FY2009 DOE Funding Opportunities

Energy Frontier Research Centers (EFRCs)

&

Single-Investigator and Small-Group Research (SISGR)

Andrew Schwartz
Program Manager
Experimental Condensed Matter Physics
DOE Office of Basic Energy Sciences

Outline

- **EFRC and SISGR**
- **The science behind EFRC and SISGR:**

  Basic Research Needs (BRN) Workshops
- **Other DOE funding opportunities**

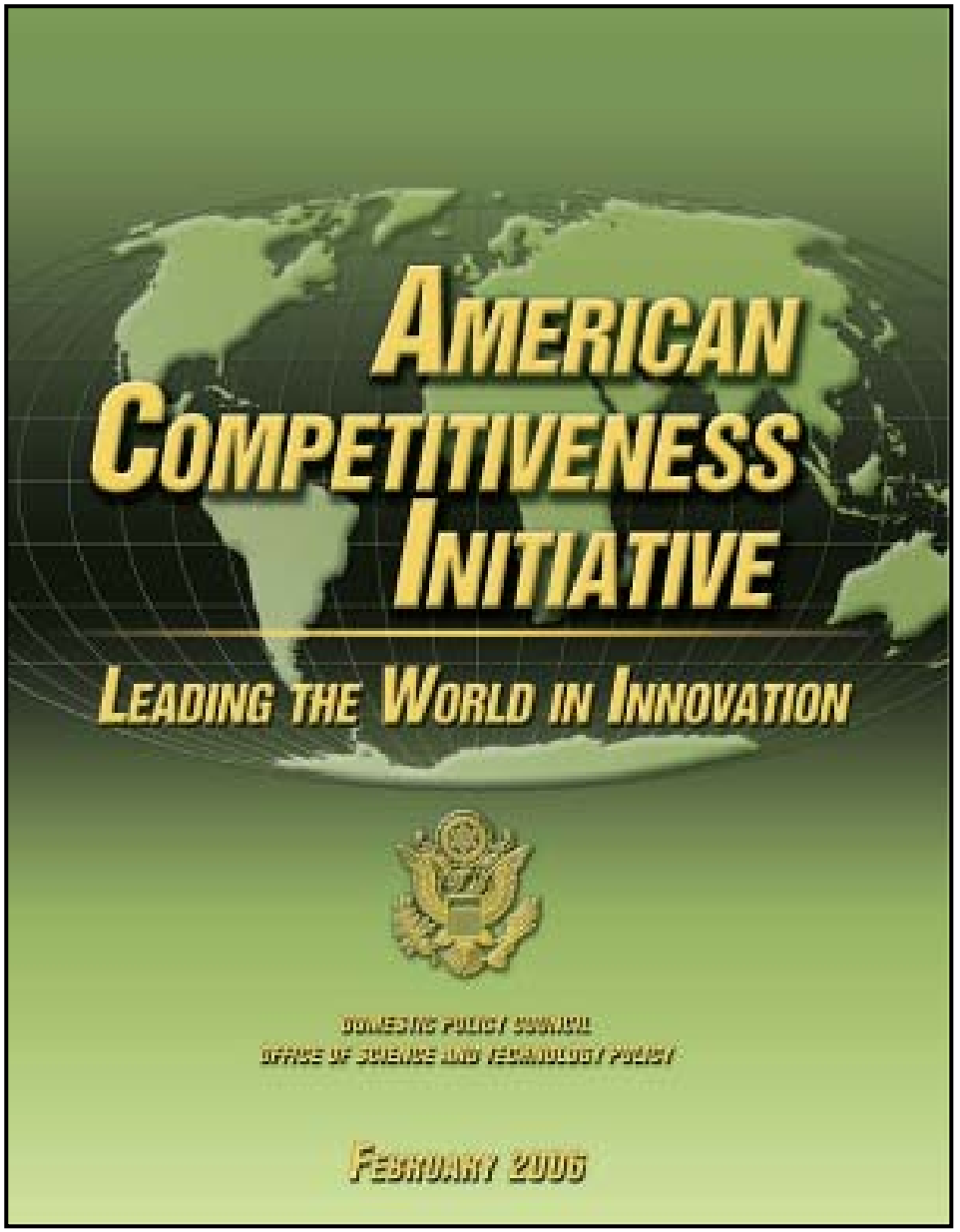
American Competitiveness Initiative

"We must continue to lead the world in human talent and creativity. Our greatest advantage in the world has always been our educated, hardworking, ambitious people – and we're going to keep that edge. Tonight I announce an American Competitiveness Initiative, to encourage innovation throughout our economy, and to give our nation's children a firm grounding in math and science."

"I propose to double the federal commitment to the most critical basic research programs in the physical sciences over the next 10 years. This funding will support the work of America's most creative minds as they explore promising areas such as nanotechnology, supercomputing, and alternative energy sources."

President George W. Bush
State of the Union Address
January 31, 2006

American Competitiveness Initiative



- **Called for doubling of R&D funding for physical sciences over 10 years**
  - DOE Office of Science
  - NSF
  - NIST

The President's Budget Request for FY2009 remains a vote of confidence for the physical sciences:

"To keep America competitive into the future, we must trust in the skill of our scientists and engineers and empower them to pursue the breakthroughs of tomorrow . . . This funding is essential to keeping our scientific edge."

President George W. Bush
State of the Union Address
January 28, 2008

The Office of Science FY09 Budget Request to Congress

(dollars in thousands)

$160M for Research

	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%
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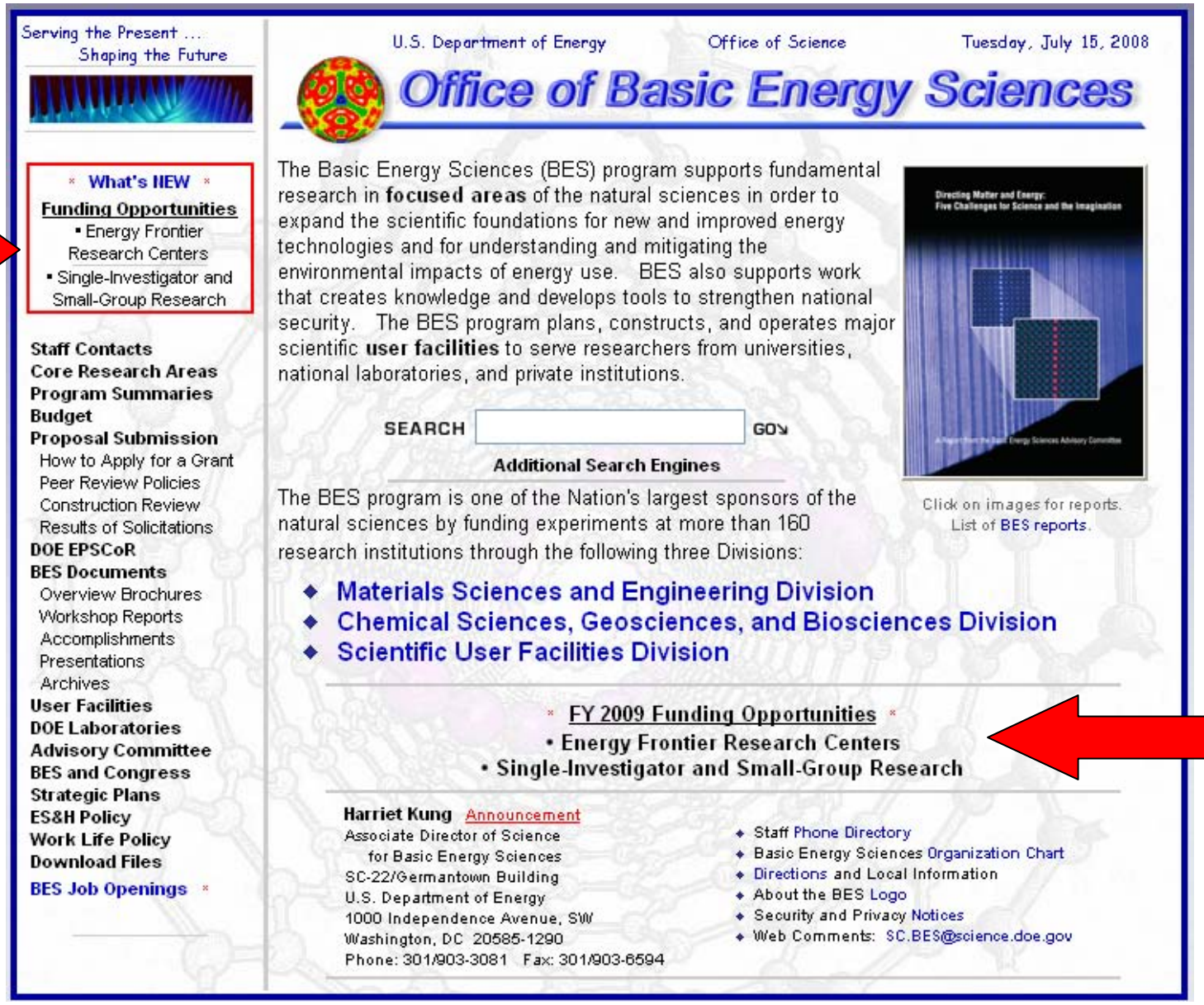
Total, Office of Science	3,836,613	3,973,142	**4,721,969**	+748,827	+18.8%

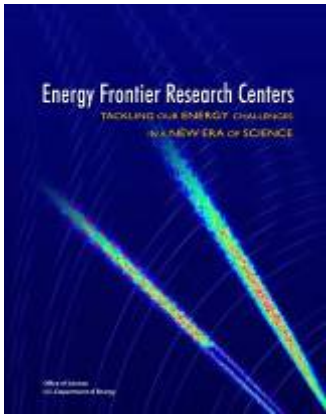
* Adjustments include SBIR/STTR funding transferred from other DOE offices (FY 2007 only), a charge to reimbursable customers for their share of safeguards and security costs (FY 2007 and FY 2008), Congressionally-directed projects and a rescission of a prior year Congressionally-directed project (FY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

http://www.sc.doe.gov/bes



Energy Frontier Research Centers

Tackling our energy challenges in a new era of science



Energy Frontier Research Centers will bring together the skills and talents of multiple investigators to enable research of a scope and complexity that would not be possible with the standard individual-investigator or small-group award.

The DOE Office of Science, Office of Basic Energy Sciences, announced the Energy Frontier Research Centers (EFRCs) program. Pending appropriations, up to $100M will be available in FY2009 for EFRC awards that are $2–5 million/year for an initial 5-year period. Universities, labs, nonprofits, and for-profit entities are eligible to apply.

Energy Frontier Research Centers will pursue fundamental research that addresses both energy challenges and science grand challenges in areas such as:

- Solar Energy Utilization
- Catalysis for Energy
- Electrical Energy Storage
- Solid State Lighting
- Superconductivity
- Bioenergy and biofuels
- Geosciences for Nuclear Waste and CO_2 Storage
- Advanced Nuclear Energy Systems
- Combustion of 21st Century Transportation Fuels
- Hydrogen Production, Storage, and Use
- Materials Under Extreme Environments

EFRC Funding Opportunity Announcement was published on April 4, 2008.
See: http://www.sc.doe.gov/bes/EFRC.html

EFRC Distinguishing Characteristics

- The research program is at the forefront of one or more of the challenges described in the BESAC report *Directing Matter and Energy: Five Challenges for Science and the Imagination*
- The research program addresses one or more of the energy challenges described in the ten BES workshop reports in the *Basic Research Needs* series
- The program is balanced and comprehensive, and, as needed, supports experimental, theoretical, and computational efforts and develops new approaches in these areas.
- The program provides opportunities to inspire, train, and support leading scientists of the future who have an appreciation for the global energy challenges of the 21st century.
- The center leadership communicates effectively with scientists of all disciplines and promotes awareness of the importance of energy science and technology.
- There is a comprehensive management plan for a world-leading program that encourages high-risk, high-reward research. The Center's management plan demonstrates that the whole is substantially greater than the sum of the individual parts.

Single-Investigator and Small-Group Research

Tackling our energy challenges in a new era of science

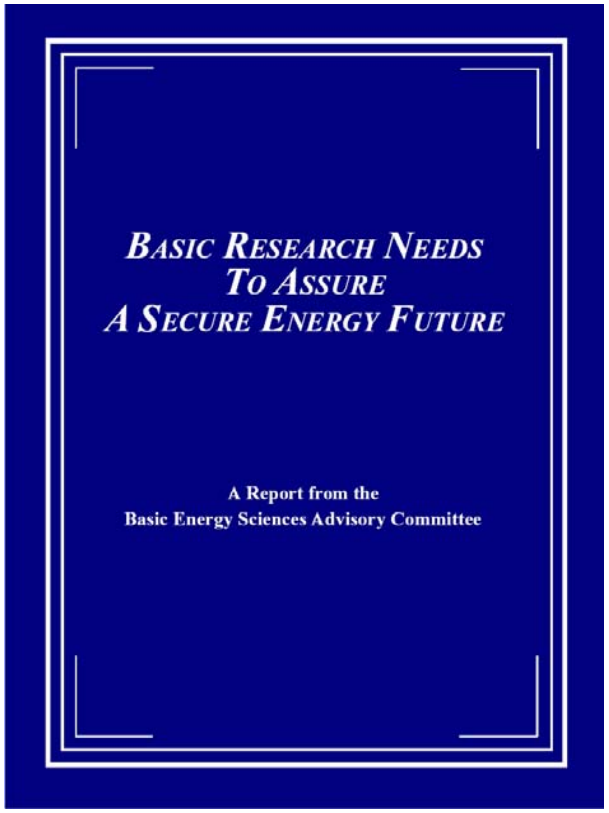
- Pending appropriations, up to $60M will be available for single-investigator and small-group awards in FY2009.
- BES seeks applications in two areas: grand challenge science and energy challenges identified in one of the Basic Research Needs workshop reports.
- Awards are planned for three years, with funding in the range of $150-300k/yr for single-investigator awards and $500-1500k/yr for small-group awards (except as noted below)
- Areas of interest include:

  Grand challenge science: ultrafast science; chemical imaging, complex & emergent behavior

  Tools for grand challenge science: midscale instrumentation; accelerator and detector research (awards capped at $5M over 3-year project duration)

  Use inspired discovery science: basic research for electrical energy storage; advanced nuclear energy systems; solar energy utilization; hydrogen production, storage, and use; geological CO2 sequestration; other basic research areas identified in BESAC and BES workshop reports with an emphasis on nanoscale phenomena
- For full details see: http://www.sc.doe.gov/bes/SISGR.html

BESAC Energy Security Plan



BESAC Basic Research Needs to Assure A Secure Energy Future Report February 2003

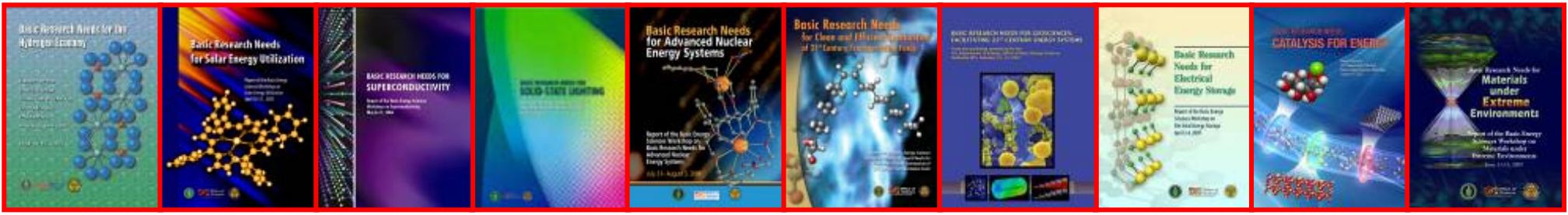
"Considering the urgency of the energy problem, the magnitude of the needed scientific breakthroughs, and the historic rate of scientific discovery, current efforts will likely be too little, too late. Accordingly, BESAC believes that a new national energy research program is essential and must be initiated with the intensity and commitment of the Manhattan Project, and sustained until this problem is solved."

10 Basic Research Needs Workshops

10 workshops; 5 years; more than 1,500 participants from academia, industry, and DOE labs

Basic Research Needs to Assure a Secure Energy Future (BESAC)

- Basic Research Needs for the **Hydrogen** Economy
- Basic Research Needs for **Solar Energy** Utilization
- Basic Research Needs for **Superconductivity**
- Basic Research Needs for **Solid State Lighting**
- Basic Research Needs for Advanced **Nuclear Energy** Systems
- Basic Research Needs for the Clean and Efficient **Combustion** of 21st Century Transportation Fuels
- Basic Research Needs for **Geosciences**: Facilitating 21st Century Energy Systems
- Basic Research Needs for **Electrical Energy Storage**
- Basic Research Needs for **Catalysis** for Energy Applications
- Basic Research Needs for Materials under **Extreme Environments**



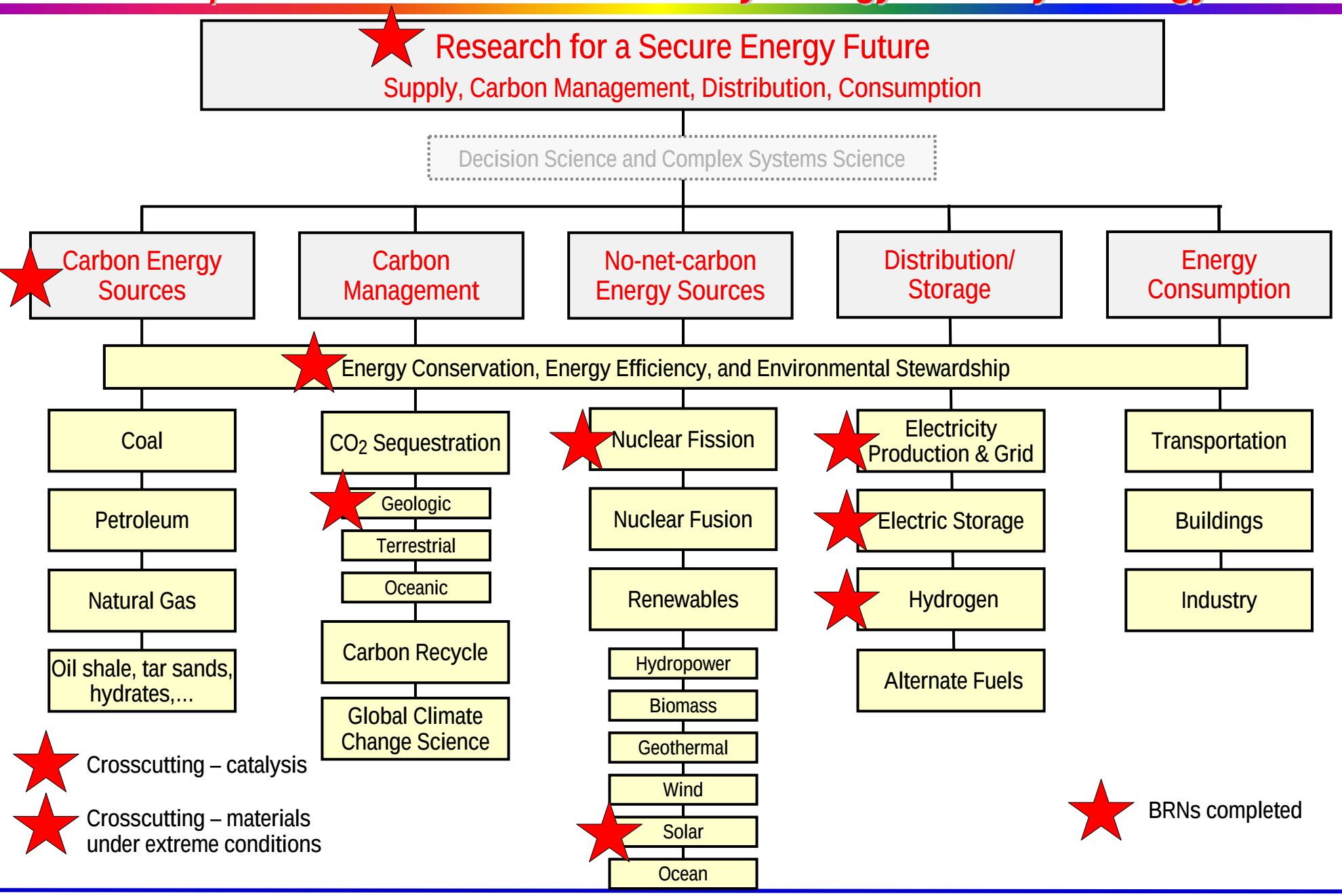
www.science.doe.gov/bes/reports/list.html

Important Recurring Themes from the Workshops

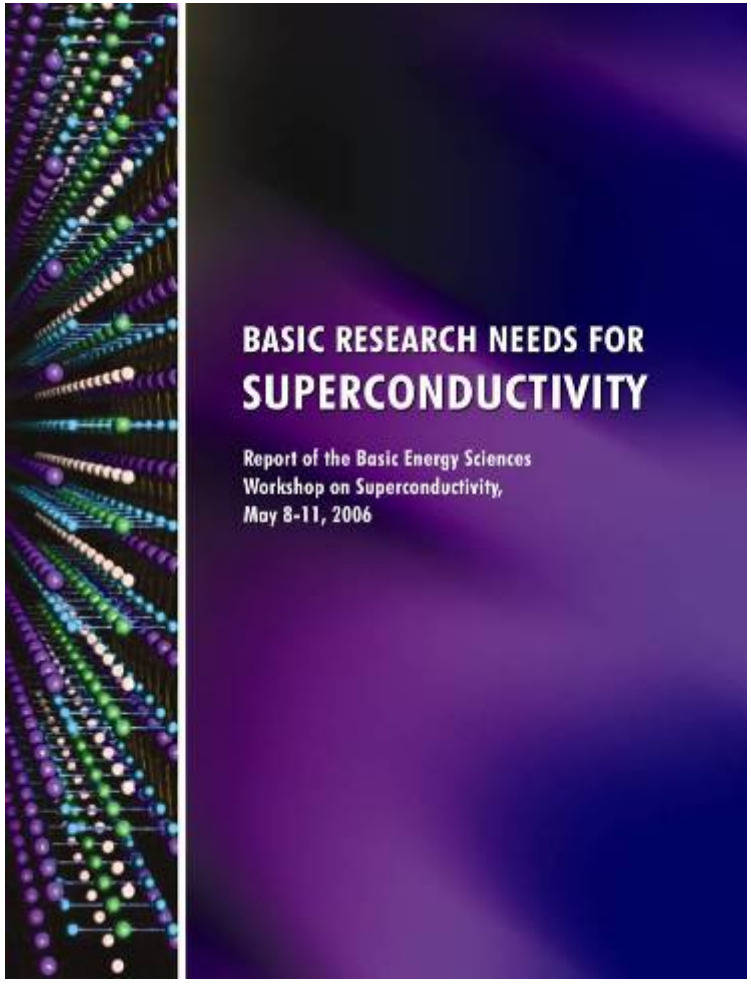
Control of materials properties and functionalities through electronic and atomic design

- New materials discovery, design, development, and fabrication, especially materials that perform well under extreme conditions
- "Control" of photon, electron, spin, phonon, and ion transport in materials
- Science at the nanoscale, especially low-dimensional systems
- Designer catalysts
- Designer interfaces and membranes
- Structure-function relationships
- Bio-materials and bio-interfaces, especially at the nanoscale
- Synthesis and Crystal Growth
- New tools for spatial characterization, temporal characterization, and for theory/modeling/computation

BRN Workshops Address Many Elements Required for a Decades-to-Century Energy Security Strategy



Workshop on Basic Research Needs for Superconductivity (8-11 May 2006)



Workshop Co-chair: John Sarrao, LANL
Co-chair: Wai-Kwong Kwok, ANL

Panel Chairs:

- Materials: I. Bozovic (BNL)
- Phenomena: J. C. Davis (Cornell), L. Civale (LANL)
- Theory: I. Mazin (NRL)
- Applications: D. Christen (ORNL)

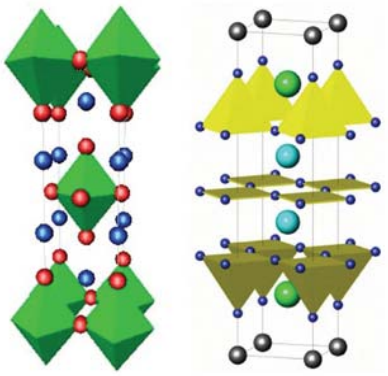
Plus 100 researchers representing 7 countries, 28 universities, and 9 national labs

Workshop Charge: "Identify basic research needs and opportunities in superconductivity with a focus on new, emerging and scientifically challenging areas that have the potential to have significant impact in science and energy relevant technologies."

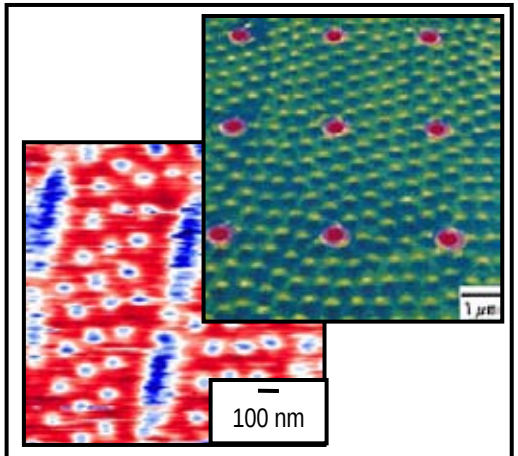
Basic Research Needs for Superconductivity

The challenge of superconductivity is finding the mechanisms of pairing and correlated electron states of high temperature superconductivity. Two decades after their discovery, high-temperature superconductors are viewed less as a singular mystery and more as a threshold to new realms of physics.

- Develop a comprehensive theory of superconductivity
- Understand and exploit competing electronic phases
- Control structure and properties of superconductors at the atomic scale
- Advance the science of vortex matter
- Maximize current-carrying ability of superconductors
- Develop the tools to probe electronic matter and vortex matter in real time



Crystal structure of the first high-Tc superconductor, $La_{2-x}Sr_xCuO_4$ (left), with a Tc of ~40 K, versus the record holder, $Hg_{0.2}Tl_{0.8}Ca_2Ba_2Cu_3O_8$, with a Tc of ~140 K (right). Because the Cu-O planes are the same in both materials, the huge 100 K difference must result from the optimization of energy scales in the Hg-based compound.



Lorenz electron microscopy (top) and scanning tunneling microscopy images of vortices.

Directing Matter and Energy: A New Era of Science

Together, these workshop reports highlighted the remarkable scientific journey that has taken place during the past few decades. The resulting scientific challenges, which no longer were discussed in terms of traditional scientific disciplines, described a new era of science – an era in which materials functionalities are designed to specifications and chemical transformations are manipulated at will.

BESAC Grand Challenge Subcommittee Report
January 2008

- How do we control materials processes at the level of electrons?
- How do we design and perfect atom- and energy-efficient syntheses of revolutionary new forms of matter with tailored properties?
- How do remarkable properties of matter emerge from the complex correlations of atomic or electronic constituents and how can we control these properties?
- How can we master energy and information on the nanoscale to create new technologies with capabilities rivaling those of living things?
- How do we characterize and control matter away—especially very far away—from equilibrium?

How Nature Works ··· to ··· Materials by Design ··· to ··· Technologies for the 21st Century

Grand Challenges	Discovery and Use-Inspired Basic Research		Applied Research	Technology Maturation & Deployment
How nature works	*Materials properties and functionalities by design*			
▪ Controlling materials processes at the level of quantum behavior of electrons ▪ Atom- and energy-efficient syntheses of new forms of matter with tailored properties ▪ Emergent properties from complex correlations of atomic and electronic constituents ▪ Man-made nanoscale objects with capabilities rivaling those of living things ▪ Controlling matter very far away from equilibrium	▪ Basic research for fundamental new understanding on materials or systems that may revolutionize or transform today's energy technologies ▪ Development of new tools, techniques, and facilities, including those for the scattering sciences and for advanced modeling and computation	▪ Basic research, often with the goal of addressing showstoppers on real-world applications in the energy technologies	▪ Research with the goal of meeting *technical milestones*, with emphasis on the development, performance, cost reduction, and durability of materials and components or on efficient processes ▪ Proof of technology concepts	▪ Scale-up research ▪ At-scale demonstration ▪ Cost reduction ▪ Prototyping ▪ Manufacturing R&D ▪ Deployment support

BESAC & BES Basic Research Needs Workshops

DOE Technology Office/Industry Roadmaps

BESAC and CMMP 2010 Grand Challenges

Energy Frontier Research Centers

Single Investigator and small-group research

Important Dates

- **EFRC**
  - July 1, 2008: Letters of intent due
  - October 1, 2008: Full proposals due

- **SISGR**
  - September 2, 2008: White papers requested
  - November 2008: Encourage/discourage decisions
  - January 2009: Full proposals due

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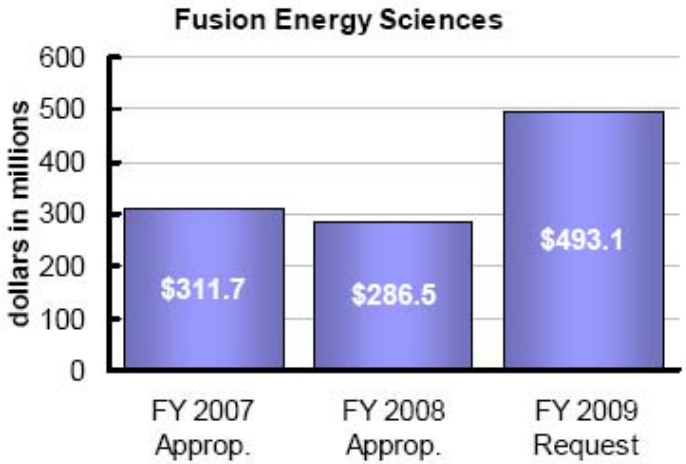
U.S. Department of Energy

Office of Science

Fusion Energy Sciences (FES)

(FY 2009=$493.1M) **+72%**

- **The U.S. Contributions to ITER.** The U.S. ITER Major Item of Equipment (MIE) project is in survival mode in FY 2008 because only $10.6M of the $160.0M requested was appropriated. Funds requested for FY 2009 will be used to resume the full range of U.S. participation in ITER. The focus will be on completing the ITER design, re-starting pre-fabrication R&D and initiating long-lead procurements for U.S. in-kind hardware, supporting the U.S. ITER Project Office, providing U.S. secondees to the international ITER Organization (IO), and providing 2008 and 2009 cash contributions to the IO per the terms of the ITER Joint Implementing Agreement. Some work planned originally for FY 2009 will be delayed into FY 2010 and beyond. (FY 2007=$60.0M; FY 2008=$10.6M; **FY 2009 =$214.5M**)
- **Operation and research on major facilities.** DIII-D, Alcator C-Mod, and NSTX will focus on key issues for ITER: confinement, stability, plasma boundary, and wave-plasma interaction. In addition, DIII-D will develop the physics basis for steady-state, high performance operation for next generation facilities; Alcator C-Mod will study operation with all metal walls; and NSTX will investigate operation with a liquid metal divertor plate and explore the unique physics of the spherical torus. (FY 2007=$112.5M; FY 2008=$125.6M; **FY 2009=$116.7M**)
- **Fabrication of the National Compact Stellarator Experiment.** Continues but is under review due to cost and schedule overruns arising from system complexity. Pending a final decision in FY2008, the budget assumes a rebaselining. (FY 2007=$15.8M; FY 2008=$15.9M; **FY 2009=$19.6M**)
- **Fusion Simulation Project (FSP).** Will take advantage of improvements in computational capabilities to develop a world leading predictive capability that can be applied to fusion plasmas. (FY 2007=$0M; FY 2008=$0M; **FY 2009=$2.0M**)
- **Other core research areas.** Theory and modeling, enabling technologies, diagnostics, experimental plasma research, high energy density physics, international research, and general plasma science, will continue to develop the knowledge base needed for an economically and environmentally attractive fusion energy source. (FY 2007=$123.4M; FY 2008=$134.4M; **FY 2009=$140.3M)**



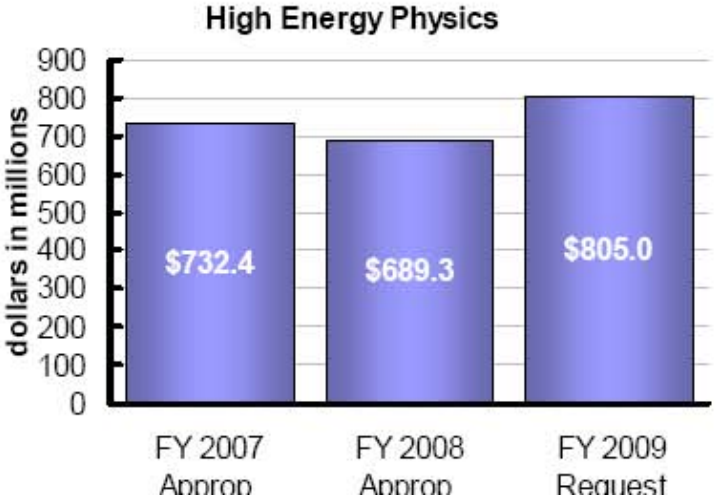
U.S. Department of Energy

Office of Science

High Energy Physics (HEP)

(FY 2009=$805.0M) **+17%**

- **Physics Research.** Core experimental and theoretical research at universities and laboratories are supported to carry out world-class programs, advancing scientific discovery at the Fermilab Tevatron and the CERN Large Hadron Collider (LHC) and with new initiatives in astrophysics and neutrino science. (FY 2007=$244.1M; FY 2008=$244.9M; **FY 2009=$254.8M**)
- **Facility Operations.** Fermilab Tevatron operations are fully supported (42 weeks) in its search for the Higgs Boson and funding is provided for the NOvA and Minerva projects; the B-Factory program was completed in FY 2008 and is supported for ramp-down and D&D activities; increased operational support is provided for U.S. researchers participating in the LHC at CERN. (FY 2007=$297.3M; FY 2008=$286.2M; **FY 2009=$320.1M**)
- **Non-Accelerator Projects.** Funding is provided for the Dark Energy Survey (DES), Reactor Neutrino Experiment (Daya Bay) and Cold Dark Matter Search (CDMS) Major Items of Equipment (MIEs) and R&D for a Joint Dark Energy Mission (JDEM). Each of these has the potential for shedding new information and insight on the mysteries of dark matter and energy. (FY 2007=$8.8M; FY 2008=$20.8M; **FY 2009=$32.2M**)
- **Advanced Technology Development.** Accelerator R&D efforts are directed at development of a proton source for a U.S. neutrino program; SRF technologies and infrastructure for the HEP program and the nation; demonstration of technologies for the ILC; and advanced accelerator concepts for next-generation accelerators. Detector R&D efforts are increased. (FY 2007=$166.9M; FY 2008=$102.8M; **FY 2009=$166.7M**)
- **Other.** Includes SBIR/STTR, stewardship responsibilities, and miscellaneous program activities. (FY 2007=$15.3M; FY 2008=$34.6M; **FY 2009=$31.2M**)



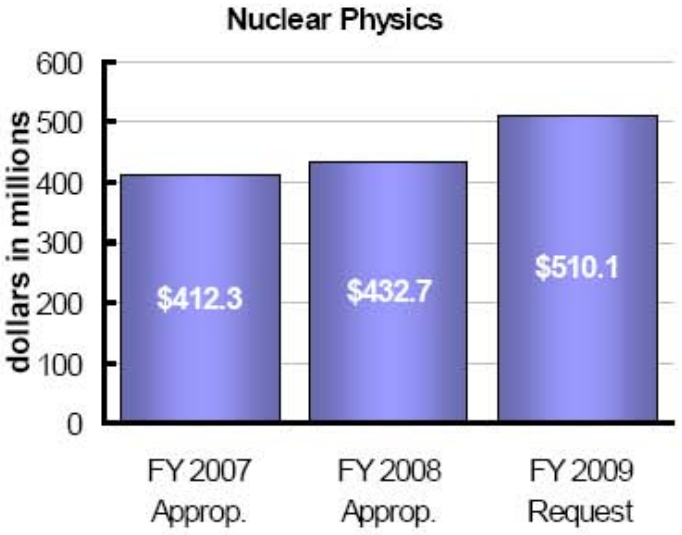
U.S. Department of Energy

Office of Science

Nuclear Physics (NP)

(FY 2009=$510.1M) **+18%**

- **Core research programs.** University and laboratory researchers will extract results from studies of hot, dense nuclear matter, the quark structure of matter, nuclear structure & astrophysics, fundamental interactions, and neutrinos. Support is provided for the program's six university centers of excellence. Support is increased for research that is relevant to the implementation of advanced fuel cycles in nuclear reactors. (FY 2007=$136.0M; FY 2008=$139.5M; **FY 2009=$159.5M**)
- **Facility Operations.** The program's four National User Facilities (RHIC, CEBAF, ATLAS and HRIBF) are operated at near optimum levels. The Electron Beam Ion Source (EBIS) being fabricated at RHIC will lead to more cost-effective operations. (FY 2007=$237.6M; FY 2008=$237.1M; **FY2 009=$257.8M**)
- **Advanced Instrumentation.** Detector upgrades at RHIC and for the heavy-ion program at LHC, the GRETINA detector for nuclear structure studies, a double-beta decay experiment (CUORE) to measure the neutrino mass, and a detector and beamline at the SNS for measurements of fundamental neutron properties. (FY 2007=$13.1M; FY 2008=$14.6M; **FY 2009=$17.2M**)
- **12 GeV CEBAF Upgrade Project.** Construction is initiated for the upgrade of the beam energy and research capabilities of CEBAF. (FY 2007=$9.5M; FY 2008=$14.4M; **FY 2009=$28.6M**)
- **Facility for Rare Isotope Beams.** Conceptual design and R&D is initiated for a next generation facility in nuclear structure and astrophysics. (FY 2007=$0; FY 2008=$0; **FY 2009=$7M**)
- **Accelerator R&D.** Accelerator R&D, including superconducting radio-frequency developments at TJNAF and electron cooling at RHIC are supported. (FY 2007=$6.8M; FY 2008=$7.3M; **FY 2009=$3.7M**)
- **Isotope Production.** The Isotope Production and Applications subprogram, transferred to the Nuclear Physics program in FY 2009, will support the R&D and production of stable and radioactive isotopes. (FY 2007=$0; FY 2008=$0; **FY 2009=$19.8M**)
- **Other.** Includes SBIR/STTR, laboratory infrastructure. (FY 2007=$9.3M; FY2008=$19.8M; **FY 2009=$16.5M**)



Summary

"Transforming the way we generate, supply, transmit, store, and use energy will be one of the defining challenges for America and the globe in the 21st century. At its heart, the challenge is a scientific one. Fortunately, American science today is entering on a new era of discovery, equipped with a powerful new generation of tools for penetrating, understanding, and manipulating matter on the atomic and molecular scales. These new capabilities have profound implications for our ability to harvest new sources of energy and to utilize the energy we have with decisively greater efficiency. The key is to mobilize the talents and creativity of our national scientific workforce in a focused nationwide effort to meet our energy challenges."

-- EFRC Initiative