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

Regarding FY 2009 Research
and Development Budget Proposal

March 5, 2008

Thank you Mr. Chairman, Ranking Member Biggert, and Members of the Committee. I am pleased to appear before your Committee for what I expect to be my final budget presentation for the Department of Energy's Office of Science. I would like to thank the Committee for your strong support for the Office of Science during my tenure. This support has enabled the Office of Science to make investments in basic research and advanced research capabilities that have and will continue to improve U.S. global competitiveness, energy security, the environment, and our fundamental understanding of the universe around us.

Our Nation continues to face significant challenges in energy security and in our ability to maintain the scientific leadership and innovation that assures our continued economic security. These challenges are addressed by the President in his American Competitiveness Initiative and Advanced Energy Initiative announced in 2006. The President's budget request for FY 2009 is a strong demonstration of his continued commitment to these important initiatives. The Congress has also spoken and expressed strong, bipartisan support for an aggressive innovation and energy security agenda in passing the Energy Policy Act (EPAct) of 2005 and in following up with both the America COMPETES Act and the Energy Independence and Security Act (EISA) in 2007.

EPAct and the COMPETES Act both recognize the pivotal role of the Office of Science in securing the advantages that basic research as well as science, math, and engineering education can bring to the Nation. EISA's provisions are intended to reduce America's dependence on oil, improve efficiency, and cut emissions. But we will not meet the targets with solely incremental improvements in current technologies. We need the breakthroughs that will result only from transformational basic research.

Here are a few examples. EISA mandates the use of at least 36 billion gallons of biofuels by 2022. Without transformational breakthroughs in deriving fuels from plant cellulose materials, we reduce our chances of reaching these aggressive goals. Even though conventional approaches, such as sugar-based and corn-based ethanol, can be modestly energy positive—although this is still debated—they consume large quantities of food and feed grain. Increasing use of these feedstocks raises environmental concerns associated with land use changes and impacts on atmospheric concentrations of carbon dioxide. Biofuels derived from cellulose, and in particular feedstock crops such as switchgrass that can be grown on marginal land with minimal water and nutrient requirements, can provide the basis for a sustainable biofuels economy in the U.S. while benefiting the American farmer. Breakthroughs in science are essential for the development of more efficient and cost-effective processes for deriving fuels from cellulose and for developing dedicated feedstock crops. The approaches to cellulosic ethanol deployed in many pilot and demonstration bioethanol plants across the United States rely on niche feedstocks and conversion technologies that are not yet cost competitive. New scientific discoveries will enable revolutionary gains in production efficiencies and cost reduction.

The transformational basic research undertaken by the Office of Science's Bioenergy Research Centers is one way the Department is addressing the difficulties of cost-effective bioethanol production with minimal environmental footprint, by using plant and microbial genomics and other novel approaches.

EISA also mandates a national fuel economy standard of at least 35 miles per gallon by 2020—an increase in fuel economy of some 40 percent that will save billions of gallons of fuel. Automobile manufacturers will need to employ numerous conventional and advanced engine and vehicle technologies to reach this goal. Office of Science basic research will be critical in the development of cost effective advanced engine and vehicle technologies through research in areas such as high-strength, low-weight materials; electrical energy storage; hydrogen production, use, and storage; fuel cell materials; catalysts, combustion processes, and materials under extreme environments.

In FY 2009 the Office of Science will initiate Energy Frontier Research Centers. They will pursue innovative basic research to accelerate the scientific breakthroughs needed to create advanced energy technologies for the 21st century. These Centers will pursue fundamental basic research areas mentioned above as well as solar energy utilization; geosciences related to long-term storage of nuclear waste and carbon dioxide; advanced nuclear energy systems; solid state lighting; and superconductivity.

The Office of Science seeks to engage the Nation's intellectual and creative talent to address scientific grand challenges. These are the necessary transformational discoveries which will fundamentally alter our approaches to energy production and use, and they will come from the next generation of scientists, mathematicians, and engineers—many trained through Office of Science-funded research and using world-leadership scientific research facilities we build and operate for the scientific community.

The Office of Science is accelerating the pace of discovery and innovation to address the Nation's energy needs through our multifaceted research portfolio. Your confidence in the Office of Science is based on a number of demonstrated successes in our mission areas, and your support for the Office of Science has enabled us to assess the basic research needs and engage the scientific community to respond aggressively. We routinely assess and update these research opportunities and priorities with an eye to our mission and with an ear to the research community, whether at a national laboratory, a university, or in industry. Since we build and operate large-scale, long-term, and, by necessity, cost-effective scientific research facilities, and because our mission is so important, we take these assessments seriously. We cannot afford to go in a wrong direction; we need the most complete and robust analysis of scientific opportunity, mission need, cost, and benefit.

A large part of this assessment effort in recent years has been accomplished through a series of Basic Research Needs workshops and other workshops led by our science programs in partnership with the Department's technology programs. These workshops have brought together subject experts with diverse views from the broader basic and applied research community to discuss and identify areas of focus for DOE's basic research efforts. These efforts have enabled the Office of Science to stay informed of research needs and new opportunity areas, as well as scientific and technological roadblocks, and have enabled us to create a prioritized and comprehensive research portfolio within our available funding.

While these workshops are critical to building and balancing our research portfolio, we also have a number of planning and advisory resources at our disposal to inform our long-term research portfolio planning. The National Academy of Sciences, our Federal Advisory Committees, informal and formal communication with the international scientific community, OSTP, OMB, the Congress, and our in-house Office of Science personnel all play important roles. Our programs are strong because our research portfolio and facilities are internally and externally assessed regularly and because our research and facilities are awarded through a competitive merit review process.

We have established effective processes for assessing basic research needs, and we have also developed the capacity to respond quickly with highly leveraged investments in scientific facilities and research at the national laboratories and universities. This informed, rapid response provides the world-class research results that will help solve some of our most intractable energy supply and environmental challenges, while keeping our Nation's scientific enterprise and industry at the forefront.

I think the best way to bring my statement into sharp focus is to discuss some examples of how your investments in the Office of Science have brought quick and remarkable results, and what we plan to do with the funding requested for FY 2009 to enhance the U.S. scientific and innovation enterprise and ensure the best possible return to the taxpayer.

Perhaps the best example of this aggressive and nimble approach is the response by the Office of Science to the challenge of High Performance Computing (HPC). In 2002 the Japanese announced the Earth Simulator, a high performance computer for open science which combined unprecedented performance and efficiency. Congress responded by dramatically increasing HPC funding, and making the Office of Science the lead in an effort to surpass the Earth Simulator. I am pleased to report that your confidence in us has already resulted in the U.S. attaining world leadership in open scientific computing—by the end of this year we will achieve peak capacity of one petaflop at our Leadership Computing Facility in Oak Ridge. This exceptional capability is helping us model such phenomena as turbulent flows related to combustion and to model and simulate complex climate processes that will inform decision makers on climate change, mitigation, and adaptation.

The benefits of Office of Science HPC capabilities extend well beyond DOE. We provide access to these resources to other Federal agencies, universities, laboratories, and industry. We have been involved in modeling and simulation runs as diverse as determining hurricane effects to save lives, and modeling aircraft engines and airframes to improve energy efficiency and reduce time-to-market. We use the Innovative and Novel Computational Impact on Theory and Experiment (INCITE) program to openly compete access to these world-leading HPC resources. The Office of Science created INCITE for the purpose of bringing the capabilities of terascale computing to the community in order to transform the conduct of science and bring scientific simulation through computational modeling to parity with theory and experiment as a scientific tool. As a result, HPC modeling and simulation is now seen as a potent tool in the scientific toolbox; one that will potentially save lives, increases our energy and national security, and propels us to a competitive edge.

Another accomplishment of the past year is the successful competition and award of three Bioenergy Research Centers. These Centers will each take different approaches to discovering fundamentally new solutions and solving critical roadblocks on the path to energy security—how will we meet the new requirement to produce 36 million gallons of biofuels by 2022 from renewable plant sources that don't compete with the food supply? In authorizing and funding the Bioenergy Research Centers, Congress expressed its confidence in the ability of the Office of Science to tap the talent of our national laboratories and universities to tackle our fuels challenge, and these Centers are up and running well.

U.S. leadership in science and technology depends on the continued availability of the most advanced scientific tools and facilities for our researchers. The suite of research capabilities built and operated by the Office of Science are still the envy of the world. And over the past several years, with your support, we have delivered new facilities and have achieved remarkable technical milestones with existing facilities, enabling the U.S. to work at the cutting-edge of many scientific disciplines. The Spallation Neutron Source, which came on line in 2006, is the world's forefront neutron scattering facility providing more neutrons, by a factor of ten, than any other neutron source in the world for research of materials and biological complexes. The Linac Coherent Light Source currently under construction will produce x-rays 10 billion times more intense than any existing x-ray source in the world when it comes on line in FY 2010. It will have the capabilities for structural studies of nanoscale particles and single molecules and for probing chemical reactions in real time. All five Office of Science Nanoscale Science Research Centers are now in operation, providing unparalleled resources to the scientific community for synthesis, fabrication, and analysis of nanoparticles and nanomaterials. The Tevatron at Fermilab currently remains the world's most powerful particle collider for high energy physics. New records for performance in peak luminosity were achieved in 2006, enabling the observation of the rare single top quark and bringing researchers closer to understanding the basic constituents of matter and the laws of nature at high energies.

On October 24, 2007, the international ITER Agreement went into force. The ITER experiment will demonstrate for the first time that a reactor can create and sustain a burning plasma. The implications of this research are far-reaching. The world faces a series of tough choices in meeting our energy needs over the next century. While no silver bullet may exist, fusion appears to be the closest. Fusion energy provides the real possibility of abundant, economical, and environmentally benign energy, starting around mid-century. Our investments today will have huge pay-offs for our children and grandchildren. We are part of an international consortium that is sharing the cost and the risk of the project and will have full access to all experimental research data.

The Office of Science is aggressively pursuing a range of research areas that will provide answers critical to our future energy security, as the material that follows will show—and we also continue to plan for the future, seeking to identify opportunities within available resources and to update our priorities appropriately. An example of this is the *'Facilities for the Future of Science: A 20-Year Outlook'* report, which was released in November 2003 and updated last year. The Outlook contained a prioritized list of facilities to underpin our major research thrusts over the next 20 years and beyond. These facilities are designed to be world class and adaptable to evolving basic research needs to ensure that U.S. taxpayers get the most value for their money. These facilities also allow researchers access to the full array of physical and biological science large-scale resources, creating an all-important balance and 'unity' of science within the Office of Science. I ask the Members during this appropriations cycle especially to consider the lasting value of the basic energy research done in the Office of Science to our Nation's well-being and economic prowess.

The information that follows is an in-depth examination of the funding and activities of the Office of Science for FY 2009.

The following programs are supported in the FY 2009 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.

OFFICE OF SCIENCE
FY 2009 PRESIDENT'S REQUEST
SUMMARY BY PROGRAM

(dollars in thousands)

	FY 2007 Approp.	FY 2008 Approp.	FY 2009 Request to Congress	FY 2009 Request to Congress vs. FY 2008 Approp.	
Basic Energy Sciences	1,221,380	1,269,902	1,568,160	+298,258	+23.5%
Advanced Scientific Computing Research	275,734	351,173	368,820	+17,647	+5.0%
Biological and Environmental Research	480,104	544,397	568,540	+24,143	+4.4%
High Energy Physics	732,434	689,331	804,960	+115,629	+16.8%
Nuclear Physics	412,330	432,726	510,080	+77,354	+17.9%
Fusion Energy Sciences	311,664	286,548	493,050	+206,502	+72.1%
Science Laboratories Infrastructure	41,986	66,861	110,260	+43,399	+64.9%
Science Program Direction	166,469	177,779	203,913	+26,134	+14.7%
Workforce Dev. for Teachers & Scientists	7,952	8,044	13,583	+5,539	+68.9%
Safeguards and Security (gross)	75,830	75,946	80,603	+4,657	+6.1%
SBIR/STTR (SC funding)	86,936	—	—	—	—
Subtotal, Office of Science	3,812,819	3,902,707	4,721,969	+819,262	+21.0%
Adjustments*	23,794	70,435	—	-70,435	—
Total, Office of Science	3,836,613	3,973,142	4,721,969	+748,827	+18.8%

* Adjustments include SBIR/STTR funding transferred from other DOE offices (FY 2007 only), a charge to reimbursable customers for their share of safeguards and security costs (FY 2007 and FY 2008), Congressionally-directed projects and a rescission of a prior year Congressionally-directed project (FY 2008 only), and offsets for the use of prior year balances to fund current year activities (FY 2007 and FY 2008).

BASIC AND APPLIED RESEARCH & DEVELOPMENT COORDINATION

The Office of Science continues to coordinate basic research efforts in several areas with the Department's applied technology offices through collaborative processes established over the last several years. These areas include biofuels derived from biomass, solar energy, hydrogen, solid-state lighting and other building technologies, the Advanced Fuel Cycle, Generation IV Nuclear Energy Systems, vehicle technologies, and improving efficiencies in industrial processes. The Department's July 2006 report to Congress *DOE Strategic Research Portfolio Analysis and Coordination Plan* identified 21 additional areas of opportunity for coordination that have great potential to increase mission success. The Office of Science supports basic research that underpins nearly all 21 areas; and six areas are highlighted in the FY 2009 Office of Science budget request for enhanced R&D coordination: Advanced Mathematics for Optimization of Complex Systems, Control Theory, and Risk Assessment; Electrical Energy Storage; Carbon Dioxide Capture and Storage; Characterization of Radioactive Waste; Predicting High Level Waste System Performance over Extreme Time Horizons; and High Energy Density Laboratory Plasmas. The Office of Science has sponsored scientific workshops corresponding to these focus areas in collaboration with related DOE applied technology program offices. The workshop reports identified high priority basic research areas necessary for improved understanding and revolutionary breakthroughs.

Advanced Mathematics for Optimization of Complex Systems, Control Theory, and Risk Assessment: The Advanced Scientific Computing Research (ASCR) program supports basic research in advanced mathematics for optimization of complex systems, control theory, and risk assessment. A recommendation from the workshop focused on this subject indicated additional research emphasis in advanced mathematics could benefit the optimization of fossil fuel power generation; the nuclear fuel lifecycle; and power grid control. Such research could increase the likelihood for success in DOE strategic initiatives including integrated gasification combined cycle coal-fired power plants and modernization of the electric power grid.

Electrical Energy Storage: About 15 percent of the Basic Energy Sciences (BES) program funding requested to support basic research in electrical energy storage (EES) is targeted for a formally coordinated program with DOE applied technology program offices. The workshop report on this focus area noted that revolutionary breakthroughs in EES have been singled out as perhaps the most crucial need for this Nation's secure energy future. The report concluded that the breakthroughs required for tomorrow's energy storage needs can be realized with fundamental research to understand the underlying processes involved in EES. The knowledge gained will in turn enable the development of novel EES concepts that incorporate revolutionary new materials and chemical processes. Such research will accelerate advances in developing novel battery concepts for hybrid and electric cars and will also help facilitate successful utilization and integration of intermittent renewable power sources such as solar, wind, and wave energy into the utility sector, making these energy sources competitive for base-load supply.

Carbon Dioxide Capture and Storage: BES, ASCR and the Biological and Environmental Research (BER) program support basic research in carbon dioxide capture and storage. The storage portion of this R&D coordination focus area was a subject of a BES workshop on Basic Research Needs for Geosciences in February 2007 that focused on the research challenges posed by carbon dioxide storage in deep porous saline geological formations. The workshop report noted that the chemical and geological processes involved in the storage of carbon dioxide are highly complex and would require an interdisciplinary approach strongly coupling experiments with theory, modeling, and computation bridging multiple length and time scales. The BES effort supports fundamental research to understand the underlying chemical, geochemical, and geophysical processes involved in subsurface sequestration sites. The BER research effort focuses on understanding, modeling, and predicting the processes that control the fate of carbon dioxide injected into geologic formations, subsurface carbon storage, and the role of microbes and plants in carbon sequestration in both marine and terrestrial environments. These aspects of this focus area were also the subject of additional SC workshops that identified basic research areas in carbon dioxide capture and storage that could benefit the optimization of fossil fuel power generation and the development of carbon neutral fuels. The ASCR research effort supports two Scientific Discovery through Accelerated Computing (SciDAC) partnerships with BER to advance modeling of subsurface reactive transport of contaminants; an area that has been identified as directly relevant to carbon sequestration research efforts.

Characterization of Radioactive Waste: BES, BER, and the Nuclear Physics (NP) program support research in radioactive waste characterization. This R&D coordination focus area was the subject of six Office of Science workshops, including three BES workshops. The workshop reports noted that the materials and chemical processes involved in radioactive waste disposal are highly complex and their characterization requires an interdisciplinary approach that strongly couples experiments with theory, modeling, and computation bridging multiple length and time scales. The BES effort will focus on research relating to the underlying physical and chemical processes that occur under the conditions of radioactive waste storage, including extremes of temperature, pressure, radiation flux, and multiple complex phases. The BER research effort addresses processes that control the mobility of radiological waste in the environment. The NP research effort is focused on characterization of radioactive waste through the advanced fuel cycle activities. The NP program areas are structured as scientific disciplines with goals to understand the nuclear cross sections important for advanced fuel cycle reprocessing. A small portion of on-going research is relevant to the issues involved with radioactive waste and related advanced fuel cycles. The knowledge gained from this research will lead to enhanced understandings of radioactive waste characterization, which would make nuclear power a far more attractive component in primary energy usage.

Predicting High Level Waste System Performance over Extreme Time Horizons: BES supports basic research in predicting high-level waste system performance over extreme time horizons. This R&D coordination focus area was a subject of a BES workshop on Basic Research Needs for Geosciences in February 2007, which focused on research challenges posed by geological repositories for high level waste. The workshop report identified major research priorities in the areas of computational thermodynamics of complex fluids and solids, nanoparticulate and colloid physics and chemistry, biogeochemistry in extreme and perturbed environments, highly reactive subsurface materials and environments, and simulation of complex multi-scale systems for ultra-long times.

High Energy Density Laboratory Plasmas: The Fusion Energy Sciences (FES) program supports basic reach in high energy density laboratory plasmas. In May 2007, Office of Science and the

National Nuclear Security Administration (NNSA) jointly sponsored a workshop to update the high energy density laboratory plasmas (HEDLP) scientific research agenda. Three scientific themes emerged from the workshop: enabling the grand challenge of fusion energy by high energy density laboratory plasmas; creating, probing, and controlling new states of high energy densities; and catching reactions in the act by ultra-fast dynamics. In FY 2009, the FES request expands existing HEDLP research in response to the research opportunities identified in the workshop.

BASIC AND APPLIED R&D COLLABORATION FUNDING SUMMARY

(dollars in thousands)

	FY 2007 Approp.	FY 2008 Approp.	FY 2009 Request	FY 2009 vs. FY 2008	
Advanced Mathematics for Optimization of Complex Systems, Control Theory, & Risk Assessment					
Science					
Advanced scientific computing research	——	1,900	2,000	+100	+5.3%
Energy Efficiency and Renewable Energy	——	——	500	+500	——
Nuclear Energy	10,000	19,410	55,000	+35,590	+183.4%
Total, Advanced Mathematics	10,000	21,310	57,500	+36,190	+169.8%
Electrical Energy Storage					
Science					
Basic energy sciences	——	——	33,938	+33,938	——
Energy Efficiency and Renewable Energy	——	——	2,000	+2,000	——
Electricity Delivery and Energy Reliability	——	——	13,403	+13,403	——
Total, Electric Energy Storage	——	——	49,341	+49,341	——
Carbon Dioxide Capture and Storage					
Science					
Basic energy sciences	5,915	5,915	10,915	+5,000	+84.5%
Advanced scientific computing research	——	976	976	——	——
Biological and environmental research	16,841	16,874	17,374	+500	+3.0%
Total, Science	22,756	23,765	29,265	+5,500	+23.1%
Fossil Energy	97,228	118,908	149,132	+30,224	+25.4%
Total, Carbon Dioxide Capture and Storage	119,984	142,673	178,397	+35,724	+25.0%

(dollars in thousands)

	FY 2007 Approp.	FY 2008 Approp.	FY 2009 Request	FY 2009 vs. FY 2008	
Characterization of Radioactive Waste					
Science					
Basic energy sciences	——	——	8,492	+8,492	——
Biological and environmental research	——	——	1,500	+1,500	——
Nuclear physics	200	200	6,603	+6,403	+3,202%
Total, Science	200	200	16,595	+16,395	+8,198%
Nuclear Energy	37,190	53,722	59,000	+5,278	+9.8%
Environmental Management	2,100	2,100	9,500	+7,400	+352.4%
Total, Characterization of Radioactive Waste	39,490	56,022	85,095	+29,073	+51.9%
Predicting High Level Waste System Performance Over Extreme Time Horizons					
Science					
Basic energy sciences	——	——	8,492	+8,492	——
Environmental Management	500	500	1,500	+1,000	+200.0%
Total, Predicting High Level Waste System Performance	500	500	9,992	+9,492	+1,898%
High Energy Density Laboratory Plasmas					
Science					
Fusion energy sciences	15,459	15,942	24,636	+8,694	+54.5%
National Nuclear Security Administration	10,000	12,295	10,147	-2,148	-17.5%
Total, High Energy Density Laboratory Plasmas	25,459	28,237	34,783	+6,546	+23.2%
Total, Basic and Applied Research Collaborations	195,433	248,742	415,108	166,366	+66.9%

OFFICE OF SCIENCE LABORATORY APPRAISALS

In 2006 the Office of Science 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 evaluates the contractor's performance against eight Performance Goals (three Science and Technology Goals and five Management and Operations 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 2007 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 2008 Appropriation - $1,269.9 Million; FY 2009 Request - $1,568.2 Million

The Basic Energy Sciences (BES) program supports research that advances the core disciplines of basic energy sciences—materials sciences, chemistry, geosciences, and physical biosciences. The scientific discoveries at the frontiers of these disciplines impact energy resources, production, conservation, efficiency, and the mitigation of adverse impacts of energy production and use—discoveries that will help accelerate progress toward long-term energy security, economic growth, and a sustainable environment. Research in materials sciences will lead to the development of materials that improve efficiency, economy, environmental acceptability, and safety of energy generation, conversion, transmission, storage, and use. Research in chemistry will lead to the development of advances such as efficient combustion systems with reduced emissions of pollutants; new solar photoconversion 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 results in advanced monitoring and measurement techniques for reservoir definition and understanding the dynamics of complex fluids through porous and fractured subsurface rock. Research into the molecular and biochemical nature of photosynthesis aids the development of solar photo-energy conversion.

In FY 2009, BES will support expanded efforts in innovative basic research to accelerate scientific breakthroughs needed to create advanced energy technologies for the 21st century. Central to this effort is the initiation of Energy Frontier Research Centers that will pursue fundamental basic research areas such as solar energy utilization; catalysis for energy; electrical energy storage; geosciences related to long-term storage of nuclear waste and carbon dioxide; advanced nuclear energy systems; hydrogen production, storage, and use; solid state lighting; superconductivity; combustion of 21st century transportation fuels; and materials under extreme environments. The Office of Science seeks to engage the Nation's intellectual and creative talent to address the scientific grand challenges associated with determining how nature works and to lead the scientific community into a new era of science—where we are able to direct and control matter at the quantum, atomic, and molecular levels and harness this new knowledge and capability for some of our most critical real-world challenges. BES anticipates making awards to 20 to 30 Energy Frontier Centers in FY 2009, each supported at two to five million dollars per year for an initial period of five years.

BES also provides the Nation's researchers with world-class research facilities, including a reactor- and two accelerator-based neutron sources, four operating light sources plus two additional next-generation light sources under construction in FY 2009, five nanoscale science research centers, and three electron beam micro-characterization centers. These facilities provide important capabilities for fabricating, characterizing, and transforming materials of all kinds from metals, alloys, and ceramics to fragile bio-inspired and biological materials. 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 2009, BES scientific user facilities will be scheduled to operate an optimal number of hours.

The Spallation Neutron Source (SNS)—a next-generation, accelerator-based, short-pulse neutron source—completed its first full year of commissioning and operations in FY 2007. In FY 2009, fabrication and commissioning of SNS instruments will continue, funded by BES and other sources including non-DOE sources. Two Major Items of Equipment are funded in FY 2009 that will allow the fabrication of nine additional instruments for the SNS, thus nearly completing the initial suite of 24 instruments that can be accommodated in the high-power target station. SNS and the High Flux Isotope Reactor at Oak Ridge National Laboratory together provide capabilities unavailable anywhere else in the world for study of the position and motion of atoms in materials.

All five Nanoscale Science Research Centers will be fully operational in FY 2009: 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 and Los Alamos National Laboratories, and the Center for Functional Nanomaterials at Brookhaven National Laboratory. In FY 2009, funding for research at the nanoscale increases for activities spanning materials sciences, chemistry, geosciences, and physical biosciences.

The Linac Coherent Light Source (LCLS) at the Stanford Linear Accelerator Center (SLAC) will continue construction in FY 2009. Full support of the operation of the SLAC linac is provided by BES in FY 2009, completing the transition of linac funding from the High Energy Physics program to BES. The LCLS project will 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 attoseconds—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. Construction of the Photon Ultrafast Laser Science and Engineering (PULSE) building renovation continues in FY 2009. 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 is provided for PED, R&D, and initiation of construction of the National Synchrotron Light Source-II (NSLS-II). NSLS-II will be a new synchrotron light source, highly optimized to deliver ultra-high brightness and flux with exceptional beam stability. This will 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 will open new regimes of scientific discovery and investigation.

ADVANCED SCIENTIFIC COMPUTING RESEARCH

FY 2008 Appropriation - $351.2 Million; FY 2009 Request - $368.8 Million

The Advanced Scientific Computing Research (ASCR) program is expanding the capability of world-class scientific research by advancing fundamental mathematics and computer science research that enables simulation and prediction of complex physical, chemical, and biological systems; providing the forefront computational capabilities needed by researchers to enable them to extend the frontiers of science; and delivering the fundamental networking research and facilities that link scientists across the nation to the Department-sponsored computing and experimental facilities. ASCR supports fundamental research and integrates the results of these efforts into tools and software that can be used by scientists in other disciplines. The applied mathematics research activity enables scientists to accurately model physical and natural systems, and provides the algorithms computers require to manipulate that representation of the world effectively. Computer science research provides the link between the mathematics and the actual computer systems. Scientific discovery results from simulations conducted on advanced computers. High performance networks and network research provide the capability to move the millions of gigabytes of data that SC's experimental and computational tools generate to the scientists' desktops. All of these elements supported by ASCR advance the frontiers of simulation and scientific discovery. ASCR and its predecessors have been leaders in the computational sciences for several decades and its activities are essential for research programs across SC and the Department.

In FY 2009, increases in core research in Applied Mathematics and Computer Science will be targeted on long-term research needs, including support for a new joint Applied Mathematics-Computer Science Institute to focus on the challenges of computing at extreme scales that blur the boundaries between these disciplines, a new effort in the mathematics of large datasets, areas of long-term research most relevant to meeting the challenges of computing at extreme scales, and risk assessment in complex systems. ASCR will also support a new basic research effort in cyber security for open science in FY 2009.

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 scientific breakthroughs that would be impossible using theoretical or laboratory studies alone, and fully realizing the potential of emerging terascale and petascale for advancing scientific discovery. The research and development activities supported under SciDAC extend key results from applied mathematics and computer science research to develop integrated software tools that computational scientists can use in high performance scientific applications. SciDAC enables new areas of science to take advantage of computation and simulation through Scientific Application Partnerships; Centers for Enabling Technologies at universities and national laboratories; and university-led SciDAC Institutes that complement the activities of the Centers and provide training for the next generation of computational scientists.

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. The National Energy Research Scientific Computing Center (NERSC) provides the core scientific computing capacity needed by the research community and complements the capabilities of the Leadership Computing Facilities (LCFs). NERSC serves over 2,500 users working on about 900 projects. The NERSC Cray XT-4 system will provide 100-150 teraflops of peak computing capacity in FY 2009. In FY 2009, the Oak Ridge National Laboratory LCF will continue to provide world-leading high-performance sustained capability to researchers with the acquisition of a one petaflop Cray Baker system by the end of 2008, which 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 within the LCF resources will be realized with the high performance IBM Blue Gene/P system at Argonne National Laboratory, which will achieve a peak capability of 250-500 teraflops in FY 2008. The Argonne LCF will bring enhanced capability to accelerate scientific understanding in areas such as molecular dynamics, catalysis, protein/DNA complexes, and aging of material. Access by the scientific community, including industry, to the LCF and NERSC resources will continue through the Innovative and Novel Computational Impact on Theory and Experiment (INCITE) program. INCITE is not only engaging universities and the national laboratories to advance SC's mission through simulation in areas like systems biology, chemical catalysis, climate modeling, and accelerator R&D, but also enabling industry to dramatically reduce the time for product and technology development. Beginning in FY 2009, the ASCR computing facilities will develop and implement a unified approach to supporting and maintaining software, languages, and tools that are critical to continued effective utilization of the machines.

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 the next generation of flexible optical telecommunications hardware, gives SC the possibility of exploiting these technologies to provide scientific data where needed at speeds commensurate with the new data volumes. Investments in the Energy Science Network (ESnet) 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 2009, ESnet, in partnership with Internet2, will continue to implement a next generation optical network structure for U.S. science and deliver 40-60 gigabits per second to SC laboratories.

Advancing high performance computing, computation, and advanced networking 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 development of a Federal Plan for Advanced Networking R&D.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

FY 2008 Appropriation - $544.4 Million; FY 2009 Request - $568.5 Million

Biological and Environmental Research (BER) supports basic research in genomics and systems biology of microbes and plants aimed at harnessing their capabilities for energy and environmental solutions; environmental measurement and the development of models to predict climate over decades to centuries; research to understand contaminant fate and transport and to develop science-based methods for the cleaning up environmental contaminants; molecular, cellular, and tissue-based low dose radiation research to provide regulators with a stronger scientific basis for developing future radiation protection standards; and advanced research in radiochemistry and imaging instrumentation. Results from this fundamental research will have broad impacts on our energy future, our environment, and our health.

In FY 2009, BER continues to support the Genomics: GTL research program. This program pursues systems biology approach that spans 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. 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. Development of a global biotechnology-based energy infrastructure requires substantial fundamental scientific understanding that enables 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 or through novel production strategies, such as engineered systems based on processes found in natural biological systems. Such strategies might include, for example, defined mixed microbial communities or consolidated biological processes. Within the GTL program, BER supports basic research aimed at developing the understanding needed to advance biotechnology-based strategies not only for new methods of producing renewable, carbon-neutral bioenergy compounds, but also for understanding how the capabilities of microbes can be applied to environmental remediation and carbon sequestration.

To accelerate the scientific breakthroughs necessary to develop novel, efficient, and cost-effective methods for producing biofuels from plant materials, BER awarded three new Bioenergy Research Centers in FY 2007. FY 2009 will be their second full year of operations. The three centers—the Joint BioEnergy Institute at Lawrence Berkeley National Laboratory, the Great Lakes Bioenergy Research Center at the University of Wisconsin at Madison, and the BioEnergy Science Center at Oak Ridge National Laboratory—consist of diverse teams of researchers from universities, national laboratories, and industry; and conduct comprehensive, multidisciplinary research programs focused on systems biology on microbes and plants. The Centers serve as catalysts for innovation and the development of transformational science for bioenergy solutions, and their research activities complement research funded within the broader GTL program.

An ability to predict long-range and regional climate, including the effects of energy-related emissions of greenhouse gases and aerosols on future climate, enables effective planning for future needs in energy, agriculture, and land and water use. Likewise, 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. DOE, in conjunction with its interagency partners under the U.S. Climate Change Science Program (CCSP), continues to focus climate change research in CCSP priority areas. These areas include abrupt climate change, advanced climate modeling, critical climate processes (including effects of clouds, aerosols, and water vapor on the atmospheric radiation balance), carbon cycling, atmospheric composition (with a focus on greenhouse gas concentrations and the effects of aerosols), the effects of climate change on important terrestrial ecosystems, and the development and evaluation of tools for assessing environmental costs and benefits of climate change and the different potential options for mitigation and adaptation to such change.

BER's Climate Change Research program enables both scientifically based predictions and assessments of the potential effects of greenhouse gases and aerosol emissions on climate and the environment, and the development of approaches for enhancing carbon sequestration in terrestrial ecosystems. Research supported by the climate program is focused on understanding the physical, chemical, and biological processes affecting the Earth's atmosphere, land, and oceans, and how these processes may be affected by changes in radiative forcing of climate resulting from carbon dioxide and aerosol emissions from energy production and use. BER support for climate modeling increases in FY 2009 to leverage the Department's leadership class computing facilities to improve both resolution and model physics, including modeling ice sheets, in a fully coupled climate model simulating historic climate and projecting future potential climate change at regional to global scales. BER also continues to support research on abrupt climate change and continues SciDAC partnership efforts with ASCR.

Research on climate forcing under the Atmospheric Radiation Measurement (ARM) program will continue to focus on resolving the largest sources of scientific uncertainty in climate change prediction—the effects of clouds and aerosols. ARM research supports individual investigators at universities and research teams at DOE laboratories. Continued support is provided for the ARM Climate Research Facility (ACRF) which consists of three stationary facilities, an ARM Mobile Facility, and the ARM Aerial Vehicles Program. The ACRF provides the data collection infrastructure needed for studies investigating atmospheric processes and properties and for the development and evaluation of climate process models. BER also continues to support AmeriFlux in FY 2009, which is a network of research sites where the net exchange of carbon dioxide, energy, and water between the atmosphere and major terrestrial ecosystems in North America is continuously measured. The AmeriFlux Network research sites provide extensive measurements of terrestrial carbon sink properties, including biological and soil processes, which provide insight into carbon cycling and inform the development of climate models. BER supports 20 of the approximately 70 sites in the network. The remaining AmeriFlux sites are funded by other Federal agencies. BER also supports research on ecosystem function and response to understand the potential effects of climate change anticipated during the coming 50-100 years on the health of important terrestrial ecosystems in the United States.

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. Research emphasis within BER's environmental remediation sciences research 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 2009, BER will support three field research sites which provide opportunities to validate laboratory findings under field conditions. The resulting knowledge and technology will assist DOE's environmental clean-up and stewardship missions. Support for the William R. Wiley Environmental Molecular Sciences Laboratory at Pacific Northwest National Laboratory in FY 2009 maintains operations at full capacity.

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 to cellular processes in microbes and plants—can be understood and improved using radiotracers and advanced imaging instruments. BER research continues on the biological effects of low dose radiation and for radiochemistry and imaging technologies. Building on DOE capabilities in physics, chemistry, engineering, biology, and computation, BER supports fundamental imaging research and maintains core infrastructure for imaging research and the development of new technologies. Funding is provided for Ethical, Legal, and Societal Issues (ELSI) associated with activities applicable to the Office of Science, including research on the ecological and environmental impacts of nanoparticles resulting from nanotechnology applied to energy technologies.

HIGH ENERGY PHYSICS

FY 2008 Appropriation - $689.3 Million; FY 2009 Request - $805.0 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 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. HEP uses 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. The research facilities and basic research supported by HEP advance our knowledge not only in high energy physics, but increasingly in other fields as 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 2009, HEP places a high priority on the operations, upgrades, and infrastructure of the two major HEP user facilities, the Tevatron Collider and the Neutrinos at the Main Injector (NuMI) beam line at Fermilab. After a very successful eight-year run, operation of the SLAC B-factory is completed in FY 2008. Funding is provided in FY 2009 to support significant analysis of data collected at the B-factory and for safe ramp-down of the facility. With completion of the scientific missions of the B-factory and Tevatron Collider by the end of this decade, the longer-term HEP program continues support for the development of new cutting-edge facilities in targeted areas like neutrino physics that will establish a U.S. leadership role in these areas in the next decade; when the centerpiece of the world HEP program will be at the Large Hadron Collider (LHC) at CERN (the European Organization for Nuclear Research).

As the LHC accelerator nears its turn-on date in 2008, support of an effective role for U.S. research groups in LHC discoveries will continue to be a high priority of the HEP program. In FY 2009, HEP increases funding for university and laboratory based research to support U.S. researchers participating in the physics discoveries enabled by the LHC and continues to provide support for operations and maintenance of the U.S.-built systems that are part of the LHC detectors. R&D for possible future upgrades to the LHC accelerator and detectors will also be pursued. A U.S. leadership role in the discoveries enabled by the LHC will require effective integration of U.S. researchers in the LHC detector calibration and data analysis efforts, and implementation and optimization of the U.S. data handling and computing capabilities needed for full participation in the LHC research program.

Support for International Linear Collider (ILC) R&D continues, but the U.S. role in the global R&D effort is reduced, resulting in a more focused but still robust program that emphasizes technical areas where the U.S. has unique or world-leading capabilities. The request positions the U.S. to play a significant role in the ILC, if governments decide to proceed with the project. In other accelerator technology R&D areas, funding is increasing to begin implementation of a strategic plan for technology R&D. Specific areas targeted for increased support are short-term R&D focused on development of high-intensity proton sources; mid-term R&D directed at development of superconducting radiofrequency structures, in view of their potential for a wide range of applications; and long-term R&D on advanced accelerator technologies with the potential to provide transformational changes. The latter effort includes fabrication of a new test facility for advanced particle acceleration concepts.

With Tevatron improvements completed, much of the accelerator development effort at Fermilab in FY 2009 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 ramps up in FY 2009 and will utilize the NuMI beam. This project includes improvements to the proton source to increase the intensity of the NuMI beam. Meanwhile, fabrication continues for the Reactor Neutrino Detector at Daya Bay, China and two small neutrino experiments, the Main Injector Experiment ν-A (MINERνA) in the Main Injector Neutrino Oscillation Search (MINOS) near detector hall at Fermilab and the Tokai-to-Kamioka (T2K) experiment using the Japanese J-PARC neutrino beam.

The HEP Non-Accelerator Physics subprogram supports fundamental research for U.S. leadership in the study of those topics in particle physics that cannot be investigated completely with accelerators, or are best studied by other means. Some of the non-accelerator-based particle sources used in this research are neutrinos from the sun, galactic supernovae, terrestrial nuclear reactors, and cosmic rays striking the Earth's atmosphere. Experimental facilities and research utilizing these particle physics techniques are often located at remote sites, such as deep underground laboratories, on mountain tops, or in space, either as satellites or as instruments attached to International Space Station. In FY 2009, HEP, in partnership with NASA, will operate the Large Area Telescope (LAT) scheduled to be launched from the Kennedy Space Center in mid-2008. The LAT, a primary instrument on NASA's Gamma Ray Large Area Space Telescope (GLAST) mission, will observe and provide insights into understanding the highest energy gamma rays observed in nature. This activity complements the ground-based VERITAS Telescope Array supported by HEP, which studies the astrophysical sources of high energy gamma rays.

HEP continues the fabrication of the Dark Energy Survey (DES) project in FY 2009, which will provide the next step in determining the nature of dark energy. HEP continues support for R&D 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 High Energy Physics Advisory Committee/Nuclear Sciences Advisory Committee subpanel review. HEP supports concept studies for a Joint Dark Energy Mission (JDEM), a joint DOE and NASA space-based satellite, leading to a mission concept selection in 2009 and a planned FY 2010 fabrication start. Support for R&D on other near-term and next-generation ground- and space-based dark energy concepts continues in FY 2009. 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.

HEP also supports major thrusts in theoretical physics, astrophysics, and particle physics grid technology, including activities supported through the SciDAC program in FY 2009, as well as proposals in accelerator modeling and design. 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 2008 Appropriation - $432.7 Million; FY 2009 Request - $510.1 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, 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 is central to the development of various technologies relevant to nuclear energy, nuclear medicine, and national security. 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, including those relevant to the Department's missions in energy, nuclear-related national security, and environmental quality.

Key aspects of the NP research agenda include understanding how quarks and gluons combine to form nucleons (protons and neutrons), 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 gained 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 FY 2009, NP will support the operations of four National User Facilities and research at universities and national laboratories, and make investments in new capabilities to address compelling scientific opportunities and to maintain U.S. competitiveness in global nuclear physics efforts. 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 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 2009. The NP program, in partnership with NASA, will continue construction of an Electron Beam Ion Source to provide RHIC with more cost-effective and reliable operations than the current Tandem Van de Graaff accelerator, as well as new research capabilities. 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 minimum viscosity) discovered at RHIC.

Operations of the Continuous Electron Beam Accelerator Facility (CEBAF) at Thomas Jefferson National Accelerator Facility (TJNAF) in FY 2009 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 2009, the accelerator will provide beams simultaneously to all three experimental halls and funding is provided for the initiation of construction of 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 Argonne National Laboratory and the Holifield Radioactive Ion Beam Facility (HRIBF) at Oak Ridge National Laboratory will be supported in FY 2009 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. Fabrication continues for the GRETINA gamma-ray detector array, which 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 Spallation Neutron Source 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 2009 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 2009 to continue U.S. participation in the fabrication of an Italian-led neutrino-less double beta decay experiment, the Cryogenic Underground Observatory for Rare Events (CUORE). 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 double beta decay will determine if the neutrino is its own antiparticle and provide information about the mass of the neutrino.

In 2008, NP plans to conduct a design solicitation and make a site selection for a Facility for Rare Isotope Beams (FRIB). This U.S. facility will enable world-leading research opportunities in nuclear structure, nuclear astrophysics, and fundamental studies, and will complement the programs of high capability radioactive ion beam facilities elsewhere in the world. Following a site selection, funds are provided in FY 2009 for R&D and to begin conceptual design activities for FRIB.

Theoretical research is important in all program areas, and NP supports the nuclear data program, which collects, evaluates, and disseminates nuclear physics data. NP increases support in FY 2009 for basic research in the characterization of radioactive waste through advanced fuel cycle activities. NP also continues to support SciDAC efforts in nuclear astrophysics, grid computing, Lattice Gauge (QCD) theory, low energy nuclear structure and nuclear reaction theory, and advanced accelerator design.

Beginning in FY 2009, NP assumes responsibilities for research, development, and production of stable and radioactive isotopes previously under the DOE Office of Nuclear Energy. A major objective of this subprogram within NP, entitled Isotope Production and Applications, is to improve the availability and reliability of research isotopes at predictable prices needed for medical, national security, and industrial applications. A portfolio of research isotopes will be established with guidance from scientific advisory committees, in consultation with BER, the National Institutes of Health, and all segments of the research community and other federal agencies interested in using stable and radioactive isotopes.

FUSION ENERGY SCIENCES

FY 2008 Appropriation - $286.5 Million; FY 2009 Request - $493.1 Million

The Fusion Energy Sciences (FES) program advances the theoretical and experimental understanding of plasma and fusion science needed to develop fusion energy. Advances in plasma physics and associated technologies will bring the U.S. closer to making fusion energy a part of the Nation's energy solution. To enable fundamental research into the nature of fusion plasmas, FES supports the operation of a set of unique and diversified domestic experimental facilities and close collaborations with international partners on specialized facilities abroad. Results from these facilities provide the data to test our theoretical understanding of fusion plasmas and extend our computer models—ultimately leading to improved predictive capabilities for fusion plasmas. The FES research program, including experiments on major facilities, theory, and computer modeling activities, will emphasize burning plasma research to prepare for the ITER scientific program. FES leads U.S. participation in ITER, an experiment to study and demonstrate the scientific and technical feasibility of fusion power.

A defining feature of the FES program is its emphasis on developing the underlying science of potential fusion energy systems. This effort consists of campaigns to develop the requisite understanding of several critical issues, including integrated burning plasma properties; macroscopic equilibrium and stability of plasmas; multi-scale transport of energy and particles; plasma boundary interfaces between a hot plasma and the surrounding material surfaces; interaction of electromagnetic waves with plasma electrons and ions; high energy density implosion physics; and fusion engineering science. In FY 2009, the FES program will begin to identify critical scientific issues and missions for the next stage in the U.S. fusion research program during the ITER era, which will keep it at the forefront of fusion and plasma sciences in the future.

Through its participation in the international ITER project, the magnetic fusion energy sciences program will begin to explore the burning plasma regime. The achievement of a burning plasma regime in ITER, wherein much more fusion energy is released than is used to heat the plasma fuel, will provide a fundamental demonstration of the viability of magnetic fusion as a potential new energy source. Our participation in the international ITER project began in FY 2006 through the U.S. Contributions to ITER Major Item of Equipment project. In FY 2008, U.S. ITER project activities are minimized because of significantly reduced funding relative to requested levels. The extent of the resulting cost and schedule impacts is still being assessed. With full funding in FY 2009, as requested, the U.S. Contributions to the ITER project will resume activities to provide for the U.S. "in-kind" hardware contributions, U.S. personnel to work at the ITER site, and funds for the U.S. share of common expenses such as infrastructure, hardware assembly, installation, and contingency.

In FY 2009, FES continues to support the operation of three major experimental facilities that provide scientists with the means to test and extend our theoretical understanding and computer models for fusion science: the DIII-D tokamak at General Atomics in San Diego, California, the Alcator C-Mod tokamak at the Massachusetts Institute of Technology in Cambridge, Massachusetts, and the National Spherical Torus Experiment at Princeton Plasma Physics

Laboratory (PPPL) in Princeton, New Jersey. Experiments on these major facilities, along with theory and computer modeling activities, will support final design decisions for ITER and assist in developing operating scenarios for the ITER research program.

Funding is currently provided for continued fabrication of the National Compact Stellarator Experiment (NCSX) at PPPL; however, a final decision on the project's future will be made in FY 2008, since the project's cost and schedule have changed significantly since the initial project baseline was established. Several reviews of NCSX were conducted by the Office of Science and Princeton University in 2007 including a scientific and programmatic review by the Fusion Energy Sciences Advisory Committee which concluded that the NCSX should be completed to maintain U.S. interests in this field. These reviews plus upcoming technical, cost, and schedule reviews by DOE will provide the necessary input to allow the Department to make the decision either to re-baseline the project or to cancel it.

FES will initiate detailed planning for a Fusion Simulation Project (FSP) in FY 2009, taking advantage of the many recent improvements in computational and computing capabilities, as well as a significant amount of preparatory work that has already been done by FES's SciDAC activities. The FSP will be directed at developing a world-leading predictive integrated plasma simulation capability that can be applied to burning plasmas of the type that will be necessary for fusion energy producing power plants. As such, the FSP will represent the embodiment of the goal of developing the knowledge base for a fusion energy system. The FSP is expected to be completed by FY 2024, but there will also be key deliverables targeted at the end of five and ten years.

FES increases support for efforts in the area of high energy density laboratory plasmas (HEDLP) as part of the HEDLP Joint Program with the National Nuclear Security Administration. In FY 2009, a rolling series of competitive solicitations will be started to identify initiatives to be supported under the HEDLP Joint Program that are consistent with the missions of both FES and NNSA. These solicitations will cover a number of exciting HEDLP research areas such as inertial fusion energy sciences, warm dense matter, and magnetized high energy density plasmas, including plasma jets, laser-plasma interactions, compressible hydrodynamics, and laboratory astrophysics.

WORKFORCE DEVELOPMENT FOR TEACHERS AND SCIENTISTS

FY 2008 Appropriation - $8.0 Million; FY 2009 Request - $13.6 Million

The Department of Energy has played a role in training America's scientists and engineers for more than 60 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 the development of a highly skilled scientific and technical workforce. The Workforce Development for Teachers and Scientists (WDTS) program helps to ensure that DOE and the Nation have a sustained pipeline of highly trained scientists, mathematicians, and engineers in the workforce. That workforce includes DOE federal employees, the DOE national laboratories, and more broadly, the university and private sector institutions that perform the science and technology required for DOE to achieve its goals in energy, environment, national security, and basic discovery. WDTS accomplishes its mission primarily by providing hands-on science and technology learning experiences to the Nation's students and educators of science, technology, engineering, and mathematics (STEM). 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 supports experiential learning opportunities that compliment classroom curriculum 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 STEM; and (3) encourage and reward middle and high school students across the Nation to 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 2009, WDTS activities are implemented through three new subprograms: Student Programs, Educator Programs, and Program Administration and Evaluation. Student Programs provide experiential learning opportunities to enhance student understanding of science and to increase their interest in pursuing STEM careers. Included within this subprogram in FY 2009 are Science Undergraduate Laboratory Internship (SULI), Community College Institute (CCI), Pre-Service Teachers (PST), and the National Science Bowl (NSB).

The DOE National Science Bowl is a nationally recognized, prestigious academic event for high school and middle school students. It has attained its level of recognition and participation through a grass-roots design, which encourages the voluntary participation of professional scientists, engineers, and educators from across the Nation. Students answer questions in scientific topics, including astronomy, biology, chemistry, mathematics, and physics, in a highly competitive, "Jeopardy-style" format. Since 1991, more than 150,000 students have participated in the regional and national competitions. The 2008 NSB High School Finals will be held in Washington, DC from May 1-6, 2008, and the Middle School Finals will be held in Golden, CO from June 19-22, 2008—you are all welcome to attend these exciting events.

The WDTS Educator Programs make the world-class intellectual and physical assets of the Department available to the U.S. education community. Included within this newly restructured subprogram in FY 2009 are DOE Academies Creating Teacher Scientists (ACTS), Faculty and Student Teams (FaST), and the Albert Einstein Distinguished Educator Fellowship.

The WDTS Program Administration and Evaluation activities leverage resources and partnerships with other Federal agencies, industry, academic institutions, and professional associations to build expertise in workforce development. These activities also include developing and deploying rigorous evaluation methods for all WDTS programs; developing longitudinal workforce studies that track students and educators who participate in DOE programs; and improving outreach efforts to communicate to the broader public the role the Department plays in STEM education and the opportunities provided to students and educators.

SCIENCE LABORATORIES INFRASTRUCTURE

FY 2008 Appropriation - $66.9 Million; FY 2009 Request - $110.3 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 Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), and Oak Ridge National Laboratory (ORNL).

In FY 2009, SLI proposes to initiate an Infrastructure Modernization Initiative. The goal of this initiative is to, by FY 2019, have facilities and infrastructure at the SC laboratories that:

- Offer a safer, healthier, and more secure work environment for employees and visitors;
- Ensure laboratory infrastructure will support world-class science;
- Meet or exceed DOE sustainability goals and are more efficient to operate and maintain; and
- Support worker productivity and facilitate effective interaction with colleagues.

Increases in construction funding proposed in FY 2009 will fund three new projects under the proposed SC Infrastructure Modernization Initiative. These are the Interdisciplinary Science Building, Phase I project at Brookhaven National Laboratory; the Seismic Life-Safety, Modernization, and Replacement of General Purpose Buildings, Phase II project, at the Lawrence Berkeley National Laboratory; and the Technology and Engineering Development Facility project at the Thomas Jefferson National Accelerator Facility. Also included under this Initiative is one project started in FY 2008, the Modernization of Laboratory Facilities project at Oak Ridge National Laboratory. Additional on-going line-item construction projects include the Physical Sciences Facility at Pacific Northwest National Laboratory and additional renovations and upgrades at the Brookhaven and Lawrence Berkeley National Laboratories.

SCIENCE PROGRAM DIRECTION

FY 2008 Appropriation - $177.8 Million; FY 2009 Request - $203.9 Million

Science Program Direction (SCPD) enables a skilled and highly-motivated Federal workforce to manage and support basic energy-related and science-related research disciplines, diversely supported through research programs, projects, and facilities under the Office of Science's leadership. This budget request addresses the overall corporate strategy and eliminates the previous subprograms of Program Direction and Field Operations.

The headquarters Federal staff is responsible for Office of Science-wide issues, operational policy, scientific program development, and management functions supporting a broad spectrum of scientific disciplines and program offices. Additionally, support is included for management of workforce program direction and infrastructure through policy, technical and administrative support staff responsible for budget and planning; general administration; information technology; infrastructure management; construction management; Safeguards and Security; and

Environment, Safety, and Health within the framework set by the Department. Additionally, Program Direction includes funding for the Office of Scientific and Technical Information, which collects, preserves, and disseminates DOE research and development information for use by DOE, the scientific community, academia, U.S. industry, and the public to expand the knowledge base of science and technology.

Field personnel are responsible and directly accountable for implementing the SC program within the framework established by headquarters policy and guidance. Site Office personnel are responsible for the day-to-day oversight of Management and Operating contractor performance supporting Office of Science laboratories and facilities. In addition, the Integrated Support Center, operated in partnership by the Chicago and Oak Ridge Operations office personnel, provides best-in-class business, administrative, and specialized technical support across the entire Office of Science enterprise and to other DOE programs. In FY 2009, Program Direction funding increases by 14.7 percent from the FY 2008 appropriated level. Most of the increase will support an additional 42 FTEs, to manage the increase in the SC research investment and the Committee of Visitors recommendations for all of the SC basic research programs.

SAFEGUARDS AND SECURITY

FY 2008 Appropriation - $75.9 Million; FY 2009 Request - $80.6 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 2009 S&S budget includes funding necessary to protect people, property, and information. In FY 2009, increased funding is provided for cyber security to respond to significantly increased risks and government-wide requirements by the Federal Information Security Management Act (FISMA) in this area and in security systems to replace and upgrade aging and obsolete systems.

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 global competitiveness. On behalf of DOE, I am pleased to present this FY 2009 budget request for the Office of Science.

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

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