operate the first fusion science facility capable of producing a sustained burning plasma to generate energy on a massive scale without environmental insult.

The historic international fusion energy agreement to build ITER with six other international partners was signed in November 2006.

We continue strong support for experimental and theoretical high energy physics and the study of the elementary constituents of matter and energy and interactions at the heart of physics. Full operations at the Tevatron Collider at Fermilab and the B-factory at SLAC are supported to maximize the scientific research and data derived from these facilities. Full operation of the neutrino oscillation experiment at Fermilab and start of fabrication of a next generation detector are supported to provide a platform for a world-leading neutrino program in the U.S. International Linear Collider (ILC) R&D and superconducting radiofrequency technology R&D are supported to enable the most compelling scientific opportunities in high energy physics in the coming decades.

Our research programs in nuclear physics continue to receive strong support. Operations at the Relativistic Heavy Ion Collider (RHIC) and additional instrumentation projects for RHIC are supported for studies of the properties of hot, dense nuclear matter, providing insight into the early universe. We will also support operations at the Continuous Electron Beam Accelerator Facility (CEBAF), the world's most powerful "microscope" for studying the quark structure of matter, and project engineering and design and R&D for doubling the energy of the existing beam at CEBAF to 12 gigaelectron volts (GeV). Support for R&D to develop advanced rare isotope beam capabilities for the next generation U.S. facility for nuclear structure and astrophysics is also provided.

The standard of living we enjoy and the security of our Nation now and in the future rests on the quality of science and technology education we provide America's students from elementary through graduate school and beyond. The FY 2008 budget will provide support for over 25,500 Ph.D.s, graduate students, engineers, and technical professionals, an increase of 3,600 over the number supported in FY 2006. The Office of Science will also support the development of leaders in the science and mathematics education community through participation of K-14 teachers in the DOE Academies Creating Teacher Scientists program, formerly the Laboratory Science Teacher Professional Development program. This immersion program at the national laboratories is an opportunity for teachers to work with laboratory scientists as mentors and to build content knowledge, research skills, and lasting connections to the scientific community, ultimately leading to more effective teaching that inspires students in science and math. The year 2008 will also mark the 18th year of DOE's National Science Bowl® for high school students. National Science Bowl® events for high school and middle school students, which will involve 17,000 students across the nation this year, provide prestigious academic competitions that challenge and inspire the Nation's youth to excel in math and science.

SCIENCE ACCOMPLISHMENTS

For more than 50 years, the Office of Science (SC) has balanced basic research, innovative problem solving, and support for world-leading scientific capabilities, enabling historic contributions to U.S. economic and scientific preeminence. American taxpayers have received good value for their investment in basic research sponsored by the Office of Science; this work has led to significant technological innovations, new intellectual capital, improved quality of life, and enhanced economic competitiveness. The following are some of the past year's highlights:

Nobel Prize in Physics. The 2006 Nobel Prize in physics was awarded to Dr. George Smoot (DOE Lawrence Berkeley National Laboratory and University of California, Berkeley) and Dr. John Mather (NASA Goddard Space Flight Center) for their discovery of "the blackbody form and anisotropy of the cosmic microwave background radiation," the pattern of minuscule temperature variations in radiation which allowed scientists to gain better understanding of the origins of galaxies and stars. These two American scientists led the teams of researchers who worked on the historic 1989 NASA COBE satellite. The results of their work provided increased support for the "Big Bang" theory of the universe and marked the inception of cosmology as a precise science. SC supported Dr. Smoot's research during the period in which he worked on the COBE experiment, and continues to support his research today. One of the principal instruments used to make the discoveries was built at SC-supported facilities at Lawrence Berkeley National Laboratory and DOE's National Energy Research Scientific Computing Center supercomputers were used to analyze the massive amounts of data and produce detailed visual maps.

Advancing Science and Technology for Bioenergy Solutions. Harnessing the capabilities of microbes and plants holds great potential for the development of innovative, cost-effective methods for the production of biofuels and bioenergy. Sequencing of the poplar tree genome was completed as part of a DOE national laboratory-led international collaboration; the information encoded in the poplar genome will provide researchers with an important resource for developing trees that produce more biomass for conversion to biofuels and trees that can sequester more carbon from the atmosphere. The DOE Joint Genome Institute (JGI) marked a technical milestone this year with the 100^{th} microbe genome sequenced; *Methanosarcina barkeri fusaro* is capable of living in diverse and extreme environments, produces methane from digesting cellulose and other complex sugars, and provides greater understanding of potential new methods for producing renewable sources of energy. A chemical imaging method developed using a light-producing cellulose synthesizing enzyme allowed researchers to observe the enzyme as it deposited cellulose fibers in a cell, providing greater understanding of the mechanism for cellulose formation.

Delivering Forefront Computational and Networking Capabilities for Science. Several 2006 advances in computing, computational sciences, and networking enabled greater opportunities for computational research and effective management of data collected at DOE scientific user facilities. NERSC began to increase its peak capacity by a factor of 100 and the Oak Ridge National Laboratory (ORNL) Leadership Computing Facility doubled its capability to 54 teraflops to provide additional resources for computationally intensive, large-scale projects. The Energy Sciences Network expanded in 2006 to include the Chicago and New York-Long Island metropolitan area networks (MANs), bringing dual connectivity at 20 gigabits per second and highly reliable, advanced network services to accommodate next-generation scientific instruments and supercomputers. Chemistry software using parallel-vector algorithms developed by researchers at ORNL has enabled computations 40 times more complex and 100 times faster than previous state-of-the-art codes. The development of a multiscale mathematical framework for simulating the process of self-organization in biological systems has led to the discovery of a previously unidentified cluster state, providing possible applications to modeling microbial populations.

Advances in Basic Science for Energy Technologies. Current and future national energy challenges may be partially addressed through scientific and technological innovation. Some recent accomplishments in basic science that may contribute to future energy solutions include the following. Basic research on the molecular design and synthesis of new polymer membranes has lead to the discovery of a new fuel cell membrane that is longer lasting and three times more proton conductive than the current gold standard for proton exchange membrane fuel cells. Computational studies showing that in titanium-coated carbon nanotubes a single titanium atom can adsorb four hydrogen molecules opens new ways that the control of matter on the nanoscale can lead to the creation of novel materials for hydrogen storage. Recent work demonstrating that visible light can split carbon dioxide into carbon monoxide and a free oxygen atom, the critical first reaction in sunlight-driven transformation of carbon dioxide into methanol, makes it feasible to consider harnessing sunlight to drive the photocatalytic production of methanol from carbon dioxide. Demonstration of the effect known as carrier multiplication in which a single photon creates multiple charge carriers during the interaction of photons with a nanocrystalline sample could lead to substantial increases in solar cell conversion efficiency.

Maintaining World-leading Research Tools for U.S. Science. The Office of Science continues to construct and maintain powerful tools and research capabilities that will accelerate U.S. scientific discovery and innovation. The following highlight a few recent accomplishments. Construction and commissioning of the Spallation Neutron Source (SNS), an accelerator-based neutron source that will provide the most intense pulsed neutron beams in the world for scientific research and industrial development, was completed and began operations. Full operation of four of the five DOE Nanoscale Science Research Centers began in 2006, providing resources unmatched anywhere in the world for the synthesis, fabrication, and analysis of nanoparticles and nanomaterials. A nanofocusing lens device at the Advanced Photon Source at Argonne National Laboratory has set a world's record for line size resolution produced with a hard x-ray beam and enables such capabilities as three-dimensional visualization of electronic circuit boards, mapping impurities in biological and environmental samples, and analyzing samples inside high-pressure or high-temperature cells. A new record for performance, a 77% increase in peak luminosity in 2006 from the previous year, was achieved at the Tevatron, the world's most powerful particle collider for high energy physics research at Fermilab. Evidence of the rare single top quark was observed at Fermilab in 2006, bringing researchers a step closer to finding the Higgs boson. The Large Area Telescope (LAT), a DOE and NASA partnership and the primary instrument on NASA's GLAST mission, was completed in 2006 and will be placed in orbit in the fall of 2007 to study the high energy gamma rays and other astrophysical phenomena using particle physics detection techniques. During the 2006 operation of the Relativistic Heavy Ion Collider (RHIC), polarized protons were accelerated to the highest energies ever recorded – 250 billion electron volts – for world-leading studies of the internal quark-gluon structure of nucleons.

PROGRAM OBJECTIVES AND PERFORMANCE

The path from basic research to technology development and industrial competitiveness is not always obvious. History has taught us that seeking answers to fundamental questions can ultimately result in a diverse array of practical applications as well as some remarkable revolutionary advances. Working with the scientific community, the Office of Science invests in the promising research and sets long-term scientific goals with ambitious annual targets. The intent and impact of our performance goals may not always be clear to those outside the research community. Therefore the Office of Science has created a website (www.sc.doe.gov/measures) to better communicate to the public what we are measuring and why it is important.

Further, the Office of Science has revised the appraisal process it uses each year to evaluate the scientific, management, and operational performance of the contractors who manage and operate each of its 10 national laboratories. This new appraisal process went into effect for the FY 2006 performance evaluation period and provides a common structure and scoring system across all 10 Office of Science laboratories. The performance-based approach focuses the evaluation of the contractor's performance against eight Performance Goals (three Science and Technology Goals and five Management and Operation Goals). Each goal is composed of two or more weighted objectives. The new process has also incorporated a standardized five-point (0-4.3) scoring system, with corresponding grades for each Performance Goal, creating a "Report Card" for each laboratory.

The FY 2006 Office of Science laboratory report cards have been posted on the SC website (http://www.science.doe.gov/News_Information/News_Room/2007/Appraisa_%20Process/index.htm).

SCIENCE PROGRAMS

BASIC ENERGY SCIENCES

FY 2007 Request - $1,421.0 Million; FY 2008 Request - $1,498.5 Million

Basic research supported by the Basic Energy Sciences (BES) program touches virtually every aspect of energy resources, production, conversion, efficiency, and waste mitigation. Research in materials sciences and engineering leads to the development of materials that may improve the efficiency, economy, environmental acceptability, and safety of energy generation, conversion, transmission, and use. Research in chemistry leads to the development of advances such as efficient combustion systems with reduced emission of pollutants; new solar photo-conversion processes; improved catalysts for the production of fuels and chemicals; and better separations and analytical methods for applications in energy processes, environmental remediation, and waste management. Research in geosciences contributes to the solution of problems in multiple DOE mission areas, including reactive fluid flow studies to understand contaminant remediation and seismic imaging for reservoir definition. Research in the molecular and biochemical nature of photosynthesis aids the development of solar photo-energy conversion and biomass conversion methods. BES asks researchers to reach far beyond today's problems in order to provide the basis for long-term solutions to what is one of society's greatest challenges—a secure, abundant, and clean energy supply. In FY 2008, the Office of Science will support expanded efforts in basic research related to transformational energy technologies. Within BES, there are increases to ongoing basic research for the hydrogen economy and effective solar energy utilization. The FY 2008 budget request also supports increased research in electric-energy storage, accelerator physics, and X-ray and neutron detector research.

BES also provides the Nation's researchers with world-class research facilities, including reactor- and accelerator-based neutron sources, light sources (soon to include an X-ray free electron laser), nanoscale science research centers, and electron beam micro-characterization centers. These facilities provide outstanding capabilities for imaging and characterizing materials of all kinds from metals, alloys, and ceramics to fragile biological samples. The next steps in the characterization and the ultimate control of materials properties and chemical reactivity are to improve spatial resolution of imaging techniques; to enable a wide variety of samples, sample sizes, and sample environments to be used in imaging experiments; and to make measurements on very short time scales, comparable to the time of a chemical reaction or the formation of a chemical bond. With these tools, we will be able to understand how the composition of materials affects their properties, to watch proteins fold, to see chemical reactions, and to understand and observe the nature of the chemical bond. For FY 2008, BES scientific user facilities will be scheduled to operate at an optimal number of hours.

Construction of the Spallation Neutron Source (SNS) was completed in FY 2006 ahead of schedule, under budget, and meeting all technical milestones. In FY 2008 fabrication and commissioning of SNS instruments will continue, funded by BES and other sources including non-DOE sources, and will continue to increase power towards full levels. Two Major Items of Equipment are funded in FY 2008 that will allow the fabrication of approximately nine to ten additional instruments for the SNS, thus nearly completing the initial suite of 24 instruments that can be accommodated in the high-power target station.

All five Nanoscale Science Research Centers will be fully operational in FY 2008: the Center for Nanophase Materials Sciences at Oak Ridge National Laboratory, the Molecular Foundry at Lawrence Berkeley National Laboratory, the Center for Nanoscale Materials at Argonne National Laboratory, the Center for Integrated Nanotechnologies at Sandia National Laboratories and Los Alamos National Laboratory, and the Center for Functional Nanomaterials at Brookhaven National Laboratory. In FY 2008, funding for research at the nanoscale increases for activities related to the hydrogen economy and solar energy utilization.

The Linac Coherent Light Source (LCLS) at the Stanford Linear Accelerator Center (SLAC) will continue construction at the planned levels in FY 2008. Funding is also provided for primary support of the operation of the SLAC linac. This marks the third year of the transition of linac funding from the High Energy Physics program to the Basic Energy Sciences program. The purpose of the LCLS Project is to provide laser-like radiation in the X-ray region of the spectrum that is 10 billion times greater in peak power and peak brightness than any existing coherent X-ray light source and that has pulse lengths measured in femtoseconds—the timescale of electronic and atomic motions. The LCLS will be the first such facility in the world for groundbreaking research in the physical and life sciences. Funding is provided separately for design and fabrication of instruments for the facility. Project Engineering and Design (PED) and construction for the Photon Ultrafast Laser Science and Engineering (PULSE) building renovation begins in FY 2008. PULSE is a new center for ultrafast science at SLAC focusing on ultrafast structural and electronic dynamics in materials sciences, the generation of attosecond laser pulses, single-molecule imaging, and understanding solar energy conversion in molecular systems. Support continues for PED and R&D for the National Synchrotron Light Source-II (NSLS-II), which would be a new synchrotron light source, highly optimized to deliver ultra-high brightness and flux and exceptional beam stability. This would enable the study of material properties and functions with a spatial resolution of one nanometer (nm), an energy resolution of 0.1 millielectron volt (meV), and the ultra-high sensitivity required to perform spectroscopy on a single atom, achieving a level of detail and precision never possible before. NSLS-II would open new regimes of scientific discovery and investigation.

The Scientific Discovery through Advanced Computing (SciDAC) program is a set of coordinated investments across all Office of Science mission areas with the goal of using computer simulation to achieve breakthrough scientific advances that are impossible using theoretical or laboratory studies alone. The SciDAC program in BES consists of two activities: (1) characterizing chemically reacting flows as exemplified by combustion and (2) achieving scalability in the first-principles calculation of molecular properties, including chemical reaction rates.

ADVANCED SCIENTIFIC COMPUTING RESEARCH

FY 2007 Request - $318.7 Million; FY 2008 Request - $340.2 Million

The Advanced Scientific Computing Research (ASCR) program is expanding the capability of world-class scientific research through advances in mathematics, high performance computing and advanced networks, and through the application of computers capable of many trillions of operations per second (terascale to petascale computers). Computer-based simulation can enable us to understand and predict the behavior of complex systems that are beyond the reach of our most powerful experimental probes or our most sophisticated theories. Computational modeling has greatly advanced our understanding of fundamental processes of nature, such as fluid flow and turbulence or molecular structure and reactivity. Soon, through modeling and simulation, we will be able to explore the interior of stars to understand how the chemical elements were created and learn how protein machines work inside living cells to enable the design of microbes that address critical energy or waste cleanup needs. We could also design novel catalysts and high-efficiency engines that expand our economy, lower pollution, and reduce our dependence on foreign oil. Computational science is increasingly important to making progress at the frontiers of almost every scientific discipline and to our most challenging feats of engineering. Leadership in scientific computing has become a cornerstone of the Department's strategy to ensure the security of the nation and success in its science, energy, environmental quality, and national security missions.

The demands of today's facilities, which generate millions of gigabytes of data per year, now outstrip the capabilities of the current Internet design and push the state-of-the-art in data storage and utilization. But, the evolution of the telecommunications market, including the availability of direct access to optical fiber at attractive prices and the availability of flexible dense wave division multiplexing (DWDM) products gives SC the possibility of exploiting these technologies to provide scientific data where needed at speeds commensurate with the new data volumes. To take advantage of this opportunity, the Energy Science Network (ESnet) has entered into a long term partnership with Internet 2 to build the next generation optical network infrastructure needed for U.S. science. To fully realize the potential for science, however, significant research is needed to integrate these capabilities, make them available to scientists, and build the infrastructure which can provide cybersecurity. ASCR is leading an interagency effort to develop a Federal Plan for Advanced Networking R&D. This plan will provide a strategy for addressing current and future networking needs of the Federal government in support of science and national security missions and provide a process for developing a more detailed roadmap to guide future multi-agency investments in advancing networking R&D.

ASCR supports core research in applied mathematics, computer sciences, and distributed network environments. The applied mathematics research activity produces fundamental mathematical methods to model complex physical and biological systems. The computer science research efforts enable scientists to perform scientific computations efficiently 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 with scientists who need access to the data. Results from enabling research supported by ASCR are used by scientists supported by other SC programs. This link to other DOE programs provides a tangible assessment of the value of ASCR's core research program for advancing scientific discovery and technology development through simulations. In FY 2008 expanded efforts in applied mathematics will support critical long-term mathematical research issues relevant to petascale science, multiscale mathematics, and optimized control and risk analysis in complex systems. Expanded efforts in computer science will enable scientific applications to take full advantage of petascale computing systems at the Leadership Computing Facilities.

In addition to its research activities, ASCR plans, develops, and operates supercomputer and network facilities that are available 24 hours a day, 365 days a year to researchers working on problems relevant to DOE's scientific missions. Investments in the ESnet will provide the DOE science community with capabilities not available through commercial networks or the commercial internet to manage increased data flows from petascale computers and experimental facilities. In FY 2008 ESnet will deliver a 10 gigabit per second (gbps) core Internet service as well as a Science Data Network with 20 gbps on its northern route and 10 gbps on its southern route. Delivery of the next generation of high performance resources at the National Energy Research Scientific Computing Center (NERSC) is scheduled for FY 2007. This NERSC-5 system is expected to provide 100–150 teraflops of peak computing capacity. The NERSC computational resources are integrated by a common high performance file storage system that enables users to use all machines easily. Therefore the new machine will significantly reduce the current oversubscription at NERSC which serves nearly 2,000 scientists annually.

In FY 2008, the Oak Ridge National Laboratory (ORNL) Leadership Computing Facility (LCF) will continue to provide world leading high performance sustained capability to researchers through the Innovative and Novel Computational Impact on Theory and Experiment (INCITE) program. The acquisition of a 250 teraflop Cray Baker system by the end of FY 2008 will enable further scientific advancements in areas such as combustion simulation for clean coal research, simulation of fusion devices that approach ITER scale, and quantum calculations of complex chemical reactions. In addition, further diversity with the LCF resources will be realized with an acquisition by Argonne National Laboratory (ANL) of a high performance IBM Blue Gene/P with low-electrical power requirements and a peak capability of up to 100 teraflops in 2007, and further expansion to 250-500 teraflops in FY 2008 will bring enhanced capability to accelerate scientific understanding in areas such as molecular dynamics, catalysis, protein/DNA complexes, and aging of material. With the ORNL and ANL LCF facilities SC is developing a multiple set of computer architectures to enable the most efficient solution of critical problems across the spectrum of science, ranging from biology to physics and chemistry.

The Scientific Discovery through Advanced Computing (SciDAC) program is a set of coordinated investments across all SC mission areas with the goal of using computer simulation and advanced networking technologies to achieve breakthrough scientific advances via that are impossible using theoretical or laboratory studies alone. In FY 2006 ASCR recompeted its SciDAC portfolio, with the exception of activities in partnership with the Fusion Energy Sciences program that were initiated in FY 2005. The new portfolio, referred to as SciDAC-2, enables new areas of science through Scientific Application Partnerships; Centers for Enabling Technologies (CET) at universities and national laboratories; and University-led SciDAC Institutes to establish centers of excellence that complement the activities of the CETs and provide training for the next generation of computational scientists.

Advancing high performance computing and computation is a highly coordinated interagency effort. ASCR has extensive partnerships with other Federal agencies and the National Nuclear Security Administration (NNSA). Activities are coordinated with other Federal efforts through the Networking and Information Technology R&D (NITR&D) subcommittee of the National Science and Technology Council Committee on Technology. The subcommittee coordinates planning, budgeting, and assessment activities of the multi-agency NITR&D enterprise. DOE has been an active participant in these coordination groups and committees since their inception. ASCR will continue to coordinate its activities through these mechanisms and will lead the development of new coordinating mechanisms as needs arise such as the ongoing development of a Federal Plan for Advanced Networking R&D.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

FY 2007 Request - $510.3 Million; FY 2008 Request - $531.9 Million

Biological and Environmental Research (BER) supports basic research with broad impacts on our energy future, our environment, and our health. By understanding complex biological systems, developing computational tools to model and predict their behavior, and developing methods to harness nature's capabilities, biotechnology solutions are possible for DOE energy, environmental, and national security challenges. An ability to predict long-range and regional climate enables effective planning for future needs in energy, agriculture, and land and water use. Understanding the global carbon cycle and the associated role and capabilities of microbes and plants can lead to solutions for reducing carbon dioxide concentrations in the atmosphere. Understanding the complex role of biology, geochemistry, and hydrology beneath the Earth's surface will lead to improved decision making and solutions for contaminated DOE weapons sites. Understanding the biological effects of low doses of radiation can lead to the development of science-based health risk policy to better protect workers and citizens. Both normal and abnormal physiological processes—from normal human development to cancer to brain function—can be understood and improved using radiotracers, advanced imaging instruments, and novel biomedical devices.

The FY 2008 BER request continues expansion of the Genomics: GTL program. This program employs a systems approach to biology at the interface of the biological, physical, and computational sciences to determine the diverse biochemical capabilities of microbes, microbial communities, and plants, with the goal of tailoring and translating those capabilities into solutions for DOE mission needs. In FY 2005 BER engaged a committee of the National Research Council (NRC) of the National Academies to review the design of the Genomics: GTL program and its infrastructure plan. The NRC committee report, *Review of the Department of Energy's Genomics: GTL Program* was released in FY 2006 and provided a strong endorsement of the GTL program, recommending that the program's focus on systems biology for bioenergy, carbon sequestration, and bioremediation be given a "high priority" by DOE and the Nation. The report also recommended that the program's plan for new research facilities be reshaped to produce earlier and more cost-effective results by focusing not on particular technologies, but on research underpinning particular applications such as bioenergy, carbon sequestration, or environmental remediation.

In response, SC revised its original single-purpose user facilities plan to instead develop and support vertically-integrated GTL Research Centers to accelerate systems biology research. BER will support the development of three Bioenergy Research Centers to be selected and initiated in FY 2007, and fully operational by the end of 2008. All three centers will conduct comprehensive, multidisciplinary research programs focused on microbes and plants to drive scientific breakthroughs necessary for the development of cost-effective biofuels and bioenergy production. These centers will not only possess the robust scientific capabilities needed to carry out their broad mission mandates, but will also draw upon the broader GTL program for technology development and foundational research. The vertically-integrated GTL Research Centers will not require construction of facilities. Moreover, the competition to establish and operate them is open to universities, non-profit research organizations, the national laboratories, and the private sector – an approach that is new for the Department. The first three research centers will focus on bioenergy research. The Department announced the solicitation for Bioenergy Research Centers in August 2006, and proposals were due on February 1, 2007.

Development of a global biotechnology based energy infrastructure requires a science base that will enable scientists to control or redirect genetic regulation and redesign specific proteins, biochemical pathways, and even entire plants or microbes. Renewable biofuels could be produced using plants, microbes, or isolated enzymes. Understanding the biological mechanisms involved in these energy producing processes will allow scientists and technologists to design novel biofuel production strategies involving both cellular and cell free systems that might include defined mixed microbial communities or consolidated biological processes. Within the Genomics: GTL program, BER supports basic research aimed at developing the understanding needed to advance biotechnology-based strategies for biofuel production, focusing on renewable, carbon-neutral energy compounds like ethanol and hydrogen, as well as understanding how the capabilities of microbes can be applied to environmental remediation and carbon sequestration.

In 2003, the Administration launched the Climate Change Research Initiative (CCRI) to focus research on areas where substantial progress in understanding and predicting climate change, including its potential causes and consequences, is possible over the next five years. In FY 2008, BER will contribute to the CCRI by focusing on (1) helping to resolve the North American carbon sink question (i.e., the magnitude and location of the North American carbon sink); (2) deployment and operation of a mobile ARM facility to provide data on the effects of clouds and aerosols on the atmospheric radiation budget in regions and locations of opportunity where data are lacking or sparse; (3) using advanced climate models to simulate potential effects of natural and human-induced climate forcing on global and regional climate and the potential effects on climate of alternative options for mitigating increases in human forcing of climate, including abrupt climate change; and (4) developing and evaluating assessment tools needed to study costs and benefits of potential strategies for reducing net carbon dioxide emissions.

In FY 2008, BER will continue to support research aimed at advancing the science of climate and Earth system modeling by coupling models of different components of the earth system related to climate and by significantly increasing the spatial resolution of such models. SciDAC-enabled activities will allow climate scientists to gain unprecedented insights into interactions and feedbacks between, for example, climate change and global cycling of carbon, the potential effects of carbon dioxide and aerosol emissions from energy production and their impact on the global climate system. BER will also add a SciDAC component to GTL and Environmental Remediation research. GTL SciDAC will initiate new research to develop mathematical and computational tools needed for complex biological system modeling and for analysis of complex data sets, such as mass spectrometry metabolomic or proteomic profiling data. Environmental Remediation SciDAC will provide an opportunity for subsurface and computational scientists to develop and improve methods of simulating subsurface reactive transport processes on "discovery class" computers.

Research emphasis within BER's Environmental Remediation Sciences subprogram will focus on issues of subsurface cleanup such as defining and understanding the processes that control contaminant fate and transport in the environment and providing opportunities for use or manipulation of natural processes to alter contaminant mobility. In FY 2008, BER will support the development of two additional field research sites (for a total of 3), providing opportunities to validate laboratory findings under field conditions. The resulting knowledge and technology will assist DOE's environmental clean-up and stewardship missions. Funding for the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL) at Pacific Northwest National Laboratory (PNNL) will be increased in FY 2008 to maintain operations at full capacity.

Also continuing in FY 2008 is BER support for fundamental research in genomics, medical applications and measurement science, and the health effects of low dose radiation in FY 2008. Resources are developed and made widely available for determining protein structures at DOE synchrotrons, and for DOE–relevant high-throughput genomic DNA sequencing. Building on DOE capabilities in physics, chemistry, engineering, biology and computation, BER supports fundamental imaging research, maintains core infrastructure for imaging research and develops new technologies to improve the diagnosis and treatment of psycho-neurological diseases and cancer and to improve the function of patients with neurological disabilities like blindness. Funding for Ethical, Legal, and Societal Issues (ELSI) associated with activities applicable to SC, increases to support research on the ecological and environmental impacts of nanoparticles resulting from nanotechnology applied to energy technologies.

HIGH ENERGY PHYSICS

FY 2007 Request - $775.1 Million; FY 2008 Request - $782.2 Million

The High Energy Physics (HEP) program provides over 90 percent of the Federal support for the Nation's high energy physics research. This research advances our understanding of the basic constituents of matter, deeper symmetries in the laws of nature at high energies, and mysterious phenomena that are commonplace in the universe, such as dark energy and dark matter. Research at these frontiers of science may uncover new particles, forces, or undiscovered dimensions of space and time; explain how matter came to have mass; and reveal the underlying nature of the universe. HEP supports particle accelerators and very sensitive detectors to study fundamental particle interactions at the highest possible energies as well as non-accelerator studies of cosmic particles using experiments conducted deep underground, on mountains, or in space. These research facilities and basic research supported by HEP advance our knowledge not only in high energy physics, but increasingly in other fields was well, including particle astrophysics and cosmology. Research advances in one field often have a strong impact on research directions in another. Technology that was developed in response to the pace-setting demands of high energy physics research has also become indispensable to other fields of science and has found wide applications in industry and medicine, often in ways that could not have been predicted when the technology was first developed.

In FY 2008 HEP supports core experimental and theoretical research to maintain strong participation in the Tevatron, Large Hadron Collider (LHC) at CERN (the European Organization for Nuclear Research), and B-factory physics program, and supports research activities associated with development of potential new initiatives such as International Linear Collider (ILC) R&D, neutrinos, dark energy, and dark matter. HEP places a high priority on maximizing scientific data derived from the three major HEP user facilities: the Tevatron Collider and Neutrinos at the Main Injector (NuMI) beam line at Fermilab, and the B-factory at SLAC. HEP will continue to lead the international scientific community with these world-leading user facilities at Fermilab and SLAC in FY 2008, but these facilities will complete their scientific missions by the end of the decade. Thus, the longer-term HEP program supported in FY 2008 begins to develop new cutting-edge facilities in targeted areas (such as neutrino physics) that will establish U.S. leadership in these areas in the next decade, when the centerpiece of the world HEP program will reside at CERN.

In FY 2008 HEP continues to support software and computing resources for U.S. researchers participating in the LHC program at CERN as well as pre-operations and maintenance of the U.S.-built systems that are scientific components of the LHC detectors. R&D in support of the proposed ILC is maintained in FY 2008 to support U.S. participation in a comprehensive, coordinated international R&D program and to provide a basis for U.S. industry to compete successfully for major subsystem contracts, should the ILC be designed and then built. The long-term goal of this effort is to provide robust cost and schedule baselines to support design and construction decisions for an international electron-positron linear collider. The ILC would provide unprecedented power, clarity, and precision to unravel the mysteries of the next energy frontier, which we will just begin to discover with the LHC. In 2006 the ILC Reference Design Report was completed, and in FY 2007 further work toward the design, including some site-specific studies and detector studies, will be performed. In FY 2008 further work on both accelerator systems and detector studies will be performed.

To provide a nearer-term future HEP program, and to preserve future research options, R&D for accelerator and detector technologies, particularly in the growing area of neutrino physics, will continue in FY 2008. With Tevatron improvements completed, much of the accelerator development effort at Fermilab in FY 2008 will focus on the neutrino program to study the universe's most prolific particle. The Neutrinos at the Main Injector (NuMI) beam allows studies of the fundamental physics of neutrino masses and mixings using the proton source section of the Tevatron complex. The NuMI beam has begun operations and will eventually put much higher demands on that set of accelerators. A program of enhanced maintenance, operational improvements, and equipment upgrades is being developed to meet these higher demands, while continuing to run the Tevatron. Fabrication of the NuMI Off-axis Neutrino Appearance (NOνA)

Detector, which was originally proposed as a line item construction project in FY 2007 under the generic name of Electron Neutrino Appearance (EνA) Detector, is funded in FY 2008 and will utilize the NuMI beam. This project includes improvements to the proton source to increase the intensity of the NuMI beam. Meanwhile, fabrication will begin for the Reactor Neutrino Detector and two small neutrino experiments, the Main Injector Experiment ν-A (MINERνA) in the MINOS near detector hall at Fermilab and the Tokai-to-Kamioka (T2K) experiment using the Japanese J-PARC neutrino beam. R&D will continue for a large double beta decay experiment to measure the mass of a neutrino. These efforts are part of a coordinated neutrino program developed from an American Physical Society study and a joint HEPAP/Nuclear Sciences Advisory Committee (NSAC) subpanel review.

To exploit the unique opportunity to expand the boundaries of our understanding of the matter-antimatter asymmetry in the universe, a high priority is given to continued operations and infrastructure support for the B-factory at SLAC. Final upgrades to the accelerator and detector are scheduled for completion in FY 2007, and B-factory operations will conclude in FY 2008. HEP support of SLAC operations decreases in FY 2008 as the contribution from BES increases for SLAC linac operations in preparation for the Linac Coherent Light Source (LCLS).

As the Large Hadron Collider (LHC) accelerator nears its turn-on date in 2007, U.S. activities related to fabrication of detector components will be completed and new activities related to commissioning and pre-operations of these detectors, along with software and computing activities needed to analyze the data, will ramp-up significantly. Support of an effective role for U.S. research groups in LHC discoveries will continue to be a high priority of the HEP program. R&D for possible future upgrades to the LHC accelerator and detectors will also be pursued.

Enhanced support for R&D on ground- and space-based dark energy experimental concepts, begun in FY 2007, will be continued in FY 2008. These experiments should provide important new information about the nature of dark energy, leading to a better understanding of the birth, evolution, and ultimate fate of the universe. For example, the Super Nova/Acceleration Probe (SNAP) will be a mission concept proposed for a potential interagency-sponsored experiment with NASA, and possibly international partners: the Joint Dark Energy Mission (JDEM). DOE and NASA are jointly funding a National Academy of Sciences study to determine which of the proposed NASA “Beyond Einstein” missions should launch first, with technical design of the selected proposal to begin at the end of this decade. JDEM is one of the candidate missions in this study. In FY 2008, fabrication for the Dark Energy Survey Project will begin.

The HEP program re-competed its SciDAC portfolio in FY 2006. Major thrusts in theoretical physics, astrophysics, and particle physics grid technology will be supported through the SciDAC program in FY 2008, as well as proposals in accelerator modeling and design to be selected in FY 2007. These projects will allow HEP to use computational science to obtain significant new insights into challenging problems that have the greatest impact in HEP mission areas.

NUCLEAR PHYSICS

FY 2007 Request - $454.1 Million; FY 2008 Request - $471.3 Million

The Nuclear Physics (NP) program is the major sponsor of fundamental nuclear physics research in the Nation, providing about 90 percent of Federal support. Scientific research supported by NP is aimed at advancing knowledge and providing insights into the nature of energy and matter and, in particular, at investigating the fundamental forces which hold the nucleus together and determining the detailed structure and behavior of the atomic nuclei. NP builds and supports world-leading scientific facilities and state-of-the-art instrumentation to carry out its basic research agenda – the study of the evolution and structure of nuclear matter from the smallest building blocks, quarks and gluons, to the stable elements in the Universe created by stars, to unique isotopes created in the laboratory that exist at the limits of stability and possess radically different properties from known matter. NP also trains a workforce needed to underpin the Department's missions for nuclear-related national security, energy, and environmental quality.

Key aspects of NP research agenda include understanding how the quarks and gluons combine to form the nucleons (proton and neutron), what the properties and behavior of nuclear matter are under extreme conditions of temperature and pressure, and what the properties and reaction rates are for atomic nuclei up to their limits of stability. Results and insight from these studies are relevant to understanding how the universe evolved in its earliest moments, how the chemical elements were formed, and how the properties of one of nature's basic constituents, the neutrino, influences astrophysics phenomena such as supernovae. Knowledge and techniques developed in pursuit of fundamental nuclear physics research are also extensively utilized in our society today. The understanding of nuclear spin enabled the development of magnetic resonance imaging for medical use. Radioactive isotopes produced by accelerators and reactors are used for medical imaging, cancer therapy, and biochemical studies. Advances in cutting-edge instrumentation developed for nuclear physics experiments have relevance to technological needs in combating terrorism. The highly trained scientific and technical personnel in fundamental nuclear physics who are a product of the program are a valuable human resource for many applied fields.

The FY 2008 budget request supports operations of the four National User Facilities and research at universities and laboratories, and makes investments in new capabilities to address compelling scientific opportunities and to maintain U.S. competitiveness in global nuclear physics efforts. In FY 2008 support continues for R&D on rare isotope beam development, relevant to the next-generation facilities that will provide capabilities for forefront nuclear structure and astrophysics studies and for understanding the origin of the elements from iron to uranium.

When the Universe was a millionth of a second old, nuclear matter is believed to have existed in its most extreme energy density form called the quark-gluon plasma. Experiments at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL) are searching to find and characterize this new state and others that may have existed during the first moments of the Universe. These efforts will continue in FY 2008. The NP program, together with the National Aeronautics and Space Administration (NASA), will continue construction of a new Electron Beam Ion Source (EBIS) to provide RHIC with more cost-effective, reliable, and versatile operations. Research and development activities, including the development of an innovative electron beam cooling system for RHIC, are expected to demonstrate the feasibility of increasing the luminosity (or collision rate) of the circulating beams by a factor of ten, which would increase the long-term scientific productivity and international competitiveness of the facility. Support for participation in the heavy ion program at the Large Hadron Collider (LHC) at CERN allows U.S. researchers the opportunity to search for new states of matter under substantially different initial conditions than those provided at RHIC. The interplay of the different research programs at the LHC and the ongoing RHIC program will allow a detailed tomography of the hot, dense matter as it evolves from the "perfect fluid" (a fluid with zero viscosity) discovered at RHIC.

Operations of the Continuous Electron Beam Accelerator Facility (CEBAF) at Thomas Jefferson National Accelerator Facility (TJNAF) in FY 2008 will continue to advance our knowledge of the internal structure of protons and neutrons. By providing precision experimental information concerning the quarks and gluons that form protons and neutrons, the approximately 1,200 experimental researchers who use CEBAF, together with researchers in nuclear theory, seek to provide a quantitative description of nuclear matter in terms of the fundamental theory of the strong interaction, Quantum Chromodynamics (QCD). In FY 2008, the accelerator will provide beams simultaneously to all three experimental halls and funding is provided for engineering design activities for the 12 GeV CEBAF Upgrade Project. This upgrade is one of the highest priorities for NP and would allow for a test of a proposed mechanism of "quark confinement," one of the compelling, unanswered puzzles of physics.

Efforts at the Argonne Tandem Linear Accelerator System (ATLAS) at ANL and the Holifield Radioactive Ion Beam Facility (HRIBF) at ORNL will be supported in FY 2008 to focus on investigating new regions of nuclear structure, studying interactions in nuclear matter like those occurring in neutron stars, and determining the reactions that created the nuclei of the chemical elements inside stars and supernovae. The GRETINA gamma-ray tracking array, which continues fabrication in FY 2008, will revolutionize gamma ray detection technology and offer dramatically improved capabilities to study the structure of nuclei at ATLAS, HRIBF, and elsewhere. The Fundamental Neutron Physics Beamline (FNPB) under fabrication at the SNS will provide a world-class capability to study the fundamental properties of the neutron, leading to a refined characterization of the weak force. Support continues in FY 2008 for the fabrication of a neutron Electric Dipole Moment experiment, to be sited at the FNPB, in the search for new physics beyond the Standard Model.

Funds are provided in FY 2008 to initiate U.S. participation in the fabrication of an Italian-led neutrino-less double beta decay experiment, the Cryogenic Underground Observatory for Rare Events (CUORE). A successful search for neutrino-less beta decay will determine if the neutrino is its own antiparticle and provide information about the mass of the neutrino. Neutrinos are thought to play a critical role in the explosions of supernovae and the evolution of the cosmos. A successful search for neutrino-less beta decay will determine if the neutrino is its own antiparticle and provide information about the mass of the neutrino.

Following the re-competition of SciDAC projects in FY 2006, NP currently supports efforts in nuclear astrophysics, grid computing, Lattice Gauge (QCD) theory, and low energy nuclear structure and nuclear reaction theory. NP is also supporting R&D in an international effort to develop a larger, more sensitive neutrino-less beta decay experiment.

FUSION ENERGY SCIENCES

FY 2007 Request - $319.0 Million; FY 2008 Request - $427.9 Million

The Fusion Energy Sciences (FES) program advances the theoretical and experimental understanding of plasma and fusion science, including a close collaboration with international partners in identifying and exploring plasma and fusion physics issues through specialized facilities. The FES program supports research in plasma science, magnetically confined plasmas, advances in tokamak design, innovative confinement options, non-neutral plasma physics and high energy density laboratory plasmas (HEDLP), and cutting edge technologies. FES also leads U.S. participation in ITER, an experiment to study and demonstrate the sustained burning of fusion fuel. This international collaboration will provide an unparalleled scientific research opportunity with a goal of demonstrating the scientific and technical feasibility of fusion power. Fusion is the energy source that powers the sun and stars. Fusion power could play a key role in U.S. long-term energy plans and independence because it offers the potential for plentiful, safe, and environmentally benign energy. On November 21, 2006, the DOE signed the ITER agreement with its counterparts in China, the European Union, India, Japan, the Republic of Korea and the Russian Federation, formalizing this historic arrangement for international scientific cooperation.

The U.S. Contributions to ITER project is being managed by the U.S. ITER Project Office (USIPO), established as an Oak Ridge National Laboratory (ORNL)/Princeton Plasma Physics Laboratory (PPPL) partnership. The FY 2008 request for the U.S. Contributions to ITER project reflects a significant increase in procurement, fabrication activities, and delivery of medium- and high-technology components, assignment of U.S. personnel to the International ITER Organization abroad, and the U.S. share of common costs at the ITER site in Cadarache, France, including installation and testing. These costs are part of the Total Estimated Cost (TEC) for the U.S Contributions to ITER project. There is a second category of costs, Other Project Costs (OPC), which is for the supporting research and development activity for our U.S Contributions. Together the TEC and OPC make up the overall Total Project Cost which is $1,122,000,000.

In support of ITER and U.S. Contributions to ITER, FES has placed an increased emphasis on its national burning plasma program—a critical underpinning to the fusion science in ITER. FES has enhanced burning plasma research efforts across the U.S. domestic fusion program, including: carrying out experiments on our national FES facilities that are exploring new modes of improved or extended ITER performance with diagnostics and plasma control that can also be extrapolated to ITER; developing safe and environmentally attractive technologies that could be used in future upgrades of ITER; exploring fusion simulation efforts that examine the complex behavior of burning plasmas in tokamaks; and integrating all that is learned into a forward-looking approach to future fusion applications. The U.S. Burning Plasma Organization has been established to coordinate these efforts.

Section 972(c)(5)(C) of the Energy Policy Act (EPAct) of 2005, required the Secretary of Energy to provide “a report describing how United States participation in the ITER will be funded without reducing funding for other programs in the Office of Science (including other fusion programs)…”. This report as well as all the other requirements for FES in EPAct have been or are in the process of being completed. The Department’s FY 2008 budget provides for modest increases for all programs within the Office of Science and supports the ITER request of $160,000,000 from new funds in the FES budget request.

FES supports the operation of a set of experimental facilities. These facilities provide scientists with the means to test and extend our theoretical understanding and computer models – leading ultimately to improved predictive capabilities for fusion science. Research and facility operations support for the three major facilities is maintained in FY 2008. Experimental research on tokamaks is continued with emphasis on physics issues of interest to the ITER project. The DIII-D tokamak at General Atomics will operate for 15 weeks in FY 2008 to conduct research relevant to burning plasma issues and topics of interest to the ITER project as well as maintain the broad scientific scope of the program. The Alcator C-Mod at the Massachusetts Institute of Technology will operate for 15 weeks and the National Spherical Torus Experiment (NSTX) at the Princeton Plasma Physics Laboratory (PPPL) will operate for 12 weeks. Fabrication of the major components of the National Compact Stellarator Experiment (NCSX) at PPPL continues and assembly of the entire device will be completed in FY 2009.

Funding for the FES SciDAC program continues in FY 2008 for the development of tools that facilitate international fusion collaborations and initiate development of an integrated software environment that can accommodate the wide range of space and time scales and the multiple phenomena that are encountered in simulations of fusion systems. Within SciDAC, the Fusion Simulation Project is a major initiative involving plasma physicists, applied mathematicians, and computer scientists to create a comprehensive set of models of fusion systems, combined with the algorithms required to implement the models and the computational infrastructure to enable them to work together.

FES will issue a joint solicitation in FY 2008, with the National Nuclear Security Administration (NNSA), focused on academic research in high energy density laboratory plasmas, which supports the Department’s programmatic goals in inertial confinement fusion science.

WORKFORCE DEVELOPMENT FOR TEACHERS AND SCIENTISTS

FY 2007 Request - $10.9 Million; FY 2008 Request - $11.0 Million

The Department of Energy has played a role in training America’s scientists and engineers for more than 50 years, making contributions to U.S. economic and scientific pre-eminence. The Nation’s current and future energy and environmental challenges may be solved in part through scientific and technological innovation and a highly skilled scientific and technical workforce. The Workforce Development for Teachers and Scientists (WDTS) program acts as a catalyst within the DOE for the training of the next generation of scientists. WDTS programs create a foundation for DOE’s national laboratories to provide a wide range of educational opportunities to more than 280,000 educators and students on an annual basis. WDTS’s mission is to provide a continuum of educational opportunities to the Nation’s students and teachers of science, technology, engineering, and mathematics (STEM).

WDTS supports experiential learning opportunities that compliment curriculum taught in the classroom and (1) build links between the national laboratories and the science education community by providing funding, guidelines, and evaluation of mentored research experiences at the national laboratories to K–12 teachers and college faculty to enhance their content knowledge and research capabilities; (2) provide mentor-intensive research experiences at the national laboratories for undergraduate and graduate students to inspire commitments to the technical disciplines and to pursue careers in science, technology, engineering, and mathematics, thereby helping our national laboratories and the Nation meet the demand for a well-trained scientific/technical workforce; and (3) encourage and reward middle and high school students across the Nation to share, demonstrate, and excel in math and the sciences, and introduce these students to the national laboratories and the opportunities available to them when they go to college.

In FY 2008, the DOE Academies Creating Teacher Scientists (DOE ACTS) program, formerly the Laboratory Science Teacher Professional Development (LSTPD) program, will support the participation of approximately 300 teachers. All 17 of DOE's national laboratories will participate in this program. Each national laboratory can elect to implement either or both of the two types of teacher professional development models in DOE ACTS: (1) Teachers as Investigators (TAI) is geared towards novice teachers typically in the elementary to intermediate grade levels; and (2) Teachers as Research Associates (TARA) for teachers with a stronger background in science, mathematics, and engineering.

The Science Undergraduate Laboratory Internship (SULI) program, which provides mentor intensive research experiences for undergraduates at the national laboratories, will support approximately 340 students in FY 2008. The Albert Einstein Distinguished Educator Fellowships, the College Institute of Science and Technology (CCI) program, the Pre-Service Teacher activity for students preparing for teaching careers in a STEM discipline, and the National and Middle School Science Bowls will all continue in FY 2008.

SCIENCE LABORATORIES INFRASTRUCTURE

FY 2007 Request - $50.9 Million; FY 2008 Request - $79.0 Million

The mission of the Science Laboratories Infrastructure (SLI) program is to enable the conduct of DOE research missions at the Office of Science laboratories by funding line item construction projects and the clean up for reuse or removal of excess facilities to maintain the general purpose infrastructure. The program also supports Office of Science landlord responsibilities for the 24,000 acre Oak Ridge Reservation and provides Payments in Lieu of Taxes (PILT) to local communities around ANL, BNL, and ORNL.

In FY 2008, SLI will fund four construction subprojects: Seismic Safety Upgrade of Buildings, Phase I, at the Lawrence Berkeley National Laboratory (LBNL); Modernization of Building 4500N, Wing 4, Phase I, at ORNL; Building Electrical Services Upgrade, Phase II, at ANL; and

Renovate Science Laboratory, Phase I, at BNL. Funding for FY 2008 includes $35,000,000 held in reserve pending resolution of issues related to capability replacement and renovation at PNNL. If the issues are resolved, DOE will initiate a reprogramming request to use these funds to replace and/or upgrade mission-critical facilities currently located in the Hanford Site 300 Area. The SLI program continues funding for demolition of the Bevatron at LBNL in FY 2008, and funding is also provided for the demolition of several small buildings and trailers at ORNL.

SCIENCE PROGRAM DIRECTION

FY 2007 Request - $170.9 Million; FY 2008 Request - $184.9 Million

Science Program Direction (SCPD) enables a skilled, highly motivated Federal workforce to manage the Office of Science's basic and applied research portfolio, programs, projects, and facilities in support of new and improved energy, environmental, and health technologies. SCPD consists of two subprograms: Program Direction and Field Operations.

The Program Direction subprogram is the single funding source for the Office of Science Federal staff in headquarters responsible for managing, directing, administering, and supporting the broad spectrum of Office of Science disciplines. This subprogram includes planning and analysis activities, providing the capabilities needed to plan, evaluate, and communicate the scientific excellence, relevance, and performance of the Office of Science basic research programs. Additionally, Program Direction includes funding for the Office of Scientific and Technical Information (OSTI) which collects, preserves, and disseminates DOE research and development (R&D) information for use by DOE, the scientific community, academia, U.S. industry, and the public to expand the knowledge base of science and technology. The Field Operations subprogram is the funding source for the Federal workforce in the Field responsible for management and administrative functions performed within the Chicago and Oak Ridge Operations Offices, and site offices supporting the Office of Science laboratories and facilities.

In FY 2008, Program Direction funding increases by 8.2 percent from the FY 2007 request. Most of the increase will support an additional 29 FTEs, to mange the increase in the SC research investment that is a key component of the President's American Competitiveness Initiative; four new FTEs to support NSLS-II, and ITER project office activities; and 35 FTEs – the staff of the New Brunswick Laboratory – transferring from the Office of Security and Safety Performance Assurance. Twenty-four FTEs are reduced across the SC complex in FY 2008 consistent with SC's corporate workforce planning strategy. The SCPD FY 2008 increase also supports a 2.2 percent pay raise; an increased cap for SES basic pay; other pay related costs such as the government's contributions for employee health insurance and Federal Employees' Retirement System (FERS); escalation of non-pay categories, such as travel, training, and contracts; and increased e-Gov assessments and other fixed operating requirements across the Office of Science complex.

SAFEGUARDS AND SECURITY

FY 2007 Request - $71.0 Million; FY 2008 Request - $71.0 Million

The Safeguards and Security (S&S) program ensures appropriate levels of protection against unauthorized access, theft, diversion, loss of custody, or destruction of 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. The Office of Science's Integrated Safeguards and Security Management strategy uses a tailored approach to safeguards and security. As such, each site has a specific protection program that is analyzed and defined in its individual Security Plan. This approach allows each site to design varying degrees of protection commensurate with the risks and consequences described in their site-specific threat scenarios. The FY 2008 budget includes funding necessary to protect people and property at the 2003 Design Basis Threat (DBT) level. In FY 2008, funding for the Cyber Security program element addresses the promulgation of new National Institute of Standards and Technology (NIST) requirements that are statutorily required by the Federal Information Security Management Act (FISMA) to improve the Federal and Office of Science laboratory cyber security posture.

CONCLUSION

I want to thank you, Mr. Chairman, for providing this opportunity to discuss the Office of Science research programs and our contributions to the Nation's scientific enterprise and U.S. competitiveness. On behalf of DOE, I am pleased to present this FY 2008 budget request for the Office of Science.

This concludes my testimony. I would be pleased to answer any questions you might have.

Dr. Raymond L. Orbach
Under Secretary for Science
U.S. Department of Energy