DOE's Office of Science

Welcome WDTS 2014 Summer Term Participant Webinar

July 24, 2014

Some perspectives on WDTS internship programs, and a brief overview on the DOE, some of its history, with an emphasis on the Office of Science's mission, facilities, and programs.

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***Office of the Deputy Director for Science Programs*
Office of Science, U.S. Department of Energy

Why does the Office of Science (SC) sponsor internships?

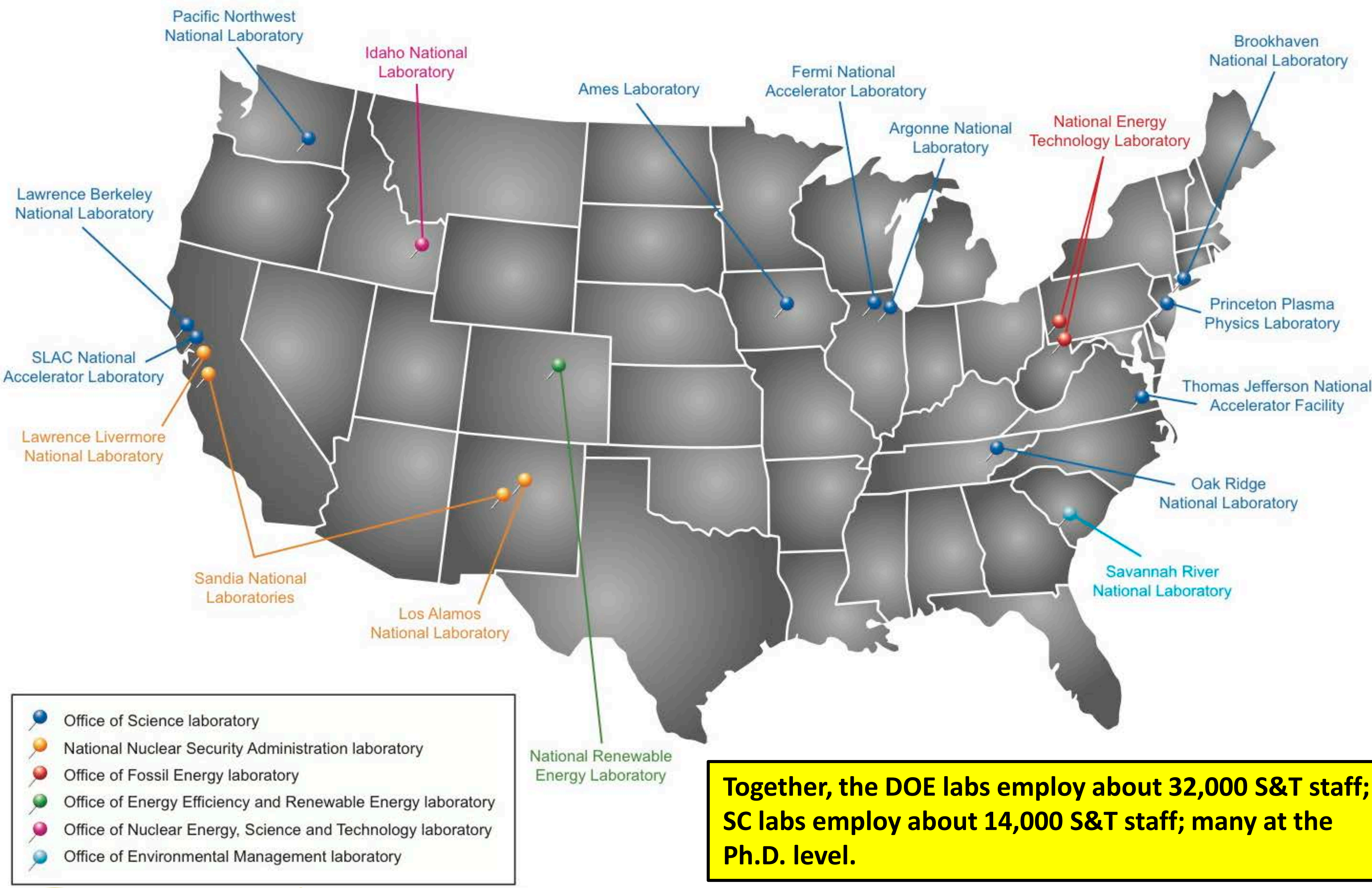
In a word… **WORKFORCE**

The Workforce Development for Teachers and Scientists (WDTS) program mission is to ensure that DOE has a sustained pipeline of science, technology, engineering, and mathematics (STEM) workers. This is accomplished, in part, through support of undergraduate internships and visiting faculty programs at the DOE laboratories, graduate student thesis research opportunities at DOE laboratories, all administered by WDTS for DOE; and Nation-wide, middle- and high-school science competitions that annually culminate in the National Science Bowl® in Washington D.C. These investments help develop the next generation of scientists and engineers required to execute the DOE mission, administer its programs, and conduct its research.

WDTS activities rely significantly on DOE’s 17 laboratories, which employ more than 30,000 workers with STEM backgrounds. The DOE laboratory system provides access to leading scientists; world-class scientific user facilities and instrumentation; and large-scale, multidisciplinary research programs unavailable in universities or industry. WDTS leverages these assets to develop and train post-secondary students and educators to enhance the DOE mission.

SC sponsors and operates these programs to help sustain the DOE’s scientific and technical workforce pipeline.

DOE Labs Employ >30,000 Scientists and Engineers



Together, the DOE labs employ about 32,000 S&T staff; SC labs employ about 14,000 S&T staff; many at the Ph.D. level.

DOE and its Predecessors
… and the Formation of the DOE Laboratories

- 1942-1946 Manhattan Project, War Department Army Corps of Engineers
  - Wartime weapons development
  - Foundations of first DOE multi-purpose labs

- 1946-1974 Atomic Energy Commission created by the 1946 Atomic Energy Act (P.L. 79-585)
  - Research in basic nuclear processes, nuclear reactor technologies, use of nuclear materials for variety of purposes
  - Establishment of 9 of the 10 DOE/SC labs

- 1974-1977 Energy Research and Development Administration, a new energy R&D agency motivated by Arab oil embargo and created by (P.L. 93-438)
  - Research expands to include solar, fossil, geothermal, synthetic fuels, transmission, conservation, etc.

- 1977-present Department of Energy (P.L. 95-91)
  - Separation of management oversight of weapons and non-weapons labs and separation of basic and applied research
  - DOE/SC labs undergo transition to “open” labs with 1000s of visitors/users annually

Mission is central to the development of the DOE lab complex

SC Workforce Programs

Managed by SC's Office of Workforce Development for Teachers and Scientists (WDTS)

Mission: WDTS program mission is to ensure that DOE has a sustained pipeline of highly skilled and diverse science, technology, engineering, and mathematics (STEM) workers.

Vision: To be the standard for workforce development programs in a mission agency where "Science and Technology lie at the heart of the mission."

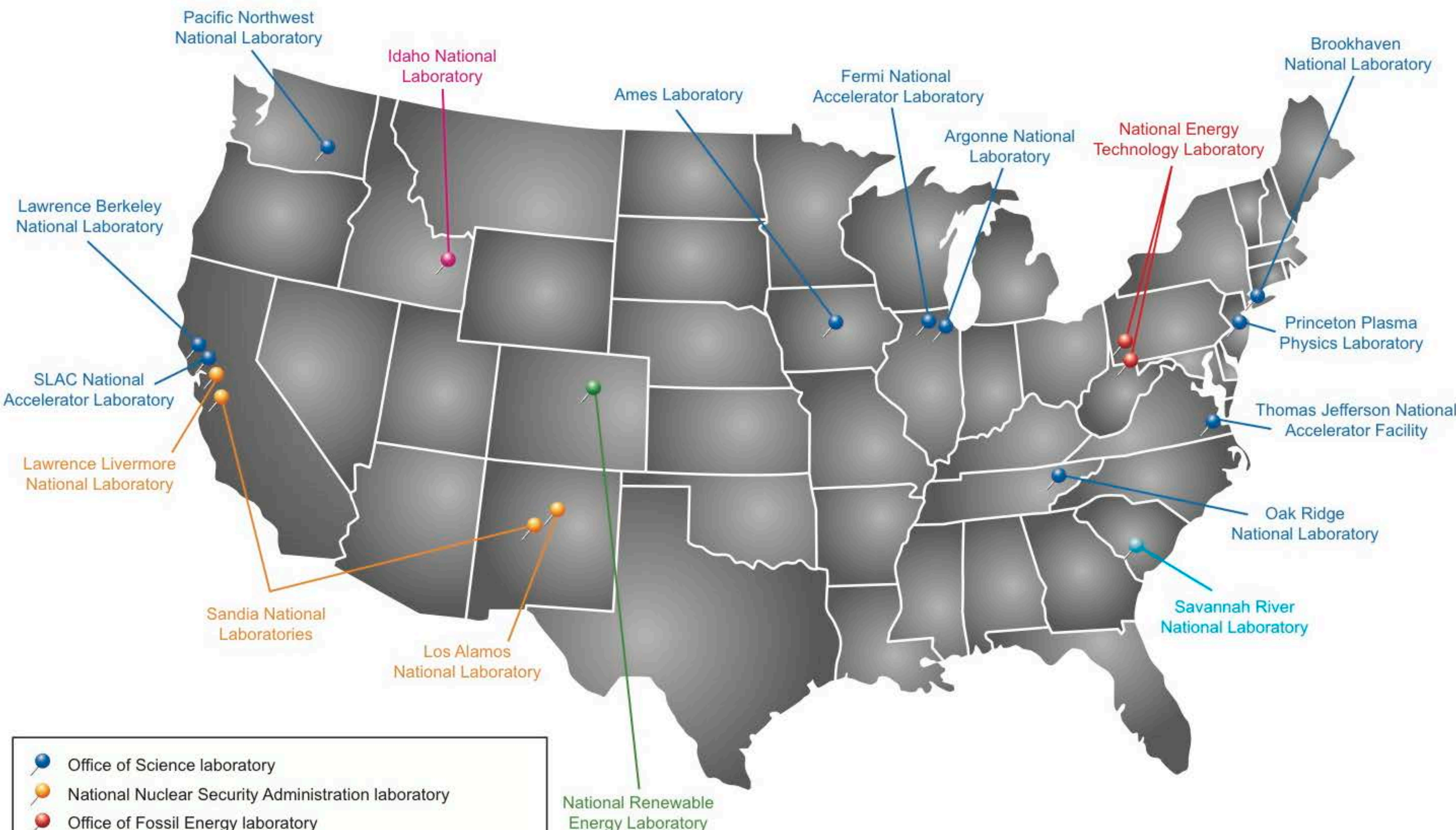
Current WDTS programs:

- At the DOE laboratories: Undergraduate student intern programs (one for 2/4-yr institutions and one for community colleges) and a visiting faculty program:
  - Science Undergraduate Laboratory Internship (SULI) - ~700/year
  - Community College Internship (CCI) - ~70/year
  - Visiting Faculty Program (VFP) - ~(50/25)/year
- Also at the DOE laboratories:
  - Office of Science Graduate Student Research Program
- Albert Einstein Distinguished Educator Fellowship
- National Science Bowl®

Who, When, What, How much?

- 10 weeks (Summer Term) or 16 weeks (Semester Term) at a DOE host Laboratory engaged in a *research project* under the guidance of a laboratory scientist or engineer (Applications to the 2015 SULI Spring Term open on July 29, 2014).
- CCI participants work on a *technical project* (10-week Summer Term only) under the guidance of a laboratory scientist or engineer.
- Enrichment activities including career professional development workshops, writing and presentation skills development activities, laboratory tours, scientific lectures and seminars, *etc.*
  - *working side-by-side, you gain first-hand experience with our lab personnel, you participate in their research activities, hopefully learning valuable out-of-classroom professional skills, and heightening your interest to continue in STEM studies and pursue related careers (perhaps at a DOE lab)*
- Obligations/Deliverables include pre- and post- participation questionnaires, presentation of results, a written report (SULI and CCI have different specific requirement), *etc.*
  - *this is hard work with formalized/normalized requirements well beyond that of typical research experience opportunities*
  - *questionnaires inform us regarding what works and what does not (we do want to know)*
- Paid internship: stipend of $500 per week; one round trip domestic travel to the host laboratory; housing options that vary with host laboratory.
- There are approximately 650 2014 Summer Term participants.

Where are undergraduate interns currently placed?



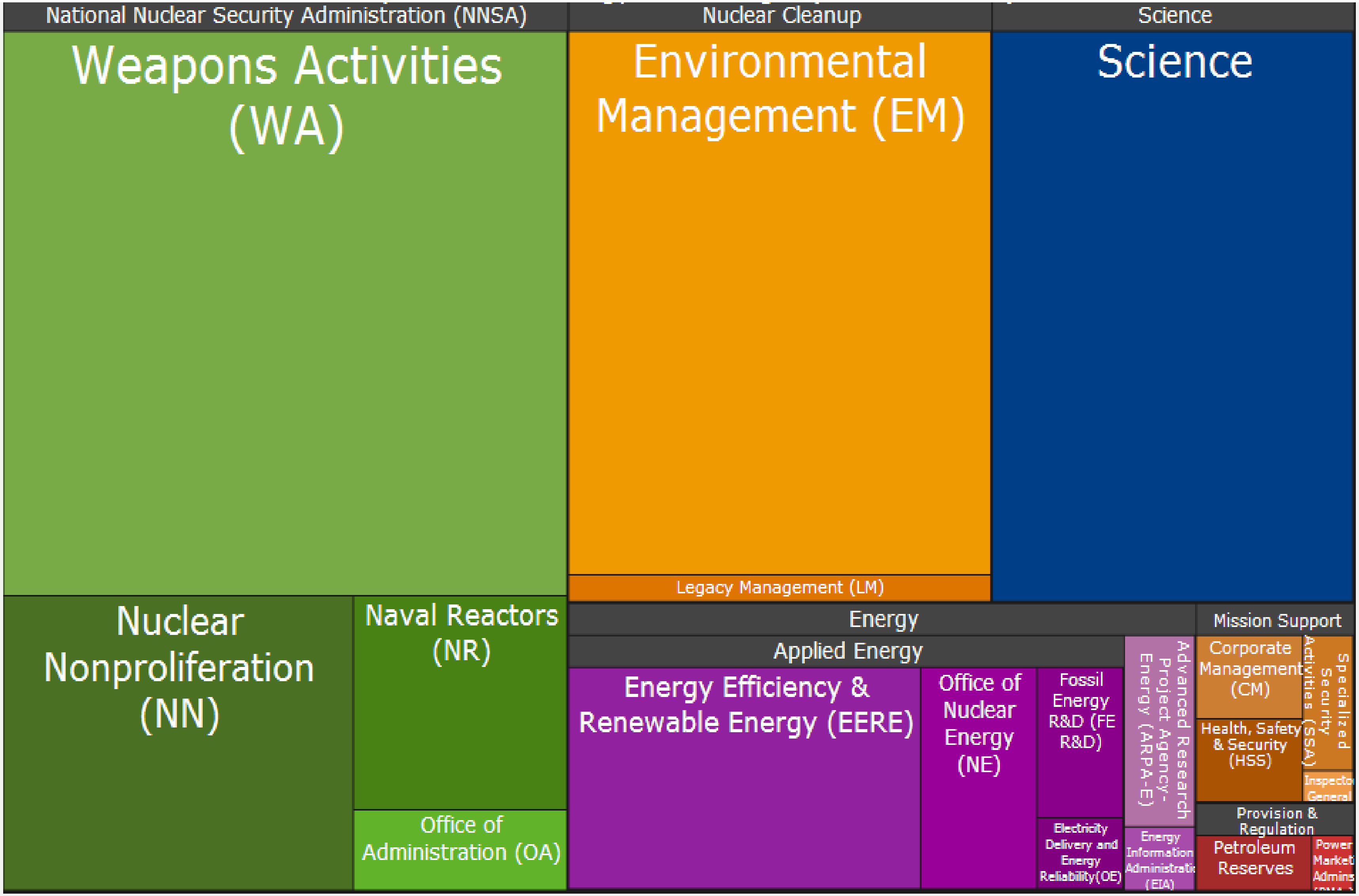
- Office of Science laboratory
- National Nuclear Security Administration laboratory
- Office of Fossil Energy laboratory
- Office of Energy Efficiency and Renewable Energy laboratory
- Office of Nuclear Energy, Science and Technology laboratory
- Office of Environmental Management laboratory

@ 16/17 DOE Laboratories

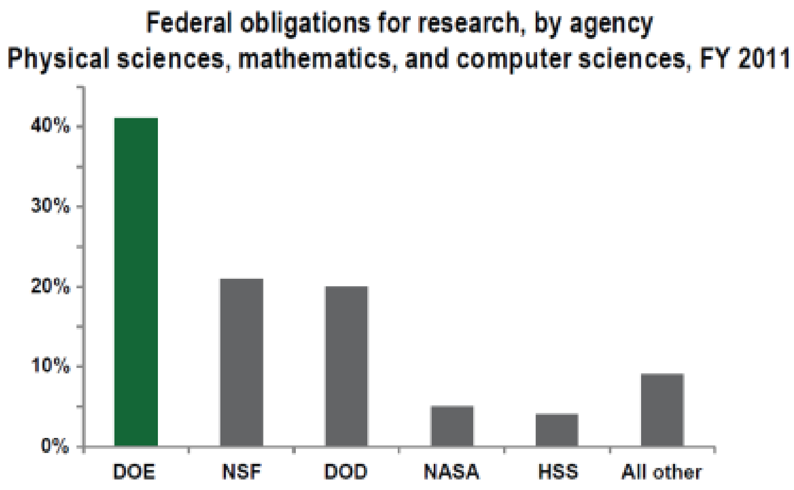
Major Federal R&D Agencies

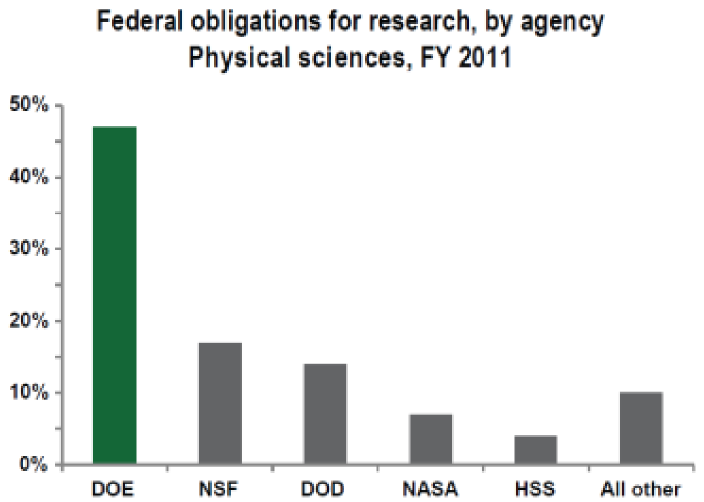
The DOE Portfolio

Area map of the FY 2013 budget request to Congress ($27.2B)



SC is the Largest Federal Supporter of Basic Research in the Physical Sciences

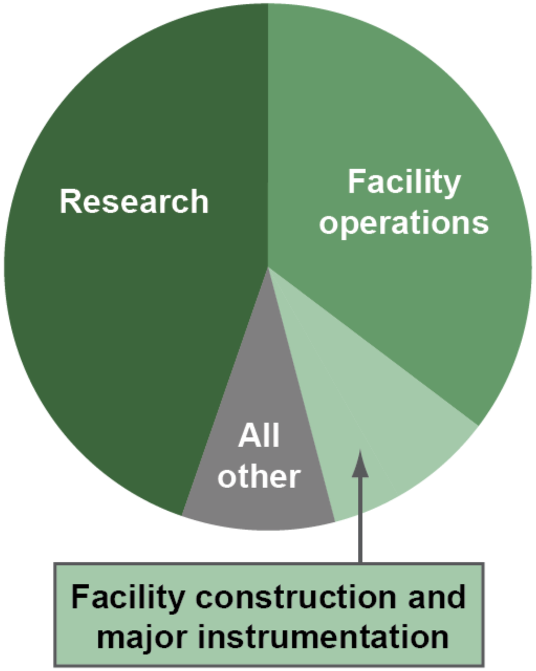


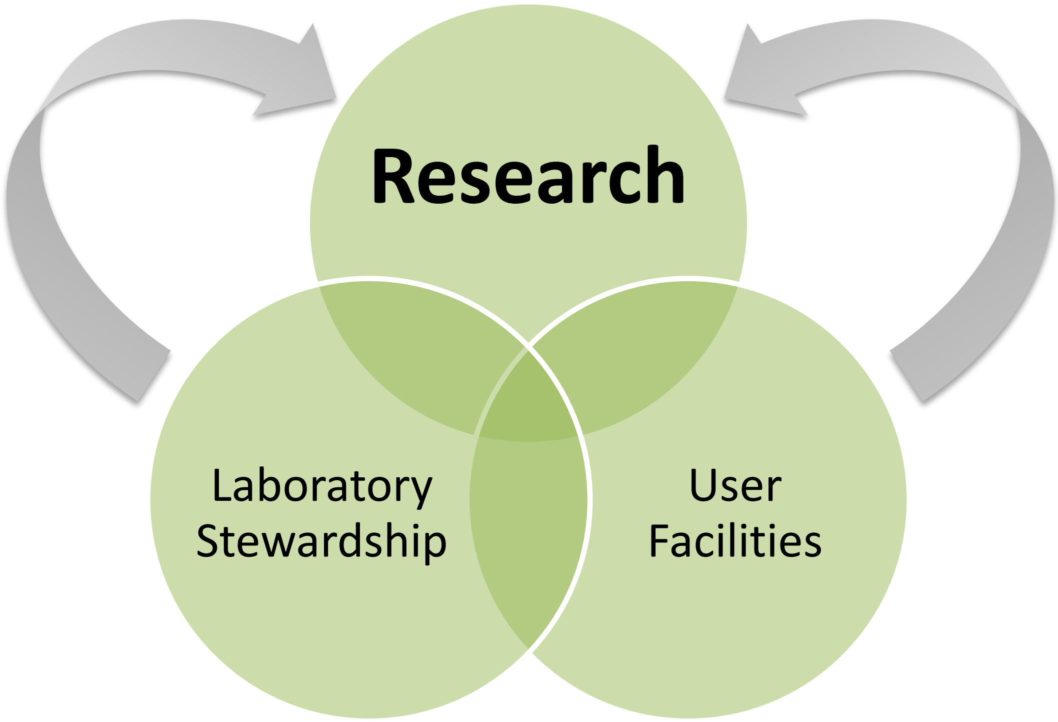


(NSF data tables on Federal Funds for Research and Development - Fiscal Year 2011.)

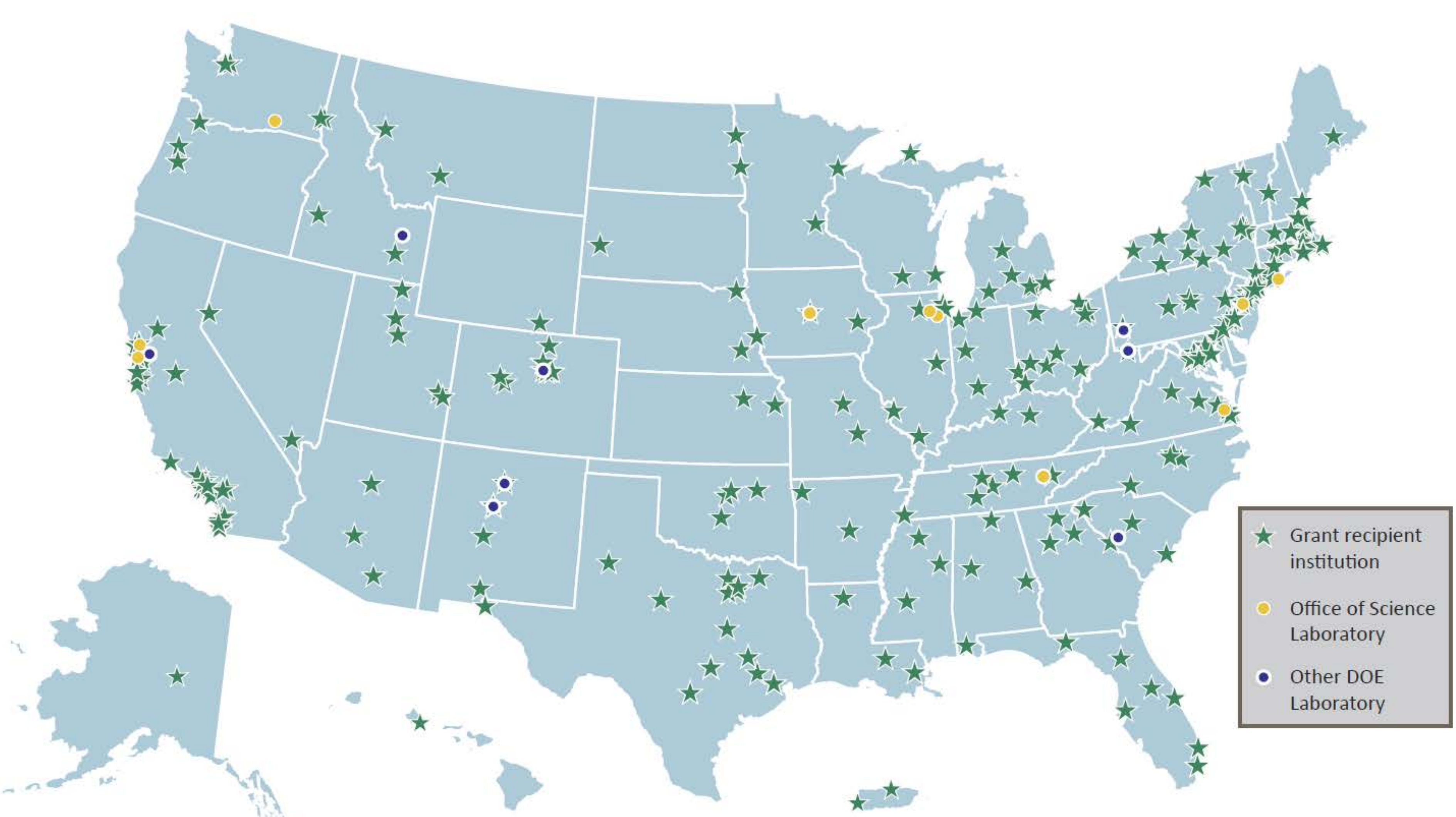
Delivering science to advance DOE's mission

FY 2012 appropriations
$4.9 billion





FY 2011 Funding Recipient Institutions



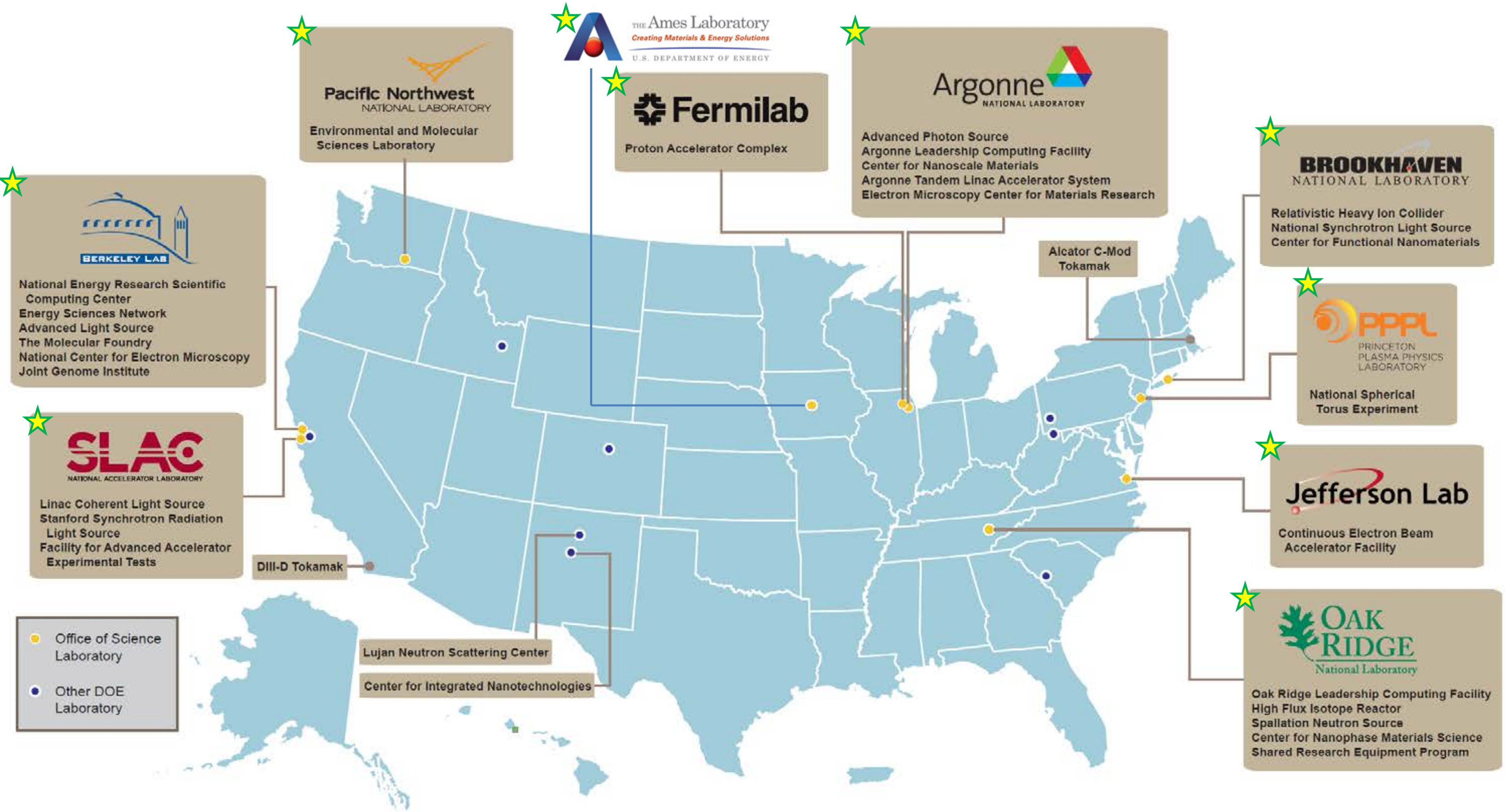
All 50 states, Puerto Rico, and D.C.

The DOE Office of Science (~$5B/year)

The undulator hall at the
Linac Coherent Light Source (LCLS) , SLAC,
2011.

- Funds 25,000 Ph.D. scientists, graduate students, undergraduates, engineers, and technical staff supported at more than 300 institutions in all 50 States and DC through competitive awards
- 31 national user facilities serving more than 29,000 users each year
- 100 Nobel Prizes during the past 6 decades—more than 20 in the past 10 years

Where the user facilities are: DOE Laboratories (mostly)



★ SC is the steward of these ten DOE laboratories

The DOE/SC Labs

Berkeley Lab

Berkeley, California
202 acres and 106 buildings
3,400 FTEs
1,084 students & postdocs
8,579 facility users
www.lbl.gov

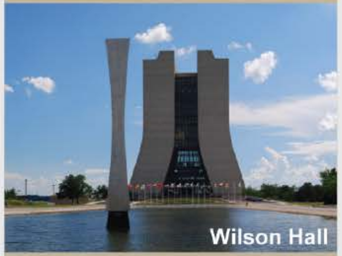
Pacific Northwest National Laboratory

Richland, Washington
600 acres and 101 buildings
4,180 FTEs
567 students & postdocs
2,414 facility users
www.pnnl.gov

The Ames Laboratory

Ames, Iowa
10 acres and 12 buildings
315 FTEs
210 students & postdocs
www.ameslab.gov

Fermilab


Wilson Hall

Batavia, Illinois
6,800 acres and 356 buildings
1,914 FTEs
1,090 students & postdocs
2,317 facility users
www.fnal.gov

Argonne National Laboratory


Advanced Photon Source

Argonne, Illinois
1,500 acres and 99 buildings
3,375 FTEs
1,147 students & postdocs
4,289 facility users
www.anl.gov

SLAC National Accelerator Laboratory

Menlo Park, California
426 acres and 142 buildings
1,681 FTEs
300 students & postdocs
3,384 facility users
www.slac.stanford.edu

Oak Ridge National Laboratory


Spallation Neutron Source

Oak Ridge, Tennessee
4,470 acres and 252 buildings
4,533 FTEs
1,753 students & postdocs
3,116 facility users
www.ornl.gov

Jefferson Lab

Newport News, Virginia
169 acres and 63 buildings
769 FTEs
74 students & postdocs
1,376 facility users
www.jlab.org

PPPL — Princeton Plasma Physics Laboratory


NSTX Spherical Tokamak

Princeton, New Jersey
89 acres and 34 buildings
428 FTEs
66 students & postdocs
145 facility users
www.pppl.gov

Brookhaven National Laboratory


Relativistic Heavy Ion Collider

Upton, New York
5,320 acres and 331 buildings
2,990 FTEs
593 students & postdocs
4,253 facility users
www.bnl.gov

Laboratory statistics reflect FY 2011 status. Grant recipient institutions based on FY 2011 awards.

Office of Science User Facilities

31 world-leading facilities serving over 29,000 researchers annually

- **supercomputers,**
- **high intensity x-ray, neutron, and electron sources,**
- **nanoscience facilities,**
- **genomic sequencing facilities,**
- **particle accelerators,**
- **fusion/plasma physics facilities, and**
- **atmospheric monitoring capabilities.**

- Open access; allocation determined through peer review of proposals

- Free for non-proprietary work published in the open literature

- Full cost recovery for proprietary work

Recent DOE/SC Nobel Prize winning work …
(many associated with SC user facilities)

Year	Prize	Name	Home Institution(s)	DOE-SC Affiliation
2013	Chemistry	Martin Karplus Nobel Lecture	Universite dé Strasbourg; Harvard University	•National Energy Research Scientific Computing Center (NERSC)
2013	Chemistry	Michael Levitt Nobel Lecture	Stanford University School of Medicine	•Biological and Environmental Research
2012	Chemistry	Brian K. Kobilka Nobel Lecture	Stanford University School of Medicine	•Argonne National Laboratory
2011	Physics	Saul Perlmutter Nobel Lecture	University of California, Berkeley	•Lawrence Berkeley National Laboratory •High Energy Physics
2009	Chemistry	Venkatraman Ramakrishnan Nobel Lecture	MRC Laboratory of Molecular Biology	•Brookhaven National Laboratory •Basic Energy Sciences
2009	Chemistry	Thomas A. Steitz Nobel Lecture	Howard Hughes Medical Institute; Yale University	•Brookhaven National Laboratory •Basic Energy Sciences
2009	Chemistry	Ada E. Yonath Nobel Lecture	Weizman Institute of Science, Israel	•Argonne National Laboratory •Basic Energy Sciences

Recent DOE/SC Nobel Prize winning work (cont.)…
(many associated with SC user facilities)

2008	Chemistry	Roger Y. Tsien Nobel Lecture	University of California, San Diego	•Brookhaven National Laboratory •Biological and Environmental Research
2008	Physics	Yoichiro Nambu Nobel Lecture	Enrico Fermi Institute; University of Chicago	
2007	Physics	Peter Grünberg Nobel Lecture	Forschungszentrum Jülich	•Argonne National Laboratory
2006	Chemistry	Roger D. Kornberg Nobel Lecture	Stanford University	•Stanford Linear Accelerator Center
2006	Physics	John C. Mather Nobel Lecture	Goddard Space Flight Center (NASA)	•Lawrence Berkeley National Laboratory •High Energy Physics
2006	Physics	George F. Smoot Nobel Lecture	University of California, Berkeley	•Lawrence Berkeley National Laboratory •High Energy Physics
2005	Chemistry	Robert H. Grubbs Nobel Lecture	California Institute of Technology	•Basic Energy Sciences
2005	Chemistry	Richard R. Schrock Nobel Lecture	Massachusetts Institute of Technology	•Basic Energy Sciences

Recent DOE/SC Nobel Prize winning work (cont.)...

(many associated with SC user facilities)

2004	Physics	David J. Gross Nobel Lecture	Princeton University; University of California, Santa Barbara	•Fermi National Laboratory •Lawrence Berkeley National Laboratory •High Energy Physics
2004	Physics	H. David Politzer Nobel Lecture	California Institute of Technology	•High Energy Physics
2004	Physics	Frank Wilczek Nobel Lecture	Massachusetts Institute of Technology	•High Energy Physics
2003	Chemistry	Peter Agre Nobel Lecture	Johns Hopkins University	•Lawrence Berkeley National Laboratory •Biological and Environmental Research
2003	Chemistry	Roderick MacKinnon Nobel Lecture	Rockefeller University	•Brookhaven National Laboratory
2003	Physics	Alexei A. Abrikosov Nobel Lecture	Institute for Physical Problems	•Argonne National Laboratory
2003	Physiology or Medicine	Sir Peter Mansfield Nobel Lecture	University of Nottingham	•Basic Energy Sciences

… to recent Fortune 500 users

SC Builds (big) Stuff!

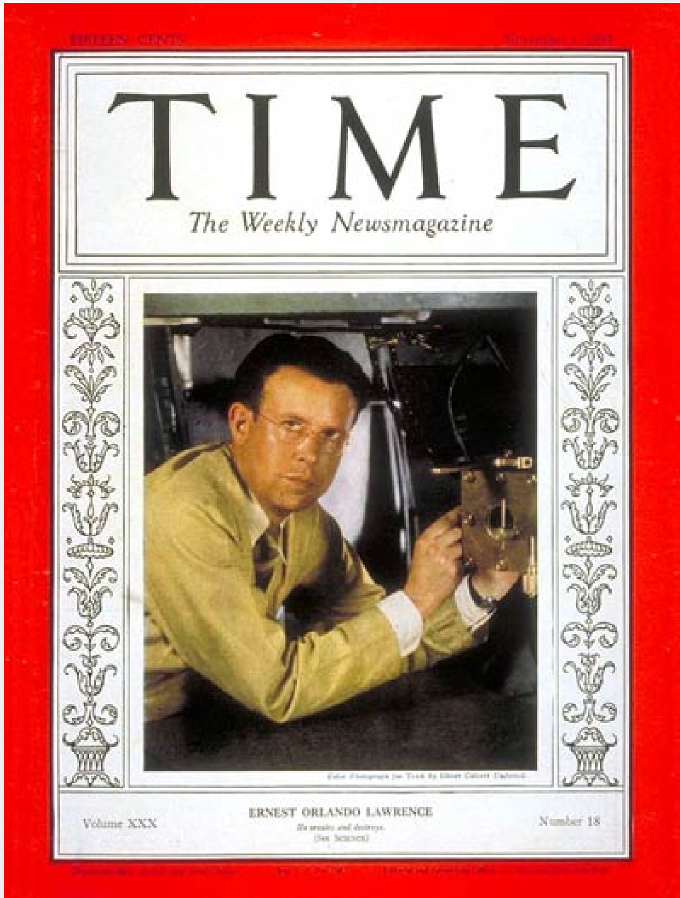
SC has completed ~40 projects each of total cost greater than $10 million in the last ten years. **90% of these projects were delivered on time and on budget** with cumulative cost growth across all projects held below 5%.

A culture of project management

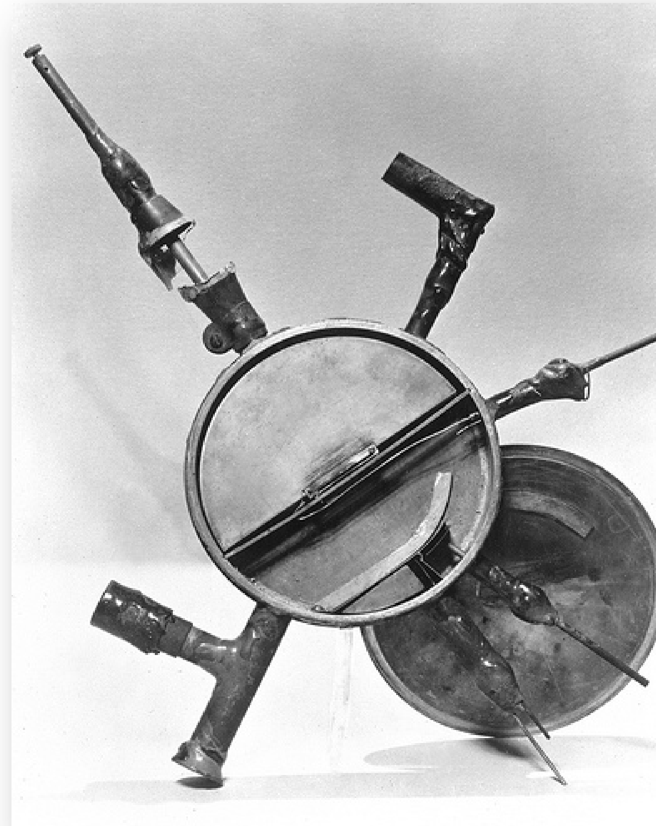
An Historical Detour: Big Science and the Office of Science

- Big science was born at the labs after World War II, on the heels of the Manhattan Project.
- Over time, big science begat the large suite of Office of Science user facilities.
- These facilities transformed the nature of the labs, and they define the Office of Science today.

Origins of Accelerator Science in (the Earliest Predecessor of) the Office of Science



Ernest O. Lawrence
November 1, 1937 (Nobel Prize 75 years ago)

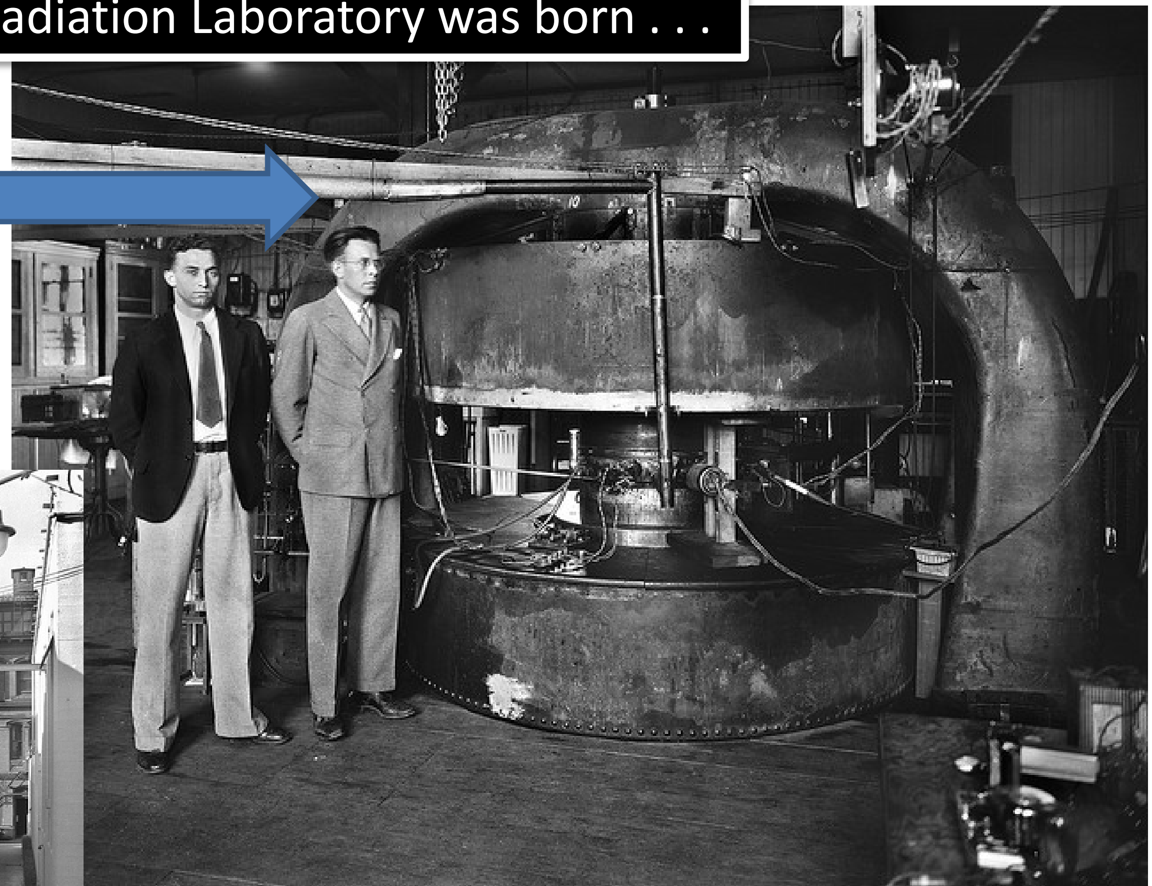


Lawrence's original
5-inch cyclotron, 80 keV, 1931

Lawrence’s Pursuit of Bigger and Bigger and Bigger Machines

Later that year the Berkeley Radiation Laboratory was born . . .

Surplus **80 ton** magnet from the Federal Telegraph Company

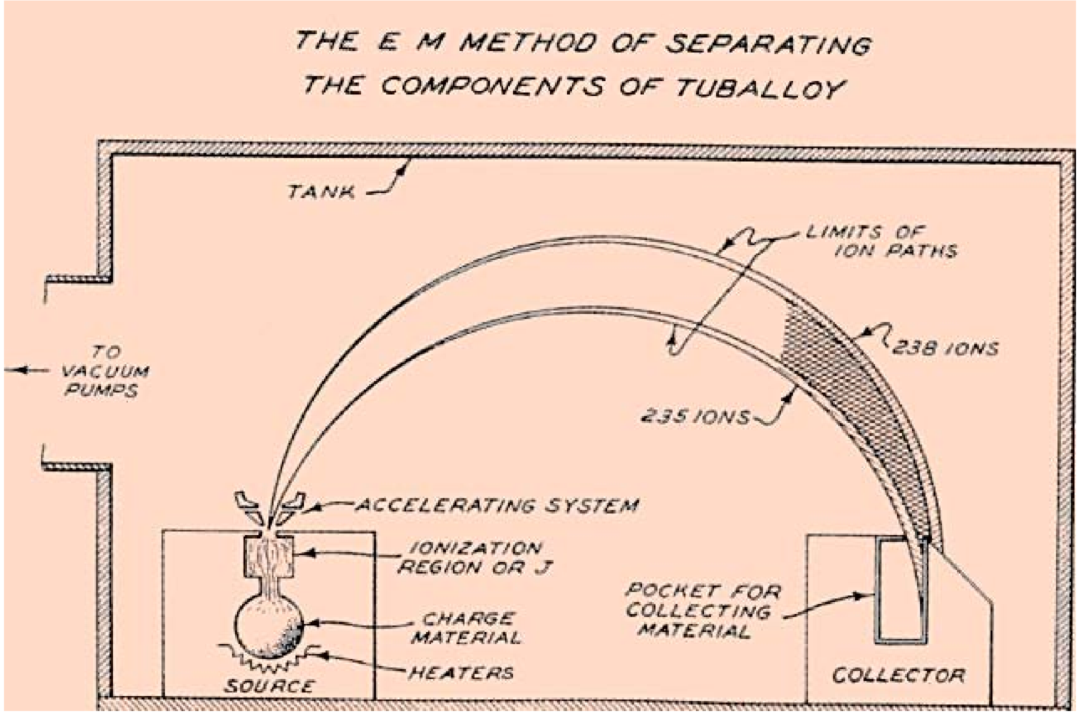


27-inch cyclotron, 3.6 MeV, 1932

During the decade, Rad Lab staff grew from 5 to 60

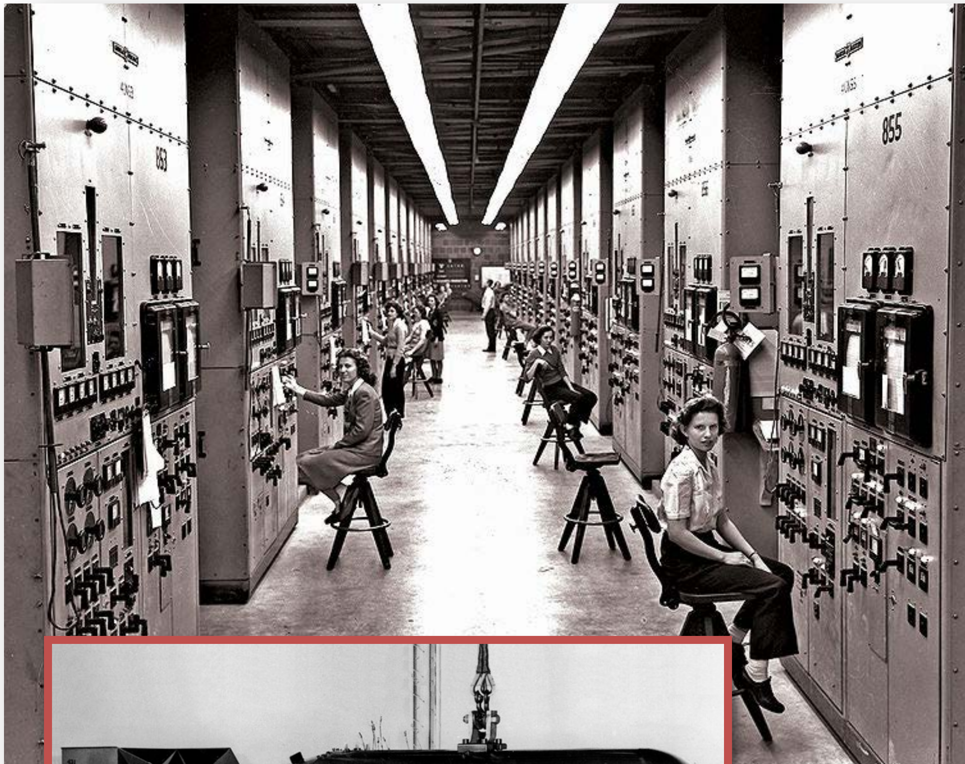
Accelerators and the Manhattan Project

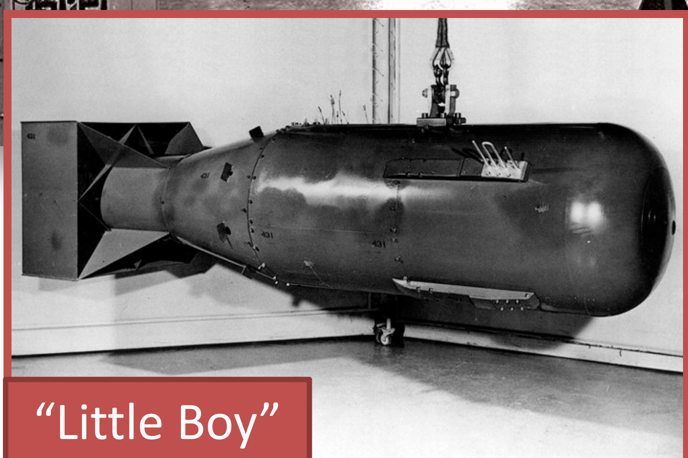
Challenge: uranium isotope separation



Lawrence advanced accelerators as mass separators through modification of the 37-inch cyclotron; he named the new configuration . . . the "**calutron**" (California University Cyclotron).

From Prototype to (Big Time) Reality

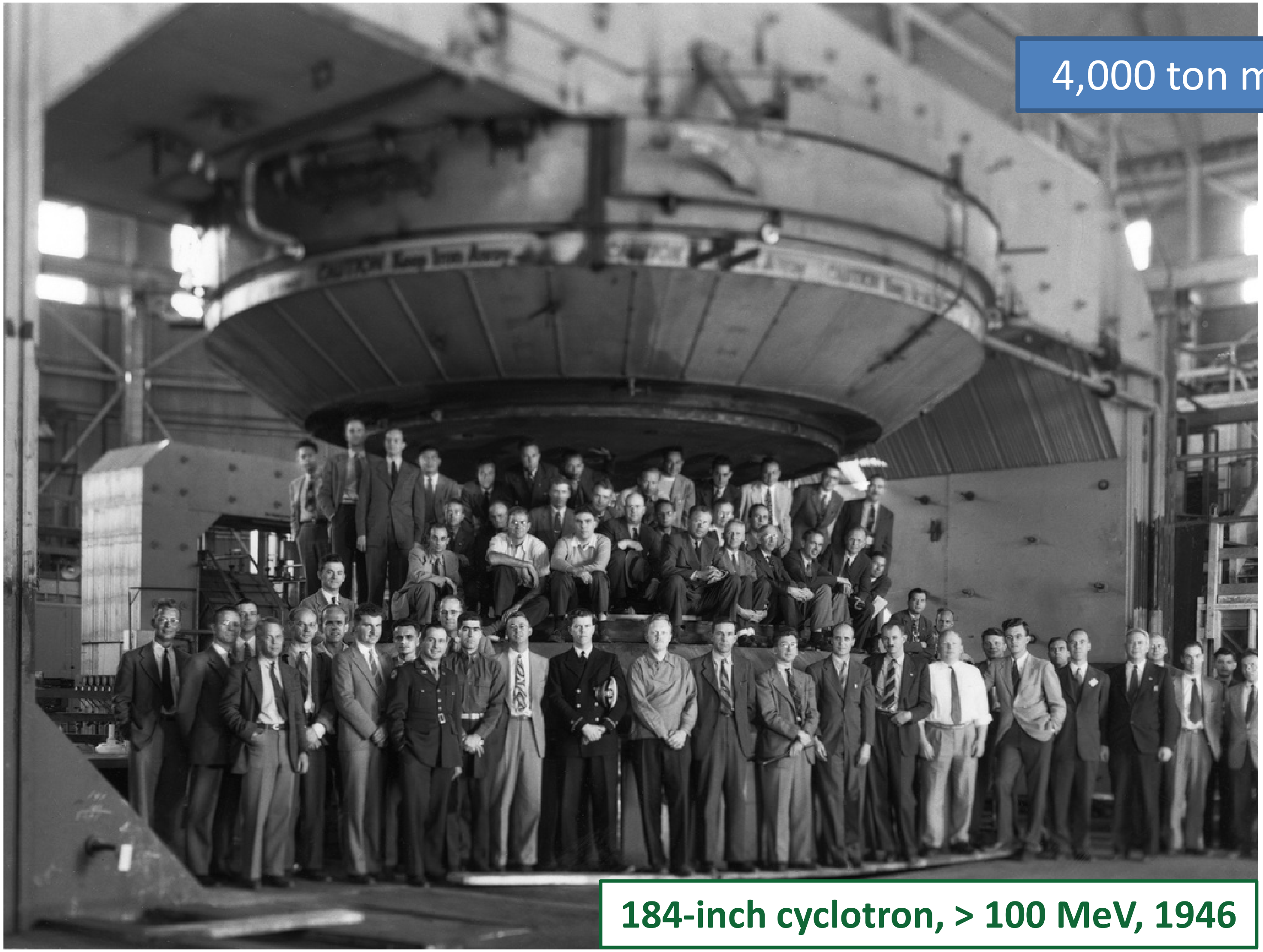




"Little Boy"

Lawrence's calutrons were built at industrial scale at the Oak Ridge Y-12 complex to yield usable quantities of uranium 235.

After several intermediate sizes came the 184-inch cyclotron …



4,000 ton magnet

184-inch cyclotron, > 100 MeV, 1946

… housed in its own designer building at LBNL , *circa* 1941

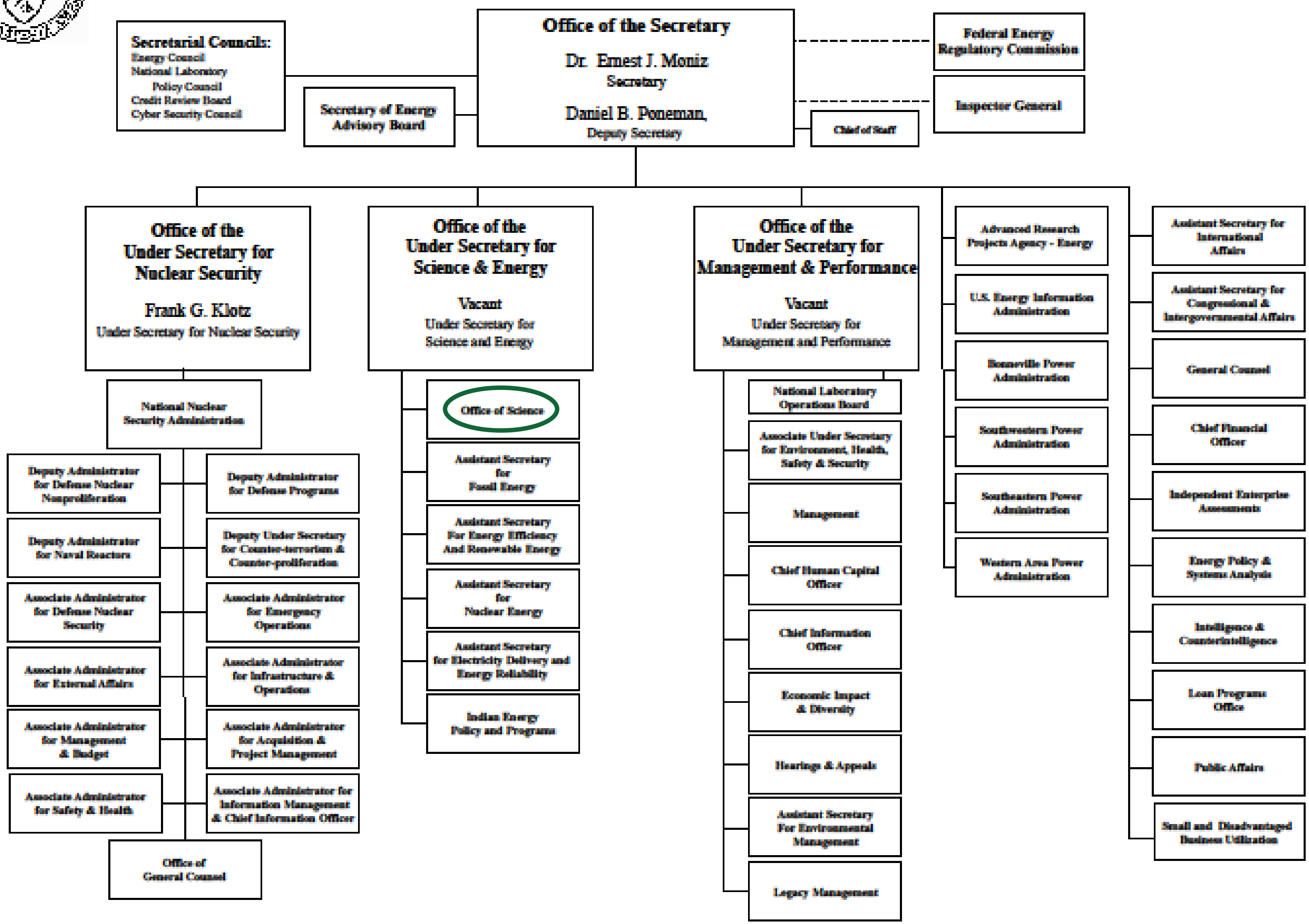
U.S. DEPARTMENT OF ENERGY | Office of Science

This building was later expanded to house the Advanced Light Source, a current SC User Facility

Big Science at the 10 DOE/SC labs in their Earliest Days

1931	**LBNL**	**E.O. Lawrence and the cyclotron at the "Rad Lab"**
1943	**ORNL**	**Nuclear reactor technology**
1946	**ANL**	**Nuclear reactor technology**
1947	**AMES**	**High-purity uranium production; heavy-element chemistry**
1947	**BNL**	**Construction/operation of large facilities for NE universities**
1951	**PPPL**	**Magnetic fusion research**
1962	**SLAC**	**(Electron) accelerator technology; particle physics research, LINAC remains in use for Linac Coherent Light Source (LCLS, an X-ray FEL)**
1965	**PNNL**	**Independent R&D associated with the Hanford site**
1967	**FNAL**	**(Proton) accelerator technology; particle physics research**
1984	**TJNAF**	**(Electron) accelerator technology; nuclear physics research**

DEPARTMENT OF ENERGY



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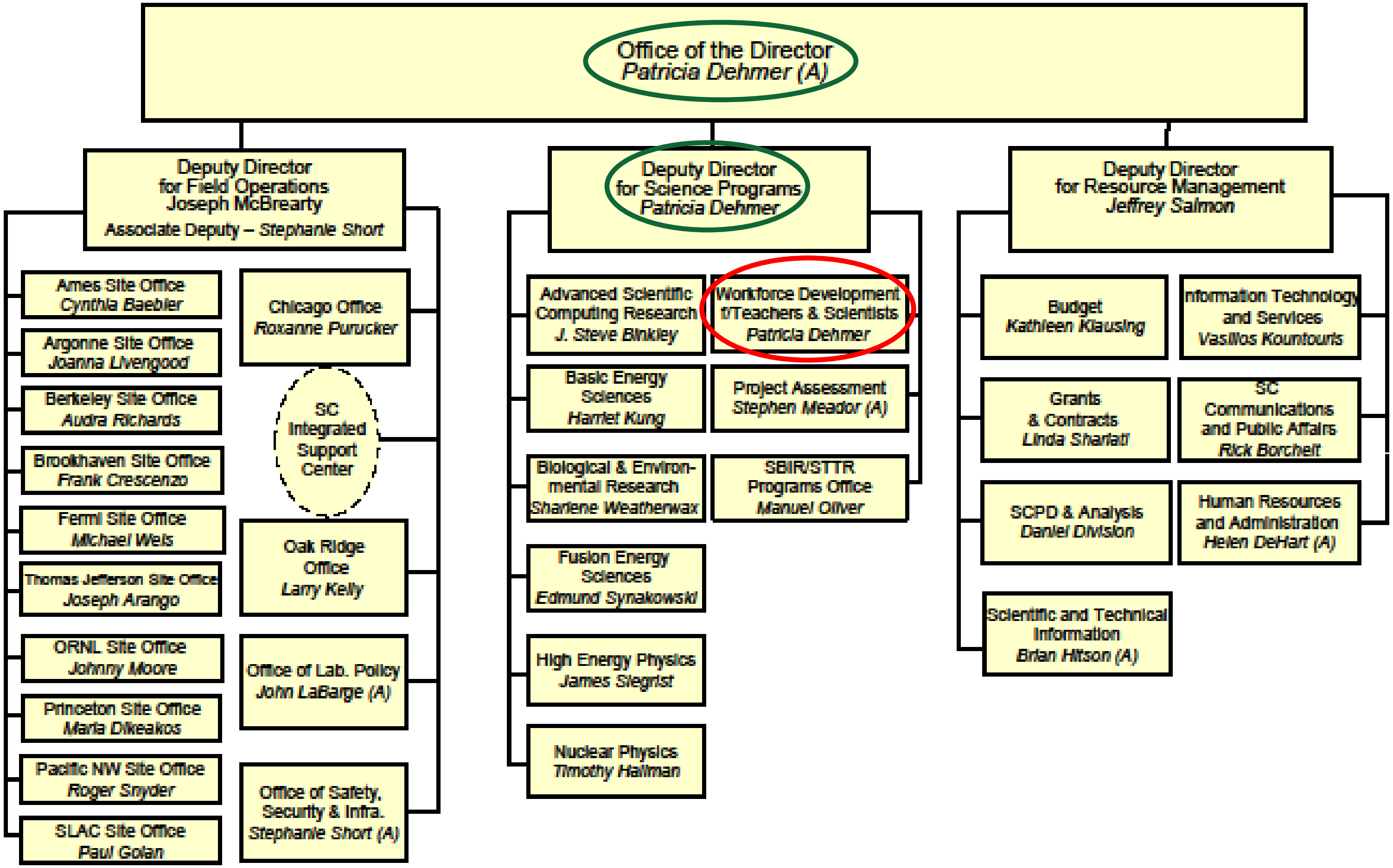


Updated 07/08/14

Challenges for the Office of Science

Energy
Leading Basic Research
for a Sustainable Future

Environment
Understanding Climate Change and
Improving the Environment

Innovation
Building Research Infrastructure and
Partnerships that Foster Innovation

Discovery
Unraveling Nature's
Deepest Mysteries

The Office of Science Research Portfolio

Advanced Scientific Computing Research	• Delivering world leading computational and networking capabilities to extend the frontiers of science and technology
Basic Energy Sciences	• Understanding, predicting, and ultimately controlling matter and energy flow at the electronic, atomic, and molecular levels
Biological and Environmental Research	• Understanding complex biological, climatic, and environmental systems
Fusion Energy Sciences	• Building the scientific foundations for a fusion energy source
High Energy Physics	• Understanding how the universe works at its most fundamental level
Nuclear Physics	• Discovering, exploring, and understanding all forms of nuclear matter

Advanced Scientific Computing Research

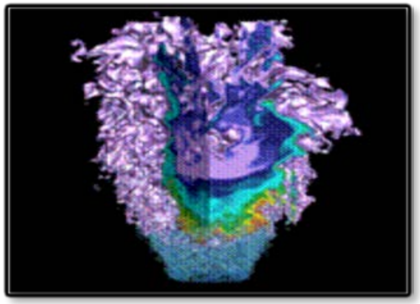
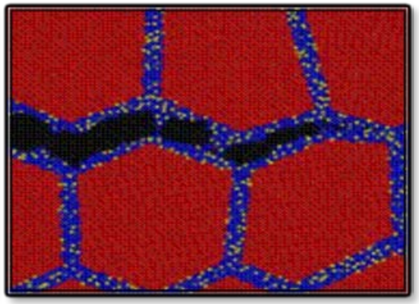
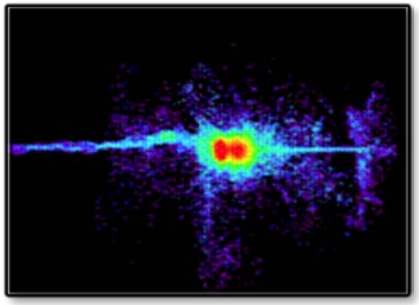
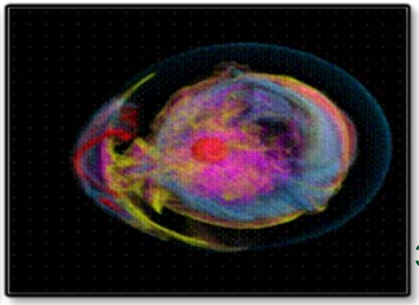
Delivering world leading computational and networking capabilities to extend the frontiers of science and technology

The Scientific Challenges:

- Deliver next-generation scientific and energy applications on multi-petaflop computers.
- Discover, develop and deploy exascale computing and networking capabilities.
- Partner with U.S. industry to develop the next generation computing hardware and tools for science.
- Discover new applied mathematics, computer science, and networking tools for the ultra-low power, multicore-computing future and data-intensive science.
- Provide technological innovations for U.S. leadership in Information Technology to advance competitiveness.

FY 2013 Highlights:

- Co-design centers to deliver next generation scientific applications.
- Investments with U.S. industry to address critical challenges on the path to exascale.
- Operation of a 10 petaflop low-power IBM Blue Gene/Q at the Argonne Leadership Computing Facility and installation and early science access to a hybrid, multi-core computer at the Oak Ridge Leadership Computing Facility.
- Research efforts across the portfolio in support of data-intensive science including the massive data produced by Scientific User Facilities.

Basic Energy Sciences

Understanding, predicting, and ultimately controlling matter and energy flow at the electronic, atomic, and molecular levels

The Program:

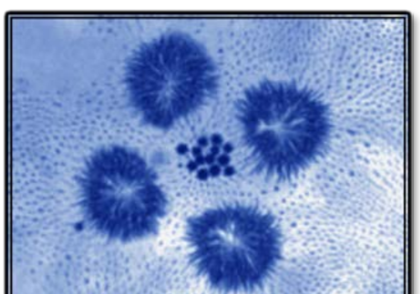
Materials sciences & engineering—exploring macroscopic and microscopic material behaviors and their connections to various energy technologies

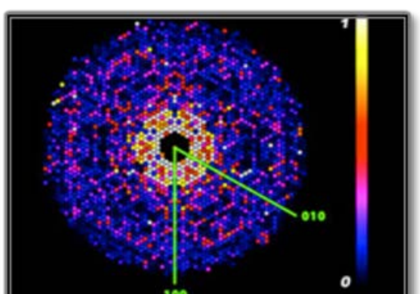
Chemical sciences, geosciences, and energy biosciences—exploring the fundamental aspects of chemical reactivity and energy transduction over wide ranges of scale and complexity and their applications to energy technologies

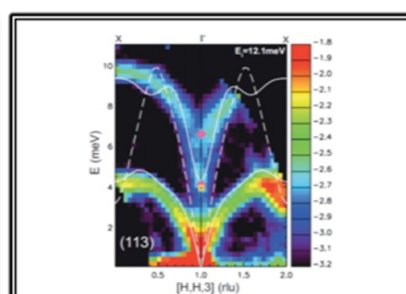
Scientific User Facilities—supporting the largest collection of facilities for electron, x-ray, and neutron scattering in the world

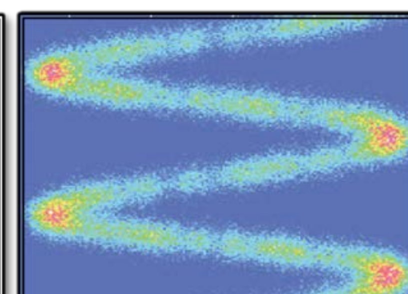
FY 2013 Highlights:

- Science for clean energy
  - Science-based chemical and materials discovery to enable manufacturing innovations
  - R&D for next-generation clean energy applications jointly funded with EERE
- Materials and chemistry by design: discovery grounded in theory and modeling
- National Synchrotron Light Source-II construction and early operations
- User facilities at near optimum operations; facility upgrades and enhancements
  - LCLS expansion (LCLS-II); NSLS-II EXperimental Tools (NEXT); APS Upgrade (APS-U)









Biological and Environmental Research

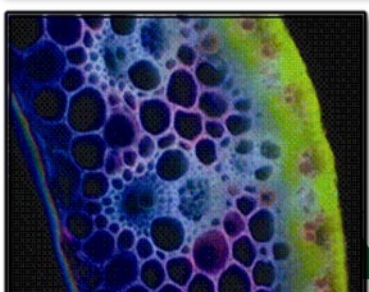
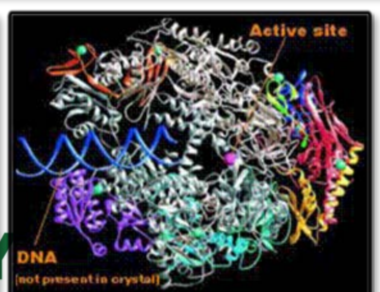
Understanding complex biological, climatic, and environmental systems across vast spatial and temporal scales

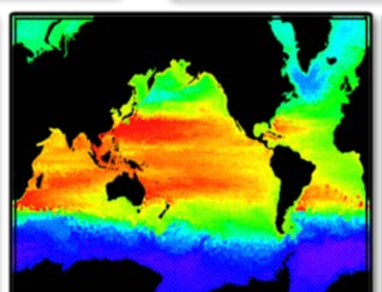
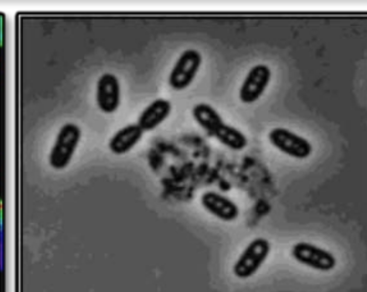
The Scientific Challenges:

- Understand how genomic information is translated to functional capabilities, enabling more confident redesign of microbes and plants for sustainable biofuel production, improved carbon storage, or contaminant remediation.
- Understand the roles of Earth's biogeochemical systems (atmosphere, land, oceans, sea ice, subsurface) in determining climate so we can predict climate decades or centuries into the future, information needed to plan for future energy and resource needs.

FY 2013 Highlights:

- Clean energy biodesign on plant and microbial systems through development of new molecular toolkits for systems and synthetic biology research.
- Research and new capabilities to develop comprehensive environmental system models in the Arctic and tropics, regions especially vulnerable to rapid climate change.
- Continue support for the three DOE Bioenergy Research Centers, and operations of the Joint Genome Institute, the Environmental Molecular Sciences Laboratory, and the Atmospheric Radiation Measurement Climate Research Facility.

Fusion Energy Sciences

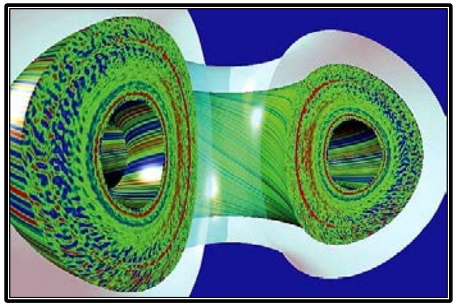
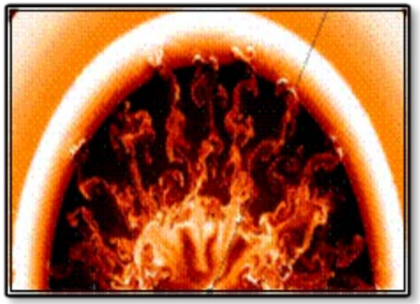
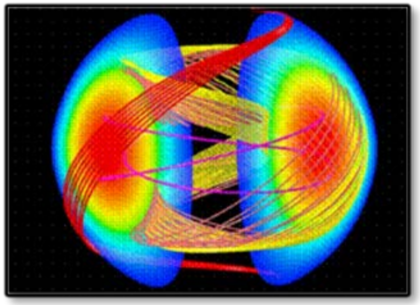
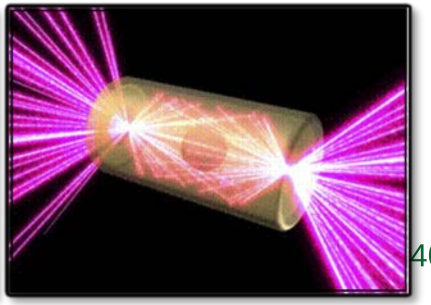
Understanding matter at very high temperatures and densities and building the scientific foundations for a fusion energy source

The Scientific Challenges:

- Control a burning plasma state to form the basis for fusion energy.
- Develop materials that can withstand the harsh heat and neutron irradiation in fusion facilities.
- Manipulate and control intense transient flows of energy and particles.
- Control the interaction of matter under extreme conditions for enabling practical inertial fusion energy.

FY 2013 Highlights:

- ITER construction is advancing.
- DIII-D investigates predictive science for ITER; NSTX undergoes performance upgrade; and Alcator C-Mod is closed.
- Matter in Extreme Condition Instrument begins operation at LCLS to study high-energy-density laboratory physics.
- New SciDAC high-performance computing projects are selected, in partnership with ASCR, to advance scientific discovery.
- International activities on experiments with world-leading technologies are increased.
- Fusion materials research is enhanced.

High Energy Physics

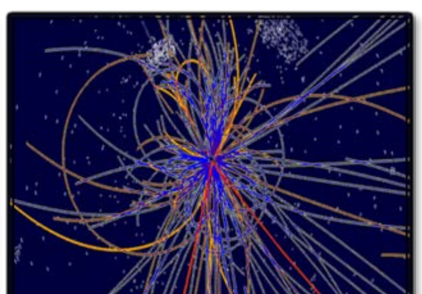
Understanding how the universe works at its most fundamental level

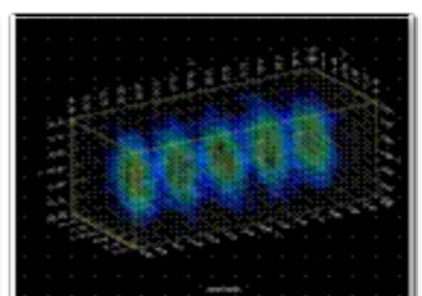
The Scientific Challenges:

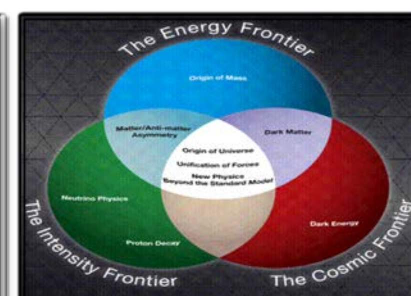
- Determine the origins of mass in terms of the fundamental particles and their properties
- Exploit the unique properties of neutrinos to discover new ways to explain the diversity of particles
- Discover new principles of nature, such as new symmetries, new physical laws, or unseen extra dimensions of space-time
- Explore the “dark” sector that is 95% of the Universe (Dark Matter and Dark Energy)
- Invent better and cheaper accelerator and detector technologies to extend the frontiers of science and benefit society

FY 2013 Highlights:

- Energy Frontier: Continued support for U.S. researchers at the LHC. The number of researchers is constant with FY 2012
- Intensity Frontier: Research, design, and construction for NOvA, LBNE neutrino experiments, and Mu2e muon experiments. The Reactor Neutrino Experiment in China begins operations in FY 2012
- Cosmic Frontier: U.S. participation in international collaborations pursuing dark matter, dark energy. The Dark Energy Survey in Chile begins operations in FY 2012
- Research in accelerator technologies including superconducting radio frequency and plasma wakefield acceleration







Nuclear Physics

Discovering, exploring, and understanding all forms of nuclear matter

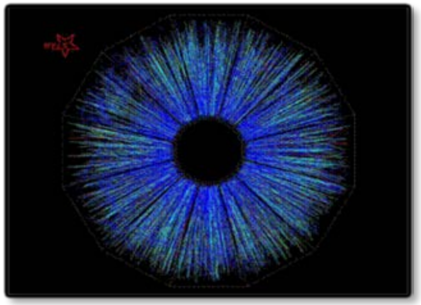
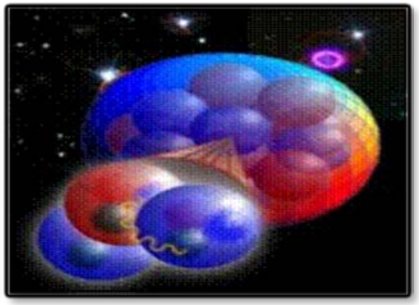
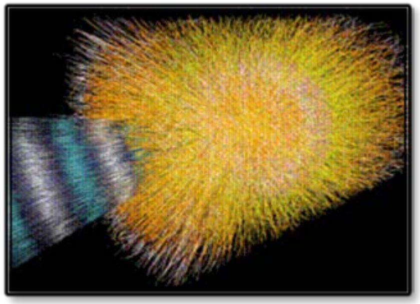
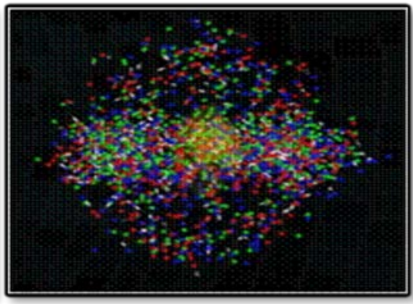
The Scientific Challenges:

Understand:

- The existence and properties of nuclear matter under extreme conditions, including that which existed at the beginning of the universe
- The exotic and excited bound states of quarks and gluons, including new tests of the Standard Model
- The ultimate limits of existence of bound systems of protons and neutrons
- Nuclear processes that power stars and supernovae, and synthesize the elements
- The nature and fundamental properties of neutrinos and neutrons and their role in the matter-antimatter asymmetry of the universe

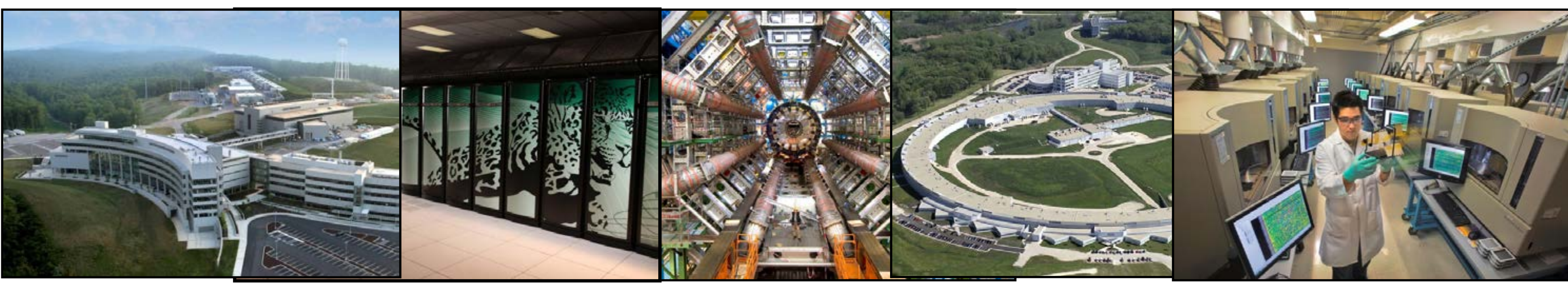
FY 2013 Highlights:

- Operations and research at three nuclear science user facilities (RHIC, CEBAF, ATLAS)
- 12 GeV CEBAF Upgrade to study systems of quarks and gluons and the force that creates protons and neutrons.
- Continued preparation for construction of the Facility for Rare Isotope Beams to study the limits of nuclear existence.
- Research, development, and production of stable and radioactive isotopes for science, medicine, industry, and national security.
- New strategic planning activity begins in FY 2012.

21st Century Tools for Science: National Scientific User Facilities

- Advanced **computational resources** – terascale to petascale computing and networks for open science
- Five **light sources**, and one next-generation light source under construction
- Three **neutron sources** for scattering
- **Particle accelerators/colliders/detectors** for high energy and nuclear physics
- **Fusion/plasma facilities**, including **ITER** which seeks to demonstrate a sustained burning plasma
- Five **Nanoscale Science Research Centers** – capabilities for fabrication and characterization of materials at the nanoscale
- **Joint Genome Institute** for rapid whole genome sequencing
- **Environmental Molecular Science Laboratory** – experimental and computational resources for environmental molecular sciences
- **Atmospheric and Environmental Facilities** – capabilities for cloud and aerosol measurement and for carbon cycling measurements



Research Internship Programs at the DOE Labs

Best wishes for a productive summer…

work safely & securely, and …

please stay in touch via the Notable Outcomes portal, which is accessible in perpetuity using your WDTS online application system profile.

Questions/Comments? – Please email SULI, CCI, or VFP inquiries to:

sc.suli@science.doe.gov; sc.cci@science.doe.gov; sc.vfp@science.doe.gov (respectively)

Best web resources for Office of Science and WDTS information:

http://science.energy.gov

http://science.energy.gov/discovery-and-innovation/

http://science.energy.gov/wdts

Please also feel free to contact me:

Jim Glownia – james.glownia@science.doe.gov; 301 903 2411