Office of Science

U.S. DEPARTMENT OF ENERGY

Laboratory Plans

FY 2008 – FY 2012

OFFICE OF SCIENCE LABORATORY PLANS

Introduction

The House Committee on Appropriations report for the FY 2007 Energy and Water Development Appropriations Bill (HR-109-474) directed the Department of Energy (DOE) to "…submit updated versions of these plans (i.e., five-year budget plans for major DOE programs as listed in House Report 109–86, for the entire Department, and laboratory business plans) …." The Office of Science (SC) Laboratory Plans are presented in this document.

Science with a Mission

The DOE national laboratories were created as a means to an end: victory in World War II and national security in the face of the new atomic age. Since then they have consistently responded to national priorities; first for national defense, but also in the space race and more recently in the search for new sources of energy, new energy-efficient materials, new methods for countering terrorism domestically and abroad, and addressing the challenges established in the President's American Competitive Initiative (ACI) and the Advanced Energy Initiative (AEI).

Today, the ten national laboratories for which SC[1] is responsible comprise the most comprehensive research system of their kind in the world. In supporting DOE's mission and strategic goals, the SC national laboratories perform a pivotal function in the nation's research and development (R&D) efforts: increasingly the most interesting and important scientific questions fall at the intersections of scientific disciplines—chemistry, biology, physics, astronomy, mathematics—rather than within individual disciplines. The SC national laboratories are specifically designed and structured to pursue research at these intersections. Their history is replete with examples of multi and inter-disciplinary research with far-reaching consequences. This kind of synergy, and the ability to transfer technology from one scientific field to another on a grand scale, is a unique feature of SC national laboratories that is not well-suited to university or private sector research facilities because of its scope, infrastructure needs or multidisciplinary nature.

As they have pursued solutions to our nation's technological challenges, the SC national laboratories have also shaped, and in many cases led, whole fields of science: high energy physics, solid state physics and materials science, nanotechnology, plasma science, nuclear medicine and radiobiology, and large-scale scientific computing are among these. This wide-ranging impact on the nation's scientific and technological achievement is due in large part to the fact that since their inception the DOE national laboratories have been home to many of the world's largest, most sophisticated research facilities. From the "atom smashers" which allow us to see back to the earliest moments of the Universe, to fusion containers that enable experiments on how to harness the power of the sun for commercial purposes, to nanoscience research facilities and scientific computing networks that support thousands of researchers, the national laboratories are the stewards of our country's "big science." As such, the national laboratories remain the best means we know of to foster multi-disciplinary, large-facility science to national ends.

In addition to serving as lynchpins for major laboratory research initiatives that support DOE missions, the scientific facilities at the SC national laboratories are also operated as a resource for the

[1] The ten SC laboratories are: Ames Laboratory (Ames), Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), Lawrence Berkeley National Laboratory (LBNL), Fermi National Accelerator Laboratory (FNAL or Fermilab), Thomas Jefferson National Accelerator Facility (TJNAF), Princeton Plasma Physics Laboratory (PPPL), Stanford Linear Accelerator Center (SLAC), Oak Ridge National Laboratory (ORNL), and the Pacific Northwest National Laboratory (PNNL).

broader national research community. Approximately 19,000 researchers and students use SC-run facilities each year and roughly half of these come from universities. An additional sizeable portion comes from other federal agencies and private companies. Thus, SC national laboratories are contributing research underlying portal monitoring systems to the Department of Homeland Security, and are collaborating with business across the country on the development of everything from high-performance batteries for biomedical applications to coatings that may allow gas turbine engines in jet aircraft and other power-generating technologies to better withstand severe, high-temperature environments.

Finally, SC is well aware that underlying its scientific success is the close partnership between its national laboratories and our national research universities. To assure this partnership continues to flourish, and that the U.S. maintains its historic strengths in scientific education, SC and its national laboratories sponsor a great variety of educational programs, which in turn support the work of approximately 21,000 scientists, 5,500 PhDs, 3,200 graduate students, 800 technicians, and many, many high-school students across the country.

Competition and Synergy

Intellectual curiosity and the scientific reward system, with it emphasis on priority of discovery, is the guiding force behind the management of the laboratories. SC allocates funds to the laboratories based on past performance and rigorously peer-reviewed proposals. This competition, which takes full advantage of the personal ambition of some of America's most brilliant scientific minds, keeps our national laboratories at the cutting edge of world science.

Competition has fostered both specialization and diversification of laboratory programs and ensured the responsiveness of the SC national laboratories to national priorities, both specific and general. The result of this competition is a system of laboratories, each with specific strengths, yet with enough common underlying capabilities that they can at the same time compete and collaborate. For example, SC supports light sources (facilities that generate very powerful and very specialized beams of light that enable researchers to determine specific properties of materials) at SLAC, LBNL, ANL and BNL. The wavelengths and beam characteristics of each light source are different, but together they cover the full range of important characteristics. This allows scientists to use the facility most appropriate to their particular problem, or to use multiple light sources if necessary to investigate their question more fully. Similarly, accelerator-based research takes place at FNAL, SLAC, ANL and BNL. But each laboratory's focus is different and each is needed to understand the physics of the earliest moments of the universe, and the workings of the smallest parts of the atom.

It is SC's challenge and responsibility to manage its laboratories to ensure focus on the Department's missions and to maintain sufficient competition to keep the laboratories scientifically "sharp," while avoiding costly duplication of effort. The following Laboratory Plans reflects part of SC's effort to do just that.

Department of Energy Laboratory Plan
For the Office of Science's
Ames Laboratory

Mission and Overview

Ames Laboratory (Ames) was formally established in 1947 by the United States Atomic Energy Commission as a result of the Ames Project's successful development of the most efficient process to produce high-purity uranium metal in large quantities for the Manhattan Project. Today, Ames' mission focus is on materials science, engineering, analytical instrumentation and chemical sciences that provides expertise to the Department of Energy (DOE) laboratory system in the areas of energy and environmental improvement. Ames operates the Materials Preparation Center (MPC) which provides capabilities in preparation, purification, fabrication and characterization of materials in support of R&D programs throughout the world. Ames also collaborates with the DOE's applied energy technology and nonproliferation programs and supports the National Institutes of Justice, National Institutes of Health, Department of Defense, FBI, and corporate entities. Since 1984, Ames Laboratory has received 16 R&D 100 awards from R&D Magazine, which selects the 100 most significant technical products and innovations each year. Over 2900 Masters and Ph.D. degrees in science and engineering have been awarded to Ames students since 1947.

Laboratory Focus and Vision

Five areas of core competency underpin activities at Ames Laboratory:

1. Materials design, synthesis and processing
2. Analytical instrumentation/device design/fabrication
3. Condensed matter theory (including photonic band gap and other novel materials)
4. Materials characterization, x-ray and neutron scattering, solid-state Nuclear Magnetic Resonance (NMR), spectroscopy/microscopy
5. Separation science.

The Office of Science believes that these five competencies will enable Ames to deliver its mission and customer focus, to perform a complementary role in the

Lab-at-a-Glance

Location: Ames, IA

Type: Single-program laboratory

Contract Operator: Iowa State University (ISU) of Science and Technology

Responsible Field Office: Ames Site Office

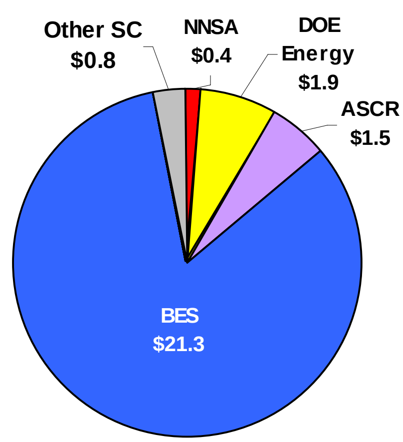
Website: http://www.ameslab.gov/

Physical Assets:
- 10 acres (lease–long term, no cost)
- 12 buildings
- 327,664 GSF in Active Operational Buildings
- Replacement Plant Value: $57.8M
- Deferred Maintenance: $1.4M
- Asset Condition Index:
  - Mission Critical 0.98 (Excellent)
  - Mission Dependent 0.96 (Good)
- Asset Utilization Index: 0.99 (Excellent)

Human Capital:
- 313 Full-time equivalent employees;
- 154 ISU grad/undergrad students
- 171 Facility users, visiting scientists, and associates

FY 2006 Total DOE Funding: $25.8M

FY 2006 DOE Funding by Source
PALS data (BA in Millions):



FY 2006 Non-DOE Funding: $2.5M

DOE laboratory system, and to pursue its vision for scientific excellence and pre-eminence in the areas of:

- Fundamental materials research with emphasis in optical magnetic, intermetallic, and catalytic materials; and studies of the structure and properties of high temperature materials.
- Analytical techniques and instrument development.

Business Lines

The following capabilities, aligned by business lines, distinguish Ames and provide a basis for effective teaming and partnering with other DOE laboratories, universities, and private sector partners in pursuit of the laboratory mission. These business lines and the distinguishing capabilities outlined in the table below provide an additional window into the mission focus and unique contributions and strengths of Ames and its role within the Office of Science laboratory complex. Items in italics within the column, Distinguishing Capabilities, identify research facilities that convey particular, strategic strengths and capabilities to the Lab. Descriptions of these facilities can be found at the website noted in the Lab-at-a-Glance section of this Plan.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
Fundamental Materials Research	• Novel optical materials; • Materials preparation, synthesis and processing; • Magnetic materials and correlated electron systems; • Complex intermetallic compounds; • Catalytic materials; • *Materials Preparation Center;* • *Scalable Computing Lab.*	Leader in photonic band gap materials and super lenses; Dr. C. Soukoulis received the Descartes Prize for Excellence in Scientific Collaborative Research in FY2006 for his contributions to the field of left-handed materials; DOE Energy 100 Award winner Recognized world leader in rare earth and intermetallic compounds; Materials Preparation Center (MPC); Dr. K. Gschneidner, Jr. named to National Academy of Engineering in FY2007 because of his contributions to rare-earth materials. Dr. I. Anderson's lead free solder technology is being licensed worldwide (more than 75 licenses). Both technologies are DOE Energy 100 Award winners. Pioneering work on environmentally-benign refrigeration and magnetic molecules; Ames Laboratory is working with Astronautics Corporation of America to develop magnetic refrigeration technology; a R&D 100 Award winner. Leader in quasi-crystals; properties of complex materials; Hosted the Ninth Annual World Quasicrystals Conference in 2006; 2 DOE Materials Science Awards; Dr. Pat Thiel received the Doctor Honoris Causa from the Institute National Polytechnique de Lorraine for her work on quasicrystals. Dr. P. Canfield spoke before the National Academy of Sciences on the current status and future prospects of the	Advance Basic Sciences for Energy Independence Synthesis and characterization of the next generation of materials for energy efficiency/storage, communications, and environmental stewardship.

		field of Condensed Matter and Materials Physics with emphasis on crystal growth. Pioneering work on novel structures; high-specificity reaction, controlled drug release; Dr. V. Lin has developed materials to cap mesoporous nanospheres, hold the drugs in place and release the drugs at a specific site. Dr Lin received the National Science Foundation Career Award and has been invited to serve on the Editorial Advisory Board for the journal "Advanced Function Materials."	
Analytical Techniques and Instrument Development	• *Mass spectrometer techniques and instrument design;* • Single-cell analyses; • Single-molecule analyses; • Electrochemically modulated liquid chromatography; • Surface-enhanced Raman scattering; • Solid-state Nuclear Magnetic Resonance (NMR) for heterogeneous polymers.	Record of internationally recognized excellence: inductively-coupled plasma – mass spectrometer (ICP-MS) in every analytical lab in world; biomolecule analysis; Pioneering work in fundamentals of cellular physiology; disease diagnosis, treatment; Dr. E. Yeung has won 3 R&D 100 Awards – his Multiplexed Capillary Electrophoresis DNA Sequencer is licensed and in production for deciphering genetic codes and disease diagnoses and his Microfluor Detection device is used in analyzing and sequencing DNA Studying reactivity at single molecule level;	Provide the Resource Foundations that Enable Great Science Development of techniques for characterization of novel materials and rapid, sensitive detection of chemicals and biomaterials for applications ranging from bioremediation to national security.

Major Activities

There are two major activities that Ames Lab is pursuing to support aspects of the DOE mission and build on core strengths and capabilities of the laboratory. These activities are either currently supported or appear in the FY 2008 budget submission to Congress.

The major activities are:

1. Materials Discovery, Synthesis and Processing, and
2. Bioinspired Materials

1. Materials Discovery, Synthesis and Processing (MDSP)

- **Summary:** Comprehensive enhancement of facilities and collaborations in materials discovery, synthesis and processing to maintain U.S. world leadership.
- **Expectations:** Enhancing facilities, staff and external collaborations to train the next generation of materials scientists in MDSP.
- **Benefit Perspective:** Potentially *Substantial*/*Sustaining* benefits
- **Risk Perspectives:**
    - o Technical: *Low risk* -- The Ames Laboratory Materials Preparation Center is known worldwide for providing high purity materials for research. In addition, Ames arguably has one of the very best "crystal-growing groups" in the world.
    - o Market/Competition: *High risk* -- Competition in the area is strong worldwide.
    - o Management/Financial: *Low risk* -- Ames Laboratory already has the management in place, the scientists on hand, and the university nearby to accomplish the goals of the

activity. Also, the desired additional investment from DOE is relatively small.

Late in 2003, the DOE's Basic Energy Sciences program sponsored a national workshop, held in Ames, Iowa, to discuss the declining dominance of the U.S. effort in design, discovery and growth of novel materials for basic research relative to the competition, specifically Europe and Japan. The conclusion was that DOE should act quickly to strengthen the Nation's efforts in this arena "by adding qualitatively new capabilities, and by significantly enhancing Ph.D. and postdoctoral training opportunities…." Ames Laboratory has the physical and intellectual infrastructure to lead in this DOE materials effort. For example, the strong connection between Ames and its contractor, Iowa State University, positions the Lab to enhance Ph.D. and postdoctoral training. This activity would enable the Lab to establish new outreach programs and collaborations with universities, laboratories and industry across the country and to increase staffing and add new research programs in the relevant areas at Ames.

2. Bioinspired Materials

- **Summary:** Synthesis and characterization of novel materials that mimic living systems.

  Expectations: Materials will be designed and synthesized that possess the ability to: switch among several states in response to the environment (pH, temperature); self-assemble and build complex structures hierarchically; and serve as directed templates for such synthetic processes as biomineralization/biometallization.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
  - Technical: *Moderate risk* -- This research area is quite new so there is a high degree of uncertainty.
  - Market/Competition: *Moderate risk* -- It is too early to determine the market/competition risk; however, certainly development of self-assembling materials is widespread in the research community.
  - Management/Financial: *Moderate risk* -- This will be a new direction for the Materials Chemistry Program. The Program is currently in a transitional period where some of the current research efforts must be phased out, as new bioinspired efforts are commenced.

Ames Laboratory management has decided to direct significant efforts and resources to the synthesis and characterization of novel materials that mimic living systems. These materials possess the ability to switch among several states in response to the environment and to self-assemble into complex structures. Ames believes that the rational design of such self-assembling systems will become a very significant part of materials science. A current project that demonstrates the power of this approach is to process the self-assembled polymers with other self-assembling components, in this case mineralization proteins, for the synthesis of a very interesting class of materials, nanomagnets. Over the next several years, Ames expects to build and strengthen this overall program in support of the DOE mission and in keeping with the future vision for the laboratory. This building process will involve creating teams of bioengineers, theorists, synthetic chemists, biologists and experts in chemical characterization, and will require the combined scientific strengths of the Lab and its contractor and collaborator, Iowa State University.

Financial Outlook

Detailed information regarding the financial outlook for the Ames Laboratory is subject to 1) competition and merit review, 2) the availability of appropriated funds and 3) programmatic decisions. The first two factors cannot be predicted or estimated in advance. The third, programmatic decisions are developed in accordance with the planning targets reflected in the Department of Energy programmatic Five Year Plans, a companion document to these strategic laboratory business plans. In addition, because of the Office of Science commitment to competition and merit review, there is often a time lag between programmatic decisions and the determination of which research provider can best deliver the greatest value in conducting the research. Thus, it is not always apparent how programmatic decisions unfold for particular laboratories. Nevertheless, some decisions, such as the plans for large scientific user facilities, show clear paths to individual labs and therefore inform their business plans.

Support for Non-DOE funded work is a vital role assumed by our national laboratories, contributing to national security, energy security, environment stewardship, scientific discovery, and more fundamentally, the competitiveness of the U.S. economy. For Ames, this is no exception. The Office of Science is supportive of this work and although it is not addressed in any detail within the accompanying Five Year Plans, the Office of Science believes it is sufficiently important and appropriate to address within this strategic laboratory business plan. A brief perspective and financial outlook is therefore provided.

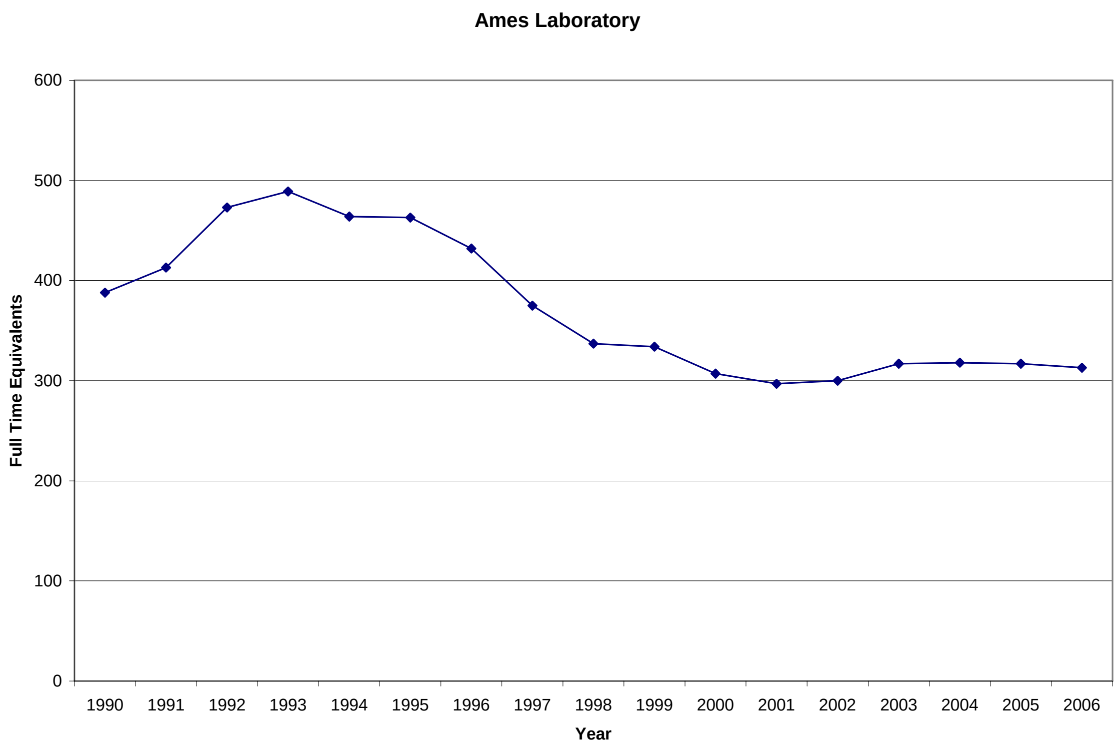
The current Ames non-DOE funded activities are primarily supported by the National Institute of Justice and the Department of Defense. The primary National Institute of Justice work is for the operation of the Midwest Forensic Resource Center, a center for advanced research and development in forensic science, whose goals are: to advance innovative technology and management practices in crime laboratories; to provide access to university and laboratory resources for use in casework; and to be a focal point for innovative training and education. Major projects for the Department of Defense include preparation and atomization for powder alloys, preparation and characterization of various alloys, and the development of research systems and software tools for virtual engineering. These two federal sponsors are expected to continue to fund projects at current levels. In addition to these sponsors, Ames has non-DOE funded work with various industrial partners, with activities ranging from designing low temperature rare earth-based magnetic regenerator materials to sharing the operational costs of the Midwest Universities Collaborative Access Team (MUCAT) sector at the Advanced Photon Source. Such industrially funded activities are also expected to continue at the current levels.

Uncertainties and Risk Management

External Factors: An important source of risk mitigation for Ames is the relationship with its contractor, Iowa State University. Many of the scientists, researchers and administrators at the Lab hold joint faculty or managerial positions at the University and the Lab has access to both undergraduate and graduate student talent. The ability of the University to include the Lab in its pursuit of top faculty and the Lab to include the University in its pursuit of new scientists helps attract key personnel. The Lab also shares the following with its Contractor: employee benefits and services; environment, safety and health support; research support; operations support; and administrative support. An additional source of long-term support for Ames is its wide-ranging scientific interactions. Ames effectively partners with researchers at other DOE laboratories and facilities, including the Ames MPC, collaboration in interlaboratory SciDAC projects, collaborations with Sandia, Argonne, Lawrence Berkeley, and Lawrence Livermore National Laboratories. There are also collaborations involving industry, non-DOE labs and other government agencies. Notably, Ames is successful in terms of licensing revenue per funding dollar, and it ranks third among the DOE national laboratories in total licensing despite its small size. No key community relations issues face the Ames Laboratory.

S&T Workforce: The workforce for Ames Laboratory, in recent years, has remained relatively stable from year to year and a major reduction in force or other downsizing over the next five years is not anticipated. Any reductions that will need to be made will likely come from attrition. The projected levels of full time equivalent employees (both direct-funded research FTEs and total FTEs), over the next five years, vary based upon the funding scenarios used to establish this business plan.

Workforce Trends



Employee Diversity: Because of its location, attracting minorities to Iowa has proven to be very challenging, especially in attracting those with the scientific and technical skills needed at a laboratory such as Ames. In addition, women and minority scientists are in great demand across the country, with competition coming from other laboratories, from universities, and from industry. To improve the minority prospects, Ames contacts a series of minority and women professional societies and universities when key openings occur.

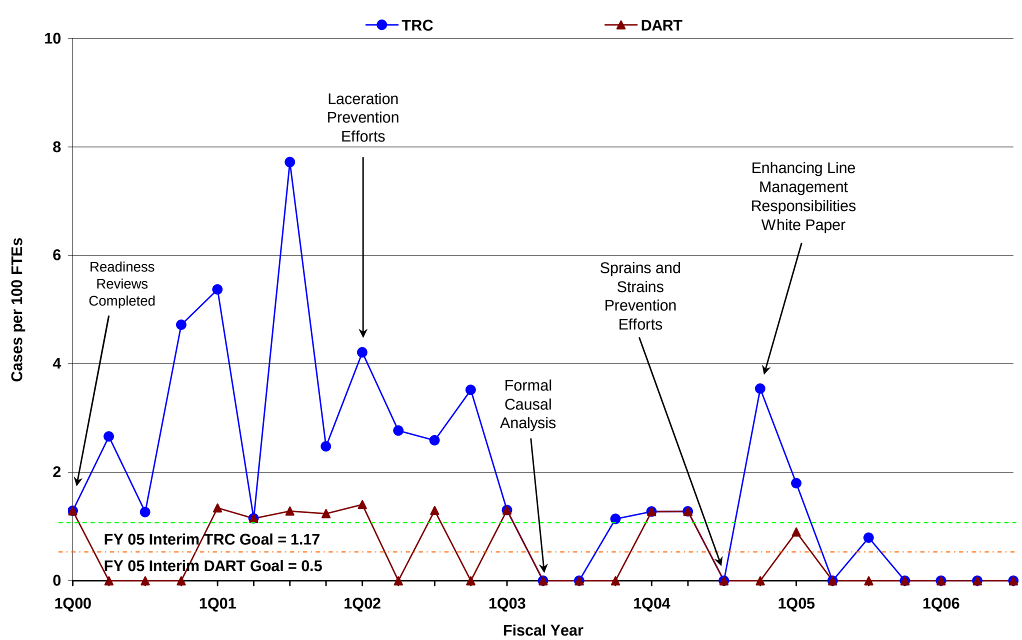
The 2015 goals for Ames in diversity are to: continue to broaden the base of applicants for job openings; increase minority and women's participation in the scientific and technical fields including increasing the percentage of women and minorities in senior management to 25%. Ames will expand upon a seed funding program (funded under the approved Royalty Use Plan) that targets junior faculty members, with the goal being that at least 25% of all projects funded are led by women and minorities. Ames Lab has been able to attract and retain excellent key personnel. The Lab is, however, cognizant of the need for succession planning. The majority of both the business and science areas have identified potential replacements in the event of departures of key personnel. Succession planning is an ISU (Ames' contractor) policy and best business practice to ensure that programs and business functions staff all jobs continuously, especially those requiring specialized experience, qualifications, and education. Hence back-up individuals are identified and commonly used in acting capacities to cover short or extended absences. This not only provides experience for back-up personnel, allowing them to better qualify for promotion, but also proves beneficial even if the perceived successor does not assume the position when it is vacated. The individual who has acted in a position has sufficient knowledge and experience to provide training and assistance once a permanent replacement is identified.

In the long run, Ames Laboratory firmly believes that engaging youth in science and engineering at an early age and keeping them engaged through their college degree is the best means to provide the next generation of scientists. The Laboratory is providing internships through the Student Undergraduate Laboratory Internships that strongly encourages applications from minority and women students. In addition, the Laboratory and Iowa State University support Science Bound, a program to engage minority children in science and math in the Des Moines, Iowa, public schools. The hope is that these children will go on to pursue careers in science and engineering and become the next generation of scientists for the National Laboratories and Universities, with many choosing Ames as their place of work.

Safety: AMES safety performance has improved over the past ten years, has met or surpassed FY 2005 and FY 2006 goals, and is expected to meet current and future goals. The FY 2006 Total Recordable Case (TRC) rate was 0.24 (1 case) and the Days Away, Restricted or Transferred (DART) rate was 0.0 (0 cases). The Laboratory's programs of employee training, readiness review, periodic walkthroughs, formal event investigations, and targeted injury prevention efforts have improved safety performance. The active, visible demonstration of upper management's commitment to safety, in addition to a comprehensive Integrated Safety and Environmental Management System based on sound safety practices and mechanisms, has become the way Ames does business. Ames expects continued improvement in safety performance.

DART and TRC Rates and Major Safety Initiatives

Ames Laboratory



Physical Infrastructure: Ames Laboratory consists of 12 buildings (327,000 square feet (sf)) operating on the campus of the Iowa State University (ISU) in Ames, Iowa. Being located on the University campus allows the Laboratory to benefit from many utility services provided by ISU, such as steam, chilled water, water treatment, sewage system, landscaping, fire department, electrical and telecommunication systems, and roads without the need for Federal investment to construct, maintain, or recapitalize. The availability of these services allows the Laboratory to focus on maintaining and operating its research and support buildings. The relationship with ISU also enables the Laboratory to use space in University–owned buildings through a space usage agreement without investing in permanent space or long-term leases. Ames's Asset Utilization Index (AUI) is 1.0 for offices (excellent), 0.98 for laboratories (excellent) and 1.00 for warehouses (excellent). The replacement plant value of Ames's general purpose facilities is $57.8M.

Maintenance, recapitalization, and modernization are supported with overhead, operating, and General Plant Project (GPP) funds (projects which cost less than $5M). Ames attained a maintenance investment index (MII) of 2.1% of replacement plant value (excellent) in FY 2006 which will be continued in FY 2007, and the out-years. Ames' deferred maintenance (DM) backlog is $1.45M. The Asset Condition Index (ACI) is 0.98 for mission critical facilities (the DOE goal is 0.964 or above) and 0.96 for mission dependent facilities (the DOE goal is 0.948 or above). ACI is computed as 1 minus the result of deferred maintenance divided by replacement plant value.

The FY 2008 GPP funding request is for $597K. Ames's future facility challenges include buildings modernization and clean-up of contaminated ductwork. The laboratory is working to achieve the goals for energy reduction and use of renewable energy established in the Energy Policy Act of 2005.

Department of Energy Laboratory Plan
For the Office of Science's
Argonne National Laboratory

Mission and Overview

Argonne National Laboratory (ANL) was founded in 1946 and traces its scientific legacy directly to nuclear physics research teams led by Nobel Laureate Enrico Fermi. ANL was largely responsible for the science behind the emergence of the U.S. nuclear power industry and today has transformed itself into a multipurpose laboratory with a mission focus and deep capabilities in basic and applied materials science, chemistry and chemical engineering, energy technologies and analysis, high-performance computing, physics, and biosciences. ANL also leads research in other scientific areas of importance to the Department of Energy (DOE) such as environmental science and national security.

ANL has retained strong capabilities in the design, construction and management of major scientific user facilities. As a DOE steward of critical national research infrastructure, the laboratory provides university, industry and government researchers with access on a competitive basis. These research facilities include the Advanced Photon Source (APS), which provides x-ray beams for research ranging from materials to structural biology; the Intense Pulsed Neutron Source (IPNS), which has achieved many "firsts" in the field of neutron scattering; the new Center for Nanoscale Materials (CNM), which focuses on exploring the nanoscale physics and chemistry of nontraditional electronic and magnetic materials; the Argonne Tandem-Linac Accelerator System (ATLAS), a superconducting linear accelerator for heavy ions; and the Electron Microscopy Center (EMC), which allows the exploration of inorganic and organic materials on the atomic scale. The ANL user community now includes over 3900 scientists and engineers.

Laboratory Focus and Vision

Six core competencies underpin activities at ANL:

1. Materials science, nanoscience, chemistry, and

Lab-at-a-Glance

Location: Argonne, IL

Type: Multi-program lab

Contract Operator: UChicago Argonne, LLC

Responsible Site Office: Argonne Site Office

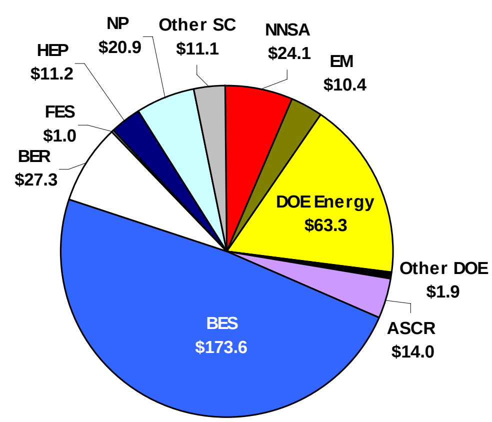
Website: http://www.anl.gov/

Physical Assets:
- 1,500 acres and 99 buildings
- 4.4M GSF in Active Operational buildings
- 82K GSF in Non-Operational buildings
- Replacement Plant Value: $1.534B
- Deferred Maintenance: $62.5M
- Asset Condition Index:
  - Mission Critical 0.96 (Good)
  - Mission Dependent 0.96 (Good)
- Asset Utilization Index: 0.96 (Good)

Human Capital:
- 2552 employees
- 565 students (undergrad and grad)
- 3921 Facility Users and Visiting Scientists

FY 2006 Total DOE Funding: $358.9M

FY 2006 DOE Funding by Source
Argonne data (BA in Millions):



FY 2006 Non-DOE Funding: $86.8M
FY 2006 Dept. of Homeland Security: $25.6M

biology.

2. Synchrotron radiation science and technology for the study of materials of all kinds.
3. Energy related research, including transportation science and engineering, and nuclear fuel cycle and reactor design.
4. Integration of modeling, fundamental science, engineering and economic expertise for energy and environmental issues.
5. Advanced software tools, massively parallel computer architectures and large-scale computational sciences.
6. Fundamental physics tied to cosmology and the origins of the elements.

The Office of Science believes that these six competencies will enable ANL to deliver its mission and customer focus, to perform a complementary role in the DOE laboratory system, and to pursue its vision for scientific excellence and pre-eminence in the following areas:

- Pursuing the limits of high spatial and temporal resolution for materials research.
- Exploring the frontiers of low- and medium-energy nuclear physics, including the study of rare and unstable isotopes, which are key to understanding element nucleosynthesis and the origin and evolution of the universe.
- Integrating physics, materials science, biology, chemistry, and computational science to create a sustainable and secure energy future.
- Creating the world's leading core accelerator technology development capability.
- Advancing computational science (architectures and applications) to tackle national R&D challenges requiring petascale capabilities and beyond.
- Realizing the vision of creating materials and catalysts (including enzyme systems) by design.

Business Lines

The following capabilities, aligned by business lines, distinguish ANL and provide a basis for effective teaming and partnering with other DOE laboratories, universities, and private sector partners in pursuit of the laboratory mission. These business lines and the distinguishing capabilities outlined in the table below provide an additional window into the mission focus and unique contributions and strengths of ANL and its role within the Office of Science laboratory complex. Items in italics within the Distinguishing Capabilities column identify research facilities that give ANL particular strategic strengths and capabilities. Descriptions of these facilities can be found at the website noted in the Lab-at-a-Glance section of this Plan.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
Materials Science	• Materials Synthesis, Characterization, and Modeling; • Hard X-ray Nanoscale Research; • *Advanced Photon Source;* • *Center for Nanoscale Materials;* • *Electron Microscopy Center;*	International leader; most highly cited papers in materials science per http://isihighlycited.com Only site with co-located photon, neutron, electron, and ion based materials analysis facilities; High caliber staff as indicated by award	Understand materials structure and properties for energy, health and national security applications; Lead portions of the nanoscale revolution.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
	• *Intense Pulsed Neutron Source.*	of 2003 Nobel Prize in Physics to Alexei Abrikosov.	
Mathematics & Computer Sciences	• Advanced Architecture Research • Applied Modeling & Simulation • Computational Mathematics	Leader in fundamental architecture for massively parallel computer systems: MPICH - for message passing – see http://www-unix.mcs.anl.gov/mpi/mpich/ PVFS - for parallel file systems – see http://www.pufs.org NEOS - for on-line optimization - see http://www-neos.mcs.anl.gov/ PETSc - for partial differential equations –see http://www-unix.mcs.anl.gov/petsc/petsc-as/ "DOE Top 10" scientific achievement for large-scale massively parallel optimization; Designated partner, with the Oak Ridge National Laboratory (ORNL), to establish leadership class computing for open scientific research.	Providing computational tools to advance the forefront of science and engineering.
Advanced Biosciences	• Structural Biology/Genomics: Biomolecular Structure Determination • Bioinformatics • Environmental Molecular Science • Terrestrial Carbon Research • HT Molecular Biology and Biochemistry • *Structural Biology Center*	Top 3 world-wide in production & characterization of protein structures; data summarized at http://www.mcsg.anl.gov (click on "SG Progress") Co-location of the APS, IPNS, and protein crystallization center provides unique capabilities	Increase bio-defense capabilities; develop new energy sources and environmental technologies; and advance systems biology as supported through the Genomics:GTL Program.
Fundamental Physics	• Nuclear Structure and Astrophysics with Stable and Unstable Ion Beams; • Laser Trapping of Individual Atoms; • High Energy Physics Experiments and Theory; • *Argonne Tandem-Linac Accelerator System (ATLAS)*	World leader in experimental & theoretical nuclear physics Most highly cited nuclear theory paper of past decade: Phys Rev c51, p. 38 (1995) see http://isihighlycited.com Lead roles in international collider experiments	Understand fundamental matter and forces and master connections between high energy & nuclear physics, astrophysics & cosmology.
Energy & Environmental S&T	• Nuclear Fuel Cycle & Reactor Design; • Transportation Science and Technology; • Integration of Economics, Computing, Engineering and Sciences; • *Cloud and Radiation Testbed;* • *Engine Research Facility for Diesels;* • *Advanced Powertrain Test*	International leadership in closed fuel cycle (UREX+1a) & reactor technologies World leader in vehicle testing (confirmed by Toyota, Hyundai, GM, Ford, others). Shared leadership of Atmospheric Radiation Measurement (ARM) program; Nationally recognized expertise in environmental assessment as evidenced by being chosen to do the Trans-Alaska Pipeline EIS.	R&D on next-generation nuclear reactors and advanced nuclear fuel cycles. Advance integrated science and technology approaches to energy & environmental challenges. Advance the frontiers of large-scale, systems-level modeling and simulations as applied to energy and environmental technologies.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
	Facility for Hybrid Vehicles.		
Accelerator Design	• Synchrotron Radiation Sources • Accelerator R&D for Heavy-Ion Beams • Superconducting RF Design	World's first superconducting heavy ion accelerator. New classes and performance standards for RF cavities World-leading development of synchrotron operations Advanced acceleration concepts	Maintain DOE lead in accelerator design, construction and operations.

Major Activities

Following is a set of major activities that ANL is currently pursuing to support elements of the DOE mission and build on core strengths and capabilities of the laboratory. These activities are either currently supported or appear in the FY 2008 budget submission to Congress. The companion documents, the DOE's Five Year Plans, provide greater insights into these activities in terms of various five-year budget scenarios.

The major activities are:

1. Synthesis, Characterization, and Modeling of Novel Structural, Electronic, Magnetic, and Superconducting Materials
2. Petascale Computing
3. Genomics, Systems Biology, and Structural Biology
4. Integrated Energy, Environment & Economic Research

1. Synthesis, Characterization, and Modeling of Novel Structural, Electronic, Magnetic, and Superconducting Materials

- **Summary**: We aim to create novel inorganic and biological materials with pre-determined properties that are tailored for specific functions or applications.
- **Expectations**: International leadership in materials science including the synthesis, characterization, and modeling of novel structural, electronic, magnetic, or superconducting materials that underpin DOE missions in fundamental and applied materials science and energy security.
- **Benefit Perspective**: Potentially *Transformational* Benefits.
- **Risk Perspectives**:
  - Technical: *Moderate risk* -- owing to exploratory nature of research. This risk is mitigated by the very high quality of the scientific and support staff.
  - Market:/Competition: *Moderate risk* -- because of the intense global competition in materials research.
  - Management/Financial: *Low risk* -- because of expected stability of programmatic funding and facility operations funding from DOE.

In addition to traditional strengths in materials research resident within the basic and applied technical divisions at ANL, the new Center for Nanoscale Materials (CNM), a state-of-the-art facility for the design, synthesis, fabrication, and characterization of materials at the nanoscale, will begin full operations in the fall of 2007. The CNM is one of five national DOE Nanoscale Science Research Centers (NSRCs). The NSRCs are based on a new model for scientific user facilities and will provide the nation with specialized tools and expert staff which, when taken together, are not readily available at universities and industrial labs. The CNM will focus on the design and synthesis of nanomaterials and nano-assemblies for coherent control of spin, charge, and photons at the nanoscale and the study of bio/organic/inorganic interfaces for energy conversion.

The CNM's six primary themes are nanofabrication, electronic and magnetic materials and devices, nanophotonics, nano-bio interfaces, x-ray imaging, and theory and simulation. The facility will employ 60 permanent staff and postdocs and will accommodate up to 80 users at one time. Keys to the success of the CNM are (a) its close partnership with the other DOE user facilities at Argonne - i.e., materials synthesized at the CNM can be characterized with the forefront tools available at the Advanced Photon Source, the Intense Pulsed Neutron Source, and the Electron Microscopy Center - and (b) collaborations with staff in technical divisions throughout the Physical Sciences, Computing & Life Sciences, Applied Science & Technology, and Scientific User Facilities Directorates.

2. Petascale Computing

- **Summary:** ANL will focus on advanced architecture deployment and integration at the petascale to support DOE's missions and INCITE investigators.
- **Expectations:** Development of petascale computing capabilities for: creation of "designer" nanomaterials for industrial, medical, and other applications; modeling of whole microbial cells for bioengineering and synthetic biology applications in support of energy and environmental research.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
  - Technical: *Moderate risk* -- because of commercial risk as well as semiconductor design and software risk. This risk is mitigated by the particular choice of application.
  - Market/Competition: *Moderate risk* -- because the transformation requires adoption by industry.
  - Management/Financial: *High risk* -- because of close coupling with business plans of computer vendors who may or may not stay in the market.

ANL is a partner with ORNL to develop leadership-class computing capabilities to support forefront science, and while supporting broad classes of advanced architectures, ANL aims to focus especially on architectures with promise for reaching petascale levels of computing capability. This activity builds on ANL's strengths in High Performance Computing (HPC) software, advanced hardware architectures, and application expertise; and enables forefront research, engineering, and facilities.

Major technical hurdles must be overcome to develop a computer architecture that achieves high application performance with reasonable cost and power consumption. ANL is working with IBM and other vendors to achieve this goal, in collaboration with researchers at other DOE laboratories and at universities. ANL also must ensure that applications software with appropriate scientific content, efficiency and reliability is available to meet the community's needs. In addition to hiring new staff, ANL will collaborate with other DOE laboratories (especially ORNL and LBNL), the University of Chicago, Northwestern, and the University of Illinois and other universities to build strong software development teams.

3. Genomics, Systems Biology, and Structural Biology

- **Summary:** Argonne will combine its world-class expertise in structural biology and bioinformatics with growing investment in systems biology to develop a comprehensive approach to the study of complex biomolecular systems. The goal is to use biological systems as a basis for solving fundamental problems in biofuel production, environmental remediation and carbon cycling.
- **Expectations:** A comprehensive approach to the design and management of microbial systems that can be used in a wide variety of industrial and environmental contexts in which they will provide cost-effective alternatives to physical processing strategies.
- **Benefit Perspective:** Potentially *Substantial* benefits.
- **Risk Perspectives:**
    - Technical: *Moderate risk* -- because engineering of complex systems is a developing capability.
    - Market/competition: *High risk* -- for the bioenergy part of the program because many groups are investing heavily in this area; moderate risk for other parts. These risks are mitigated by the broad range of potential applications of the developing technology.
    - Management/Financial: *Moderate risk*-- because although funding may become available from diverse sources, the needed technical advances may require prolonged investment.

Research at the interface of structural and systems biology is poised to lead to significant advances in our understanding of the function of molecular complexes that are key to the functioning of the cell. These breakthroughs will have immediate and substantial impact on applications to DOE mission needs. Existing Argonne programs will position the laboratory for significantly increased programmatic support of fundamental research through the DOE Genomics: GTL Program as well as through NIH and other agencies. Currently, Argonne is partnering with regional institutions to apply for a DOE GTL Bioenergy Research Center.

With the University of Chicago, Argonne has formed the joint Institute for Genomics and Systems Biology (IGSB) to drive forward capabilities in this field. The State of Illinois has funded the construction of the Advanced Biosciences Facility, a $33M building that will house programs in structural and systems biology including the IGSB. Initial planning for this facility is underway, with construction scheduled to begin in FY 2008 and be completed in FY 2010.

4. Integrated Energy, Environment & Economic Research

- **Summary:** Combine ANL's expertise in decision science, computational, fundamental, and applied research with social/economic science capabilities to develop a suite of products and tools that advance DOE's mission to provide a more diverse, sustainable and secure energy future for the Nation while mitigating environmental impacts.
- **Expectations:** An integrated analytical science and engineering-based energy/environment/economic and social modeling framework to provide the DOE with a new capability for (1) informing policy and investment decisions leading to a more diverse, sustainable and secure energy future; (2) developing new technology options, primarily in the transportation, transmission and nuclear generation sectors; and (3) integrating R&D programs from basic to applied to deployment.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
    - Technical: *Moderate risk* -- in terms of developing a decision-support framework; *High*

risk in terms of developing specific technologies due to uncertainties in basic research.
  - Market/Competition: *High risk* because many different organizations (public and private) are competing for market share in this area.
  - Management/Financial: *Low risk* because the programs will be implemented incrementally.

The DOE currently lacks an integrated approach to the analysis of the impacts that technology options have on energy utilization and production, the economy, and the environment. ANL's ability to draw upon the systems and decision modeling expertise, as well as the basic and applied scientific talent, contained within the lab and the social/economic sciences capabilities of the University of Chicago (together with its partner universities Northwestern University and the University of Illinois) presents an opportunity to provide analytical capabilities that DOE has never before had available.

This investment exploits ANL's considerable technical expertise in advanced materials synthesis and characterization, nuclear fuel cycle and reactor design, transportation science and engineering, molecular photochemistry, computational sciences, and large-project delivery. It is anticipated to have broad economic impact, e.g., reduced dependence on foreign petroleum, more efficient energy production, and a significant reduction in greenhouse gas emissions.

Financial Outlook

Detailed information regarding the financial outlook for the Argonne National Laboratory is subject to 1) competition and merit review, 2) the availability of appropriated funds, and 3) programmatic decisions. The first two factors cannot be predicted or estimated in advance. The third, programmatic decisions are developed in accordance with the planning targets reflected in the Department of Energy programmatic Five Year Plans, a companion document to these strategic laboratory business plans. In addition, because of the Office of Science commitment to competition and merit review, there is often a time lag between programmatic decisions and the determination of which research provider can best deliver the greatest value in conducting the research. Thus, it is not always apparent how programmatic decisions unfold for particular laboratories. Nevertheless, some decisions, such as the plans for large scientific user facilities, show clear paths to individual labs and therefore inform their business plans.

Performance of non-DOE funded work is a vital role of our national laboratories, contributing to national security, energy security, environment stewardship, scientific discovery, and more fundamentally, the competitiveness of the U.S. economy. For the Argonne National Laboratory, this is no exception. The Office of Science is supportive of this work and although it is not addressed in any detail within the accompanying Five Year Plans, the Office of Science believes it is sufficiently important and appropriate to address within this strategic laboratory business plan. A brief perspective and financial outlook is therefore provided.

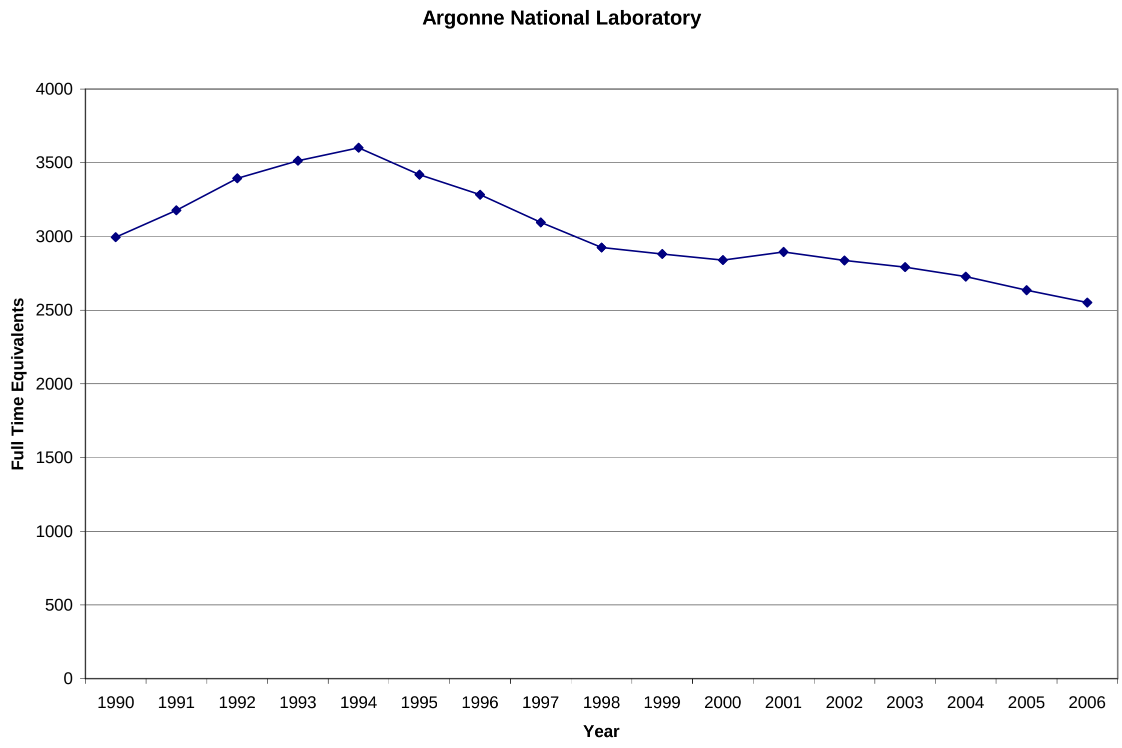
Argonne's non-DOE funded work engages both the Federal and private sectors and represents approximately 25% of the laboratory's total budget. The major ANL non-DOE federally funded activities are primarily supported by the Department of Homeland Security, focused on infrastructure assurance; the National Institutes of Health, emphasizing but not limited to protein characterization; the Department of Defense, covering a broad range of specialized technical (and often classified) assistance, infrastructure assurance, environmental assessments and nuclear-related issues; the Department of Agriculture, for hazardous waste assessments; the Department of State, in support of the International Atomic Energy Agency; and the Nuclear Regulatory Commission, providing a technical basis for regulatory decisions. It is anticipated that each of these areas will continue to grow. Also anticipated is that the Intelligence Community will become a key sponsor over the next five years. Argonne's work for the private sector is varied and is typically a much smaller effort per project and of shorter duration than that for the Federal sector. Typical current work examples include locomotive engine combustion studies for GM Electromotive and EUV lithography support for Intel.

Uncertainties and Risk Management

External Factors: Over the next five years, ANL will have a number of concerns driven by external forces. ANL's future is directly coupled with Federal support for a broad science and technology program.

S&T Workforce: ANL's ability to recruit and retain scientific staff and maintain relationships with external partners (universities, other labs, private industry) is vital to its ability to maintain core science and technology programs. At the postdoctoral level, ANL has revamped its core program by making it more competitive and providing more fellowship positions. The Office of Science has requested that ANL, along with other laboratories, explore and/or expand such incentives as onsite daycare and flexiplace working arrangements to attract the best and brightest to replace its aging workforce and Argonne has accepted these specific recommendations and has undertaken additional activities mentioned in the following discussion of diversity.

Workforce Trends



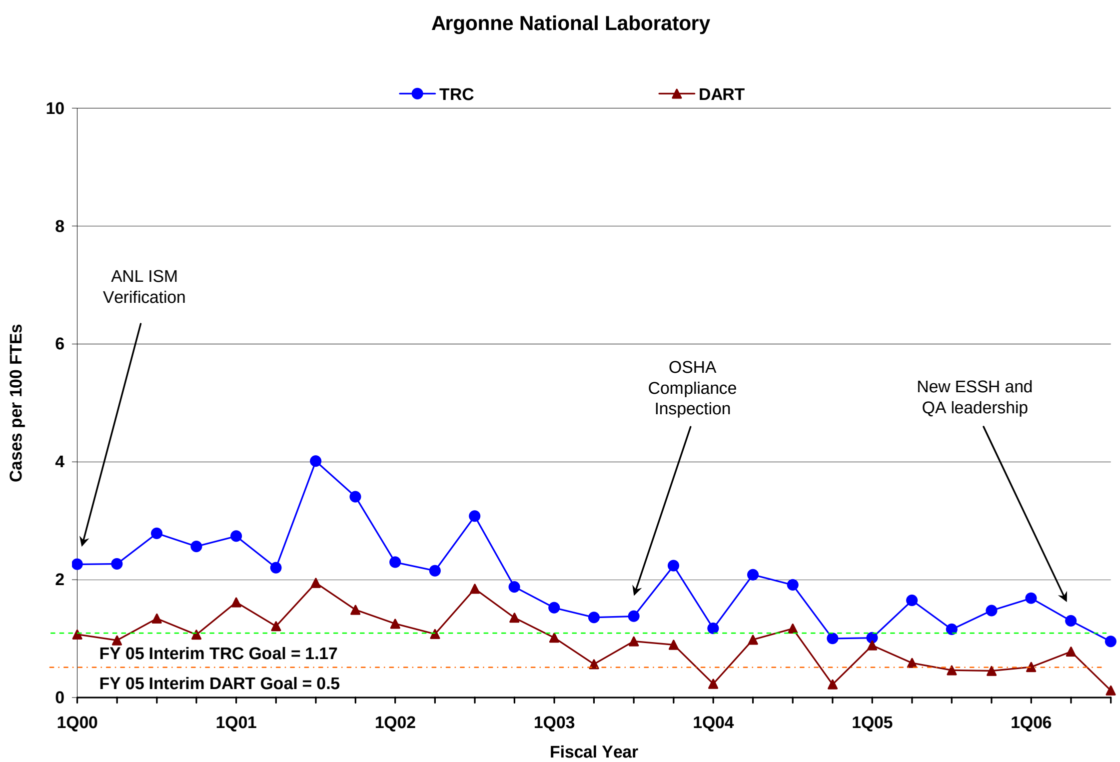
Workforce Diversity: As with most DOE labs, ANL must make significant progress in the recruitment and retention of under-represented populations. Developing a new strategy for attracting, developing and retaining world-class talent is a priority during FY 2007 as the laboratory tries new approaches to workforce planning. Particular attention is focused on improving and retaining workforce diversity and strength by leveraging partnerships with regional universities and targeted professional societies to develop longer-term relationships; insisting on wide searches and qualified diverse candidates for each job posting; encouraging an inclusive culture through training and development opportunities; maximizing the value of employee affinity groups as laboratory resources; addressing exit issues critical to retaining a diverse workforce; and continuing effective educational outreach programs to maintain a diverse workforce development pipeline.

Safety: Argonne is continuing to improve its safety culture and performance. The laboratory is bolstering its environment, safety, and health efforts and its quality assurance efforts under newly placed leadership and through management-supported rigorous self-assessment activities. Under the new contract with UChicago Argonne LLC, Jacobs Engineering and BWXT will bring their "best practices" in safety to the lab. One of these best practices is the Jacobs behavior-based safety program. BWXT will bring its expertise to bear on improving the nuclear safety compliance program and will play a significant role in refining continuous-improvement processes that are now under way.

Immediate challenges facing Argonne include improved nuclear safety compliance; the advent of 10CFR851, Worker Safety and Health; and the revamping of the lab's quality assurance program. As part of its program to improve nuclear safety compliance, the lab has created a stand-alone nuclear operations division.

Argonne is committed to several short- and long-term goals intended to achieve and institutionalize safety and quality improvements, including ISO 14001 certification of the environmental management program and ISO 9001 certification of the laboratory's business systems. On a longer timeline is the lab's commitment to strive for DOE Voluntary Protection Program "Star" status for its safety and health programs.

DART and TRC Rates and Major Safety Initiatives



Physical Infrastructure: ANL is located on a 1,500 acre federal reservation near Chicago, Illinois. Established in the late 1940s, it has 4.5M square feet of space in 99 buildings. Sixty percent of its space, as well as most of its utility systems and roads, are over 40 years old. ANL's Asset Utilization Index (AUI) is 0.96 for offices, 0.95 for laboratories and 0.98 for warehouses. The replacement plant value of ANL's general purpose facilities is $1.534B.

Maintenance, recapitalization, and modernization are supported both with overhead (for maintenance and Institutional General Plant Projects [IGPP]), operating, and GPP funds, and with line-item funding (for projects that cost $5M or more). ANL attained a maintenance investment index of 2.1% of replacement plant value (excellent) in FY 2006, which will be continued in FY 2007 and the out-years. ANL's deferred-maintenance (DM) backlog is $62.5M. The Asset Condition Index (ACI) is 0.96 for mission critical facilities (the DOE goal is 0.964 or above) and 0.96 for mission dependent facilities (the DOE goal is 0.948 or above). ACI is computed as 1 minus the result of deferred maintenance divided by replacement plant value. To reduce the DM backlog, thereby improving the ACI, ANL has initiated a deferred maintenance reduction effort with $1.982M of funding in FY 2008. The laboratory will begin funding $2M of IGPP in FY 2008 to address roofing needs.

The proposed FY 2008 funding for the cleanup and demolition of excess facilities is $469,000 to complete demolition of Building 40, Calibration Laboratory. While the Office of Environmental Management is currently funding the demolition of some excess facilities (e.g., Building 301 Hot Cells), ANL has a backlog of excess facilities with an estimated disposition cost of approximately $185 million, including many that were not built and operated by the Office of Science such as the Alpha Gamma Hot Cell Facility and Building 200 Hot Cells.

The FY 2008 GPP funding request is for $5.7M. Funding has been approved for one new $17M line-item project, Building Electrical Services Upgrade, Phase II, started in FY 2007. This project will upgrade critical portions of the electrical power distribution system in 18 multiprogram buildings and five support facilities, including the cooling towers that supply cooling water for site experiments. ANL's future recapitalization and modernization challenges include laboratory roofs, space modernization, roads/parking/lighting upgrades, fire safety improvements, and central heating plant upgrades, as well as the cleanup and demolition of numerous contaminated facilities. The laboratory is working to achieve the goals for energy reduction and use of renewable energy established in the Energy Policy Act of 2005.

Department of Energy Laboratory Plan
For the Office of Science's
Brookhaven National Laboratory

Mission and Overview

Established in 1947, Brookhaven National Laboratory (BNL) originated as a nuclear science facility, conceived by representatives of nine major eastern universities. Today, BNL maintains a primary mission focus in the physical sciences, basic energy sciences, and biomedical sciences, with additional expertise in environmental sciences, energy technologies, and national security. BNL brings specific strengths and competencies to the Department of Energy (DOE) laboratory system to produce excellent science and advanced technologies with the cooperation and involvement of the scientific and local communities. In support of its Office of Science mission, BNL builds and operates major scientific facilities. These facilities serve not only the basic research of the DOE, but they reflect BNL and DOE stewardship of national research infrastructure that is made available on a competitive basis to a wide range of university, industry and government researchers. The Relativistic Heavy Ion Collider (RHIC)-Alternating Gradient Synchrotron (AGS) complex and the National Synchrotron Light Source (NSLS) are the two facilities that account for most of the approximately 4,000 scientists/year served at BNL. To date, six Nobel Prizes have been awarded for discoveries made at the laboratory.

Laboratory Focus and Vision

Four core competencies underpin activities at Brookhaven National Laboratory:

1. Conceptualization and design of advanced accelerators, detectors, magnets, and instrumentation
2. Synchrotron radiation science and technology
3. Imaging expertise (including both radiotracer chemistry and imaging instrumentation)
4. Advanced software and computing facilities for analysis of High Energy Physics and Nuclear Physics data

Lab-at-a-Glance

Location: Upton, NY

Type: Multi-program lab

Contract Operator: Brookhaven Science Associates

Responsible Field Office: Brookhaven Site Office

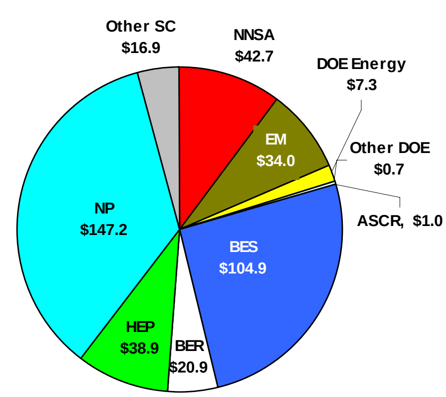
Website: http://www.bnl.gov/

Physical Assets:
- 5,300 acres and 336 buildings
- 3.8M GSF in Active Operational Buildings
- 34K GSF in Non-Operational Buildings
- Replacement Plant Value: $1.553B
- Deferred Maintenance: $90.3M
- Asset Condition Index:
  - Mission Critical 0.95 (Good)
  - Mission Dependent 0.91 (Adequate)
- Asset Utilization Index: 0.97 (Good)

Human Capital:
- 2582 full time employees
- 1550 students (Undergrad and grad)
- 4000 Facility Users and Visiting Scientists

FY 2006 Total DOE Funding: $414.6M

FY 2006 DOE Funding by Source
PALS data (BA in Millions):



FY 2006 Non-DOE Funding: $55.3M
FY 2006 Dept. Of Homeland Security: $2.6M

The Office of Science believes that these four competencies will enable BNL to deliver its mission and customer focus, to perform a complementary role in the DOE laboratory system, and/or to pursue its vision for scientific excellence and pre-eminence in the following areas:

- High-energy heavy ion and spin physics research to understand the essence of nuclear matter
- Functional nanomaterials for energy technology applications
- Translational biomedical imaging to understand the origin of addiction and other disorders that might lead to cures.

Business Lines

The following capabilities, aligned by business lines, distinguish BNL and provide a basis for effective teaming and partnering with other DOE laboratories, universities, and private sector partners in pursuit of the laboratory mission. These business lines and the distinguishing capabilities outlined in the table below provide an additional window into the mission focus and unique contributions and strengths of BNL and its role within the Office of Science laboratory complex. Items in italics within the Distinguishing Capabilities column identify research facilities that convey particular strategic strengths and capabilities to the laboratory. Descriptions of these facilities are available at the website noted in the Lab-at-a-Glance section of this Plan.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
Nuclear Physics	• Relativistic heavy ion physics; • Proton spin studies with beams of polarized protons; • Quantum Chromodynamics (QCD) theory; • High Performance Computing effort in Lattice QCD; • Accelerator design and R&D in advanced beam cooling techniques; • Advanced detector instrumentation & electronics; • *Relativistic Heavy Ion Collider (RHIC).* • ***RHIC Computing Facility.***	RHIC, a unique world-class accelerator facility for colliding intersecting beams of symmetric or asymmetric nuclei and polarized protons; AGS Booster accelerator delivers dedicated Heavy Ion beams to the new NASA Space Radiation Laboratory (NSRL). Joint U.S.-Japan Riken Research Center dedicated to the study of strong interactions and spin physics. The new state of strongly interacting matter produced by the collisions at RHIC was cited by AIP as the top physics story of 2005, and by several other organizations. Highly cited nuclear theory group with over twelve thousand citations to papers by senior staff	Search for and characterize quark-gluon plasma. Understand the structure of the nucleon.
Basic Energy Sciences	• Novel X-ray and Ultraviolet/Infrared techniques; • Strongly correlated systems in materials research; • Fuel cell nanoparticle synthesis and reactivity; • *National Synchrotron Light Source (NSLS);* • *Center for Functional*	Nobel Prize in Chemistry for research conducted at NSLS; NSLS-II (PED) expected to have 1nm spatial resolution, 0.1meV energy resolution, and world's highest brightness; Since discovery of high Tc superconductors and start of BNL's strongly correlated electron program in 1987, BNL has produced 35 papers with >200 citations, 7 papers with >500 citations (of which 3>1000 citations);	Advance core disciplines of basic energy sciences. Lead nanoscale science revolution (BNL's focus is to promote U.S. energy security). Master control of energy-relevant complex systems.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
	Nanomaterials (CFN).	Fuel cell electrocatalysis program cited (Science, 9/29) as an example of SC's basic research for building cheaper fuel cells, focusing on hydrogen.	
Bio-medical Sciences	• Radiotracer, instrument and technique development; • PET/fMRI for translational neuroimaging focused on addiction; • Structural Biology; protein crystallography; • *Scanning Transmission Electron Microscope (STEM); cryo-EM;* • *Center for Translational Neuroimaging (CTN).*	Leader on the subject of the impact of addiction on the brain as determined by major external scientific awards to several staff members (National Academy of Sciences, National Institute of Medicine, American Chemical Society National Awards, PECASE, DOE/BER Medical Sciences Distinguished Fellow, etc.) New IPO based on BNL-discovered anti-addiction drug research	Master the convergence of physical and life sciences for health & medicine.
Climate Change Science	• Significant capabilities in aerosol research; • *Free Air Carbon Dioxide Enrichment (FACE) Facility.*	Chief scientists for the DOE Atmospheric Science and Atmospheric Radiation Measurement (ARM) Programs, as well as the ARM Mobile Facility Scientist are BNL researchers. Operates ARM External Data Center	Unravel mysteries of earth's changing climate.
High Energy Physics and Physics Instrumentation	• Detector expertise in the calorimeter and muon systems (U.S. ATLAS[1] detector for the Large Hadron Collider [LHC]); • Low noise electronics and innovative detectors for particles and photons; • *Accelerator Test Facility (ATF).*	Five Nobel Prizes in Physics awarded for discoveries that point to physics beyond the Standard Model; Key role in transition from construction project to research program for U.S. ATLAS; hosts Tier I Computing Facility and Analysis Support Center; Leading role in defining proposal on Deep Underground Science and Engineering Laboratory (DUSEL) and the next-generation long-baseline neutrino oscillation with FNAL; Leadership roles in project management and antineutrino detector design, the muon tracker, and the liquid scintillator for the Daya Bay Experiment; Innovative contributions to the proposed International Linear Collider (ILC) final focus; Home to the ATF, the first user facility for advanced accelerator research; it is dedicated to long-term R&D in the physics of particle and laser beams	Search for possible Physics Beyond the Standard Model and extend it to an all-inclusive theory.
Nuclear Data Program	• *National Nuclear Data Center.*	Number of data retrievals (>1,000,000 in FY 2006) far exceeds that of any other	Understand structure of nucleonic matter and for development of applied technologies (power plants,

[1] http://atlasexperiment.org/

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
		nuclear data center	national security, and medicine).

Major Activities

Following is a set of major activities that BNL is pursuing to support aspects of the DOE mission and build on core strengths and capabilities of the laboratory. These activities are either currently supported or appear in the FY 2008 budget submission to Congress.

The major activities are:

1. National Synchrotron Light Source-II (NSLS-II) PED
2. Relativistic Heavy Ion Collider (RHIC)
3. Nanoscience research
4. Translational Biomedical Imaging
5. Energy

1. NSLS-II PED

- **Summary:** The proposed billion-dollar-class NSLS-II would be the world's most advanced storage-ring-based synchrotron light source, and together with advanced insertion devices, optics, detectors, and a suite of scientific instruments, will accommodate radically new types of experimental capabilities.
- **Expectations:** The unique characteristics of NSLS-II would open up new regimes of scientific discovery and investigation, and enable exploration of: the correlation between nanoscale structure and function; the mechanisms of molecular self-assembly; understanding of structural molecular biology; and the science of emergent behavior, especially for correlated electron systems
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
  - Technical: *Moderate risk* -- due to technical specifications of 1 nm spatial resolution and 0.1 meV energy resolution. Achieving such high spatial resolution has stimulated efforts in the worldwide synchrotron optics community to develop the required advanced optics for NSLS-II. An innovative design incorporating damping wigglers was developed to provide world leading brightness.
  - Market/Competition: *Moderate risk* -- Although NSLS-II would be best in class, other light sources worldwide are also pursuing aggressive goals in areas of spatial and energy resolution.
  - Management/Financial: *High risk* due -- to world-class team requirement and magnitude of funding required. Maintaining positive relationships with all stakeholders is essential in order to complete the project. Construction funds have not yet been requested for this project.

For the discovery potential of the NSLS to continue beyond the next decade, BNL would like to upgrade its capability by constructing the world's best synchrotron light source, NSLS-II, a 3rd generation storage ring, together with advanced insertion devices, optics, detectors, and a suite of scientific instruments. The NSLS is the first dedicated and the only remaining second generation DOE synchrotron light source. It has been operating since 1982 and serves on average 2300 users/year. However, its capabilities are restricted because the brightness has reached its theoretical limit after many stages of improvement and only a small number of insertion devices are possible. These factors will increasingly limit the scientific productivity and impact of its large user community.

NSLS-II would deliver the world's highest brightness and flux, an increase over those of the current NSLS by more than 10,000 times and 10 times, respectively, and unprecedented stability. Its advanced optics will produce spatial resolution of 1 nm and energy resolution of 0.1 meV. The unique characteristics of NSLS-II will open up new regimes of scientific discovery and investigation. It would enable exploration of the correlation between nanoscale structure and function, the mechanisms of molecular self-assembly and the science of emergent behavior, especially for correlated electron systems. These are precisely the challenges for Basic Energy Sciences posed in the *Office of Science Strategic Plan*. NSLS-II would advance nanoscale science leading to improved energy technologies and systems. In addition, it would provide the Nation's science community access to a world leading research facility, and U.S. industry a competitive advantage for new materials beyond silicon.

DOE approved the mission need for NSLS-II in the fall of 2005. A construction start has not yet been approved by DOE.

2. RHIC

- **Summary:** The scope of this activity is to conduct research at the RHIC facility and evolve the accelerator and instrumentation to study the states of matter that existed in the early moments of the Universe, to understand the spin of the proton and to further study quantum chromodynamics (QCD), the theory of strong interactions of quarks and gluons, experimentally and theoretically. The major experiments at RHIC, STAR and PHENIX, are in the process of being upgraded to provide new capabilities. The Electron Beam Ion Source (EBIS) is an accelerator upgrade which will replace the current Tandem as the heavy ion injector, improving reliability and leading to more cost effective operations. Accelerator R&D is being conducted to demonstrate the feasibility of electron cooling, a necessary component for possible beam luminosity upgrades.

- **Expectations:** RHIC will play a major role in determining: the nature of the quark-gluon plasma and the visible universe; the origin of the spin of the proton; and the role of the color glass condensate in the structure and interaction of high energy hadrons
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
  - Technical: *High risk* -- due to challenges associated with electron cooling and the superconducting energy recovery linac. In a major technical breakthrough, stochastic cooling of a bunched beam, which in the long run will complement e-cooling, was recently demonstrated at BNL.
  - Market/Competition: *Low risk* -- since the facility would offer unique capabilities.
  - Management/Financial: *High risk* – Although the ongoing accelerator and detector upgrades are relatively low risk, significant upgrades in beam luminosity would require substantial investments.

Results from RHIC help scientists study what the Universe may have looked like in the first few moments after its creation, which, in turn, help scientists to understand the large-scale structure of the Universe. RHIC has had a tremendous impact in nuclear physics and science, with over a hundred experimental papers being cited more than five thousand times, and a comparable body of theory papers. The April 2005 announcement that RHIC's heavy ion collisions are producing a "perfect liquid" (instead of the postulated gas) topped the *American Institute of Physics'* list of top physics stories for 2005, as well as being cited at year end by *Science News*, *USA Today*, and *Discover*. Furthermore, RHIC is an outstanding educator of nuclear physicists, with about 30 Ph.Ds per year granted for RHIC research.

3. Nanoscience

- **Summary:** Nanoscience at BNL exploits the synergy of the research conducted at the Center for Functional Nanomaterials (CFN), NSLS, and in the future, NSLS-II. The CFN will provide state-of-the-art capabilities for understanding and using the unprecedented functionality of nanomaterials to promote U.S. energy security.
- **Expectations:** To develop the scientific foundation and tools for the design and creation of functional nanomaterials toward: an atomic level view of reactivity in nanocatalysts; bio-inspired assembly of hybrid systems for energy manipulation; tailored nanomaterials for solar energy conversion; and non-noble metal fuel cell catalysts.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
    - Technical: *Low risk* -- CFN scientific themes are associated to core programs, and coordinated facilities are tied to existing expertise.
    - Market/Competition: *Moderate risk* as nanoscience is an emerging field, in which the competition is worldwide. The CFN will be the last DOE nanocenter to be constructed.
    - Management/Financial: *Low risk* -- success of the CFN relies on a team approach that integrates research programs and facilities. BNL developed a policy on handling engineered nanoparticles that is being implemented by the other Nanoscale Science Research Centers (NSRCs) and is proactive in communicating ES&H issues/policy to staff, regulators, and the public. The CFN construction is nearly completed. A recent Lehman review indicated that the project is well managed.

Nanoscience offers a new approach to address the energy security challenges facing the U.S. through the development of materials exhibiting novel and unprecedented functionality for energy manipulation and utilization. The CFN is one of five NSRCs in development at DOE's Office of Science labs, which will provide research facilities for the synthesis, processing, and fabrication of nanoscale materials. The NSRCs make accessible to the research community specialized equipment and the expertise of support staff not available at their home institutions. Each facility has a unique focus. Research at CFN will focus on nanoscience for energy security in the areas of nanostructured catalysts**,** electronic nanomaterials**,** and bio/soft nanomaterials and interfaces in order to develop the scientific foundation and tools for the design and creation of functional nanomaterials.

The specific objectives are to understand reactivity in nanocatalysts at the atomic level using the CFN, NSLS, and NSLS-II; synthesize and characterize bio-inspired hybrid systems for energy manipulation; tailor nanomaterials for solar energy conversion, and devise non-noble fuel cell catalysts. BNL is on schedule to begin full CFN operations in April 2008.

4. Translational Biomedical Imaging

Summary: The objective of BNL's translational biomedical imaging program is to develop new scientific tools, including radiotracers and multi-dimensional imaging technologies, to image the function of the brain and other organs, and to rapidly translate BNL-developed imaging techniques and capabilities to knowledge that impacts human health.

- **Expectations:** A relatively small but significant activity – the unique combination of expertise in radiotracer chemistry, imaging physics, and preclinical and clinical neuroscience – will enable BNL to emphasize instrument and technique development and ultimately translation to clinical practice.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
  - Technical: *Low risk* -- Imaging is a highly visible core competency at BNL. Advances in novel positron emission tomography (PET) applications and PET are stable and possibly growing. DOE's long-term investment in radiochemistry and imaging instrumentation at BNL is beginning to have a real payoff, in light of highly regarded results on addictive behaviors.
  - Market/Competition: *Moderate risk* --. Medical imaging is a very active area worldwide; BNL is unique in studying the impact of addiction on the brain. Two notable projects, advances with vigabatrin to treat substance abusers (also known as gamma-vinyl GABA or GVG) and Imaging the Awake Animal, are fueling BNL to gain a competitive market edge, as they succeed.
  - Management/Financial: *High risk* -- BNL's imaging programs were structured as the Center for Translational Neuroimaging to facilitate research and enhance program management. BNL has been proactive in collaborating with nearby institutions for translational research, which is an increasing focus at the National Institutes of Health (NIH).

This activity will evolve the capability of BNL's biomedical imaging program (the basis of the Center for Translational Neuroimaging (CTN)) in its studies of the function and response of the human brain to a variety of factors including addiction, aging, etc. and translate them to clinical use at the other end. To accomplish this, BNL will develop collaborations and joint appointments with neighboring research institutions and industry that emphasize forefront PET and MRI capabilities for animal and human studies and that enable the development of new tools, i.e., instruments and techniques based on existing core strengths. The impact is to improve human health, worldwide.

5. Energy

- **Summary:** Establish BNL as a recognized laboratory in energy R&D that is leading the development of advanced materials and processes for energy applications**.**
- **Expectations:** BNL's effort will directly support the mission of the Office of Basic Energy Sciences by conducting fundamental research for new and improved energy technologies and for understanding and mitigating the environmental impacts of energy use. The four areas where BNL will concentrate are biologically derived fuels, high performance materials, catalysis, and solar energy conversion, of which the latter three have direct connections to BNL's nanoscience effort.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
  - Technical: *Low risk* -- BNL has expertise in all four focus areas and is home to current (CFN, NSLS) and future (BG/L, NSLS-II) world-class facilities for accomplishing the research.
  - Market/Competition: *Moderate risk* -- Since President Bush's Advanced Energy Initiative outlines an energetic plan to help the U.S. move beyond its dependence on fossil fuels by expanding the development of alternative energy sources, the climate is advantageous for implementing a comprehensive strategy for energy R&D. However, the

competition is strong, especially in the areas of biofuels, catalysis, and solar energy. Forming external partnerships is essential to a viable energy program. The new Advanced Energy Research and Technology Center at SBU affords an opportunity for such collaboration. BNL has also been interacting with several New York energy and nanotechnology centers, other national laboratories, and private industry in this regard. BNL has strengthened its position by participating in the Laboratory Working Group, and is preparing to take advantage of the American Competitiveness Initiative and the Advanced Energy Initiative.

- Management/Financial: *Moderate risk* -- BNL's director established an Energy Steering Committee to develop a strategic plan for energy and a business case for targets of opportunity. BNL will identify strategic hires in key areas to reorient/rebuild programs and use discretionary funding to seed them. In addition, BNL is responding aggressively to the Office of Basic Energy Sciences (BES) grant solicitation notices.

BNL's effort will directly support the mission of the BES by conducting fundamental research for new and improved energy technologies and for understanding and mitigating the environmental impacts of energy use. The four areas of concentration are biologically derived fuels, high performance materials, catalysis, and solar energy conversion, of which the latter three have direct connections to BNL's nanoscience effort. The strategy will capitalize on unique strengths and facilities, i.e., the CFN, NSLS and NSLS-II, modeling/analysis capabilities, and energy efficiency test laboratories.

Financial Outlook

Detailed information regarding the financial outlook for the Brookhaven National Laboratory is subject to 1) competition and merit review; 2) the availability of appropriated funds; and 3) programmatic decisions. The first two factors cannot be predicted or estimated in advance. The third factor, programmatic decisions, is developed in accordance with the planning targets reflected in the Department of Energy programmatic Five Year Plans, a companion document to these strategic laboratory business plans. In addition, because of the Office of Science commitment to competition and merit review, there is often a time lag between programmatic decisions and the determination of which research provider can best deliver the greatest value in conducting the research. Thus, it is not always apparent how programmatic decisions unfold for particular laboratories. Nevertheless, some decisions, such as the plans for large scientific user facilities, show clear paths to individual labs and therefore inform their business plans.

Support for non-DOE funded work is vital to our national laboratories, contributing to national security, energy security, environment stewardship, scientific discovery, and more fundamentally, the competitiveness of the U.S. economy. For the Brookhaven National Laboratory, this is no exception. The Office of Science is supportive of this work and although it is not addressed in any detail within the accompanying Five Year Plans, the Office of Science believes it is sufficiently important and appropriate to address within this strategic laboratory business plan. A brief perspective and financial outlook is therefore provided.

The major BNL non-DOE federally funded activities are primarily supported by the National Institutes of Health (NIH), the National Aeronautics and Space Administration (NASA), the Nuclear Regulatory Commission (NRC), the Department of Homeland Security (DHS), and the Department of Defense (DoD). NIH currently funds aspects of biomedical imaging and molecular, cell, and structural biology at the laboratory; it is difficult to speculate about future NIH funding levels for imaging. NASA supports research to probe the effects of ionizing radiation on biological specimens and industrial materials at the laboratory; this support is expected to remain constant. NRC funding is likely to grow due to expected increases in nuclear plant licensing. DHS/DoD support for detectors and homeland protection is also expected to grow as BNL develops a business case for advanced nuclear detection.

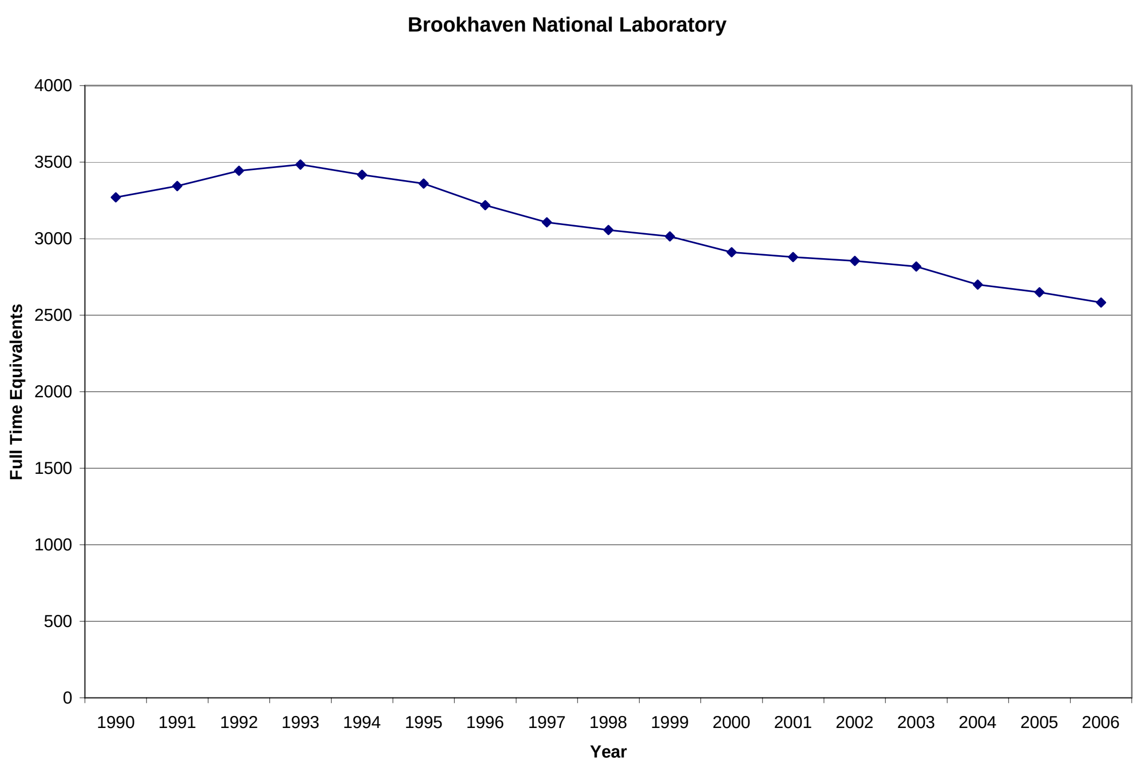
Other partnering agreements with state, university, community, and other business entities are also critical to the laboratory. In FY 2006, the largest commitments were $26M for a BG/L supercomputer from New York State (NYS); $30M for the Joint Photon Science Institute, a gateway to grow science projects that capitalize on the proposed NSLS-II, once it is sited BNL (also from NYS) and $13M from private investors at Renaissance Technologies, Inc. for RHIC operations.

Uncertainties and Risk Management

External Factors: Over the next five years, BNL will have a number of concerns driven by external forces. For example, the power rates beyond 2008 and the high cost of living on Long Island are of particular concern. The BSA prime contract expires in 2008 and that introduces uncertainty for the contractor, as it will be re-competed. With the large user population for the scientific facilities, implementing the unclassified foreign visits and assignments policy provides challenges to operations. Relations with the local community and New York political community are very good, but always require attention. Careful management, creative thinking, and the development of risk mitigation strategies will need to occur to handle each one of these significant items.

S&T Workforce: BNL faced challenges with reductions in laboratory staffing in FY 2006. As of September 30, 2006, BNL employed 2582 Full Time Equivalents (FTEs), a reduction of 40 FTEs. With scientific opportunities at the CFN and NSLS-II beginning to emerge, this trend should start to reverse.

Workforce Trends

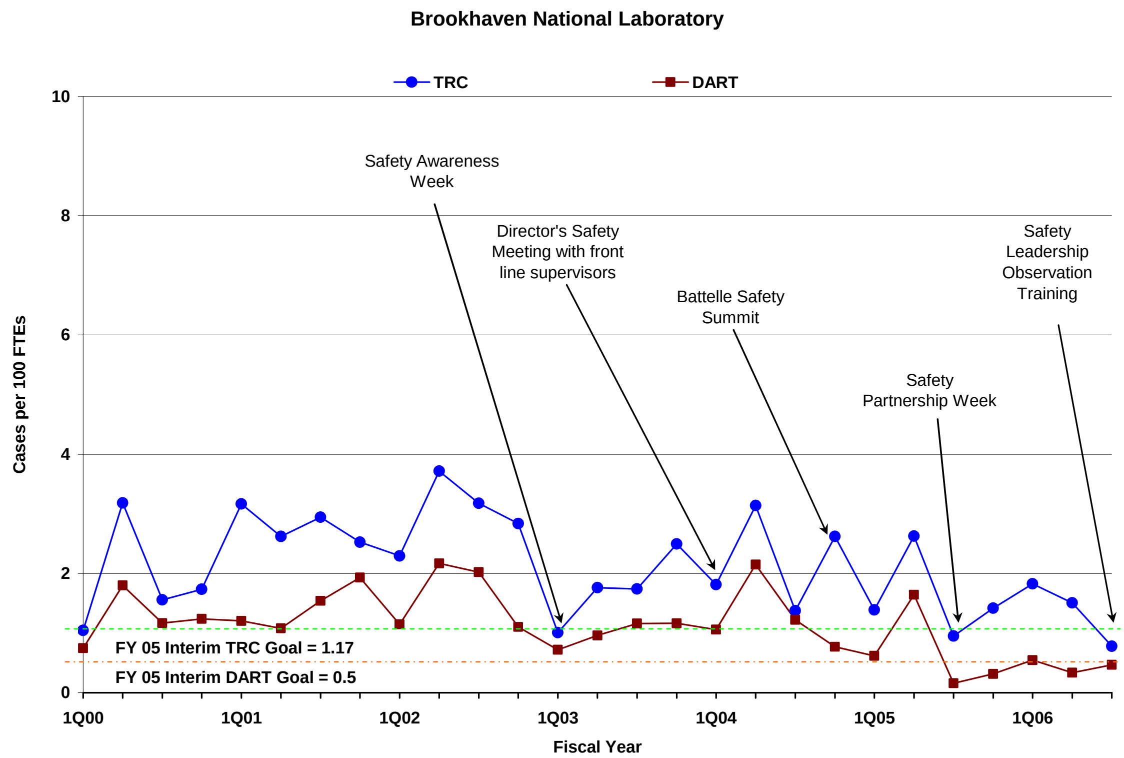


Employee Diversity: BNL's workforce is 79% Caucasian and 21% minority, as compared to the corresponding national averages of 73% and 27%. BNL intends to increase the number of minorities on both the scientific and support staffs, and has taken several steps such as: subsidizing the salary of underrepresented scientific/professional staff; building partnerships with historically black colleges and universities (HBCUs), minority serving institutions (MSIs), and minority professional associations; increasing communication tools and training to support diversity practices; and partnering with corporate affiliates to identify viable diversity candidates to achieve this. Additionally, BNL has invested in on-site daycare and is working with the county and state to take advantage of recruitment and retention programs, subsidies, and housing to attract/retain the best and brightest staff. Specific targets and goals over the next several years (and progress in meeting them, where applicable) include:

- Increase representation of minority scientists, which will be accomplished by requiring each directorate to designate staff to receive, review, and provide feedback to Human Resources and the Diversity Office on applicants' curriculum vitae (CV), thereby engaging scientific and professional managers in the recruitment process. To further implement this, in FY 2006 a working group was established to oversee the lab-wide review of CVs of Ph.D. level diversity candidates.
- Continue a succession-planning program that is designed to identify women and minorities as successors to key management positions.
- Continue the mentoring program for scientific staff and provide training in mentoring to 25% of lab employment by 2008.
- Establish a standard search procedure for all non-scientific positions by 2007.
- Continue to expose minority faculty from MSIs and HBCUs to BNL through the National Science Foundation (NSF) Faculty and Student Teams (FaST) program, which is administered through the Office of Educational Programs. Last summer BNL hosted fourteen FaST collaborations with BNL researchers. The goal is to host a minimum of five each summer.

Safety: The injury rate at BNL continued to decline during FY 2006 with a 33% decrease in DART (Days Away Restricted Time) and an 8% decrease in TRC (Total Recordable Cases) compared to FY 2005. Despite this progress, the FY 2006 goals for safety were not met. BNL's DART and TRC cases and major safety initiatives undertaken since 1998 are shown in the figure below. Reaching DOE's FY 2007 targets will be a significant challenge.

DART and TRC Rates and Major Safety Initiatives



BNL's strategy for improvement includes safety work observations, enhanced work planning, injury case management, Occupational Health and Safety Assessment Series (OHSAS) 18001 registration, and human performance initiatives. There have been some notable successes. Based on injury causal analysis, the lab's efforts to prevent injuries included a special focus on ergonomics, snow removal, "slips, trips and falls" and insect bites. Each of these efforts resulted in a reduction in the number and severity of injuries due to these causes.

The Phase 2 OHSAS organizations achieved registration, and the Phase 1 registration was maintained. The Management Review process of OHSAS has stimulated line ownership of safety performance and resulted in improvements at all levels. BNL piloted a "safety solutions" program to provide funding for safety improvement ideas submitted by employees. This program encouraged broad participation in the safety program in addition to making demonstrable safety improvements. Full OHSAS registration was recommended in the first quarter of FY 2007, making BNL the first DOE laboratory to achieve this distinction.

BNL provided safety observation training to Level 1, 2 and 3 managers during FY 2006. The presence of managers in the field and the interaction managers have with their staffs about safety is a key strategy for changing safety behaviors and improving safety in the workplace. The full deployment of the observation process is a primary safety performance improvement area for FY 2007.

BNL also developed an innovative and comprehensive approach to issues and event management during FY 2006. This system provides effective means of tracking, analyzing and trending issues and events including low-level issues and events. Senior managers have been trained in this area and over

50 employees were trained in performing causal analysis. Additional causal analysis and facilitator training is planned for FY 2007.

As BNL's integrated safety management system matures, the laboratory will be a recognized leader in ES&H. The three foundations for the safety culture at BNL and their chief features are:

1. Employee involvement: effective programs and policies that strive to include everyone on site in the safety and environmental program; a highly respected safety and environmental stewardship recognition program; routine and effective measures and surveys of safety culture to provide feedback to management; effective and productive employee safety committees; continual education and training on hazard identification and mitigation; a strongly reinforced stop work policy; and employee representation in developing safety and environmental policies, goals and objectives.
2. Management engagement: Driving principles of human performance throughout the organization; regular and systematic management review of safety and environmental performance; robust and useful self assessment and lessons learned processes that reinforce the learning organization; and feedback and improvement through direct and frequent observation of work.
3. Building and maintaining stakeholder trust and confidence: Maintaining robust and demonstrable continuous improvement that enables the continuity of third party registrations, such as ISO 14001 and OHSAS 18001; providing regular venues for involvement, such as the Community Advisory Council, Summer Sundays and the Brookhaven Executive Round Table; and regularly hosting safety and environmental conferences and workshops.

Physical Infrastructure: BNL is located on a 5,322-acre federal reservation on Long Island, approximately 100 kilometers east of New York City. Established in the late 1940's on the site of the Army's Camp Upton, the laboratory has 3.9M square feet (sf) of space in 336 buildings. Sixty-nine percent of its space, as well as most of its utility systems and roads, is over 40 years old. Twenty-two percent of the space is 60 years old or older. BNL's Asset Utilization Index (AUI) is 0.96 for offices, 0.97 for laboratories and 0.94 for warehouses. The replacement plant value of BNL's general-purpose facilities is $1.553B.

Maintenance, recapitalization and modernization are supported with overhead, operating, and GPP funds, and with line item funding. BNL attained a maintenance investment index of 2.0% of replacement plant value (excellent) in FY 2006, which will continue in the outyears. BNL's deferred maintenance (DM) backlog is $90.3M. The Asset Condition Index (ACI) is 0.95 for mission critical facilities (the DOE goal is 0.964 or above) and 0.91 for mission dependent facilities (the DOE goal is 0.948 or above). ACI is computed as 1 minus the result of deferred maintenance divided by replacement plant value. To reduce the DM backlog, thereby improving ACI, BNL has initiated a deferred maintenance reduction effort with $7.1M of funding in FY 2008.

The proposed FY 2007 funding for the clean up and demolition of excess facilities is budgeted at $697,000 with $650,000 expected in FY 2008. BNL's legacy cleanup program has transitioned to long-term response actions (i.e., maintaining systems to ameliorate past contamination). Decontamination and Decommissioning (D&D) of the laboratory's Brookhaven Graphite Research Reactor and High Flux Reactor is ongoing.

The FY 2008 GPP funding request is $7.3M. The Renovate Science Lab, Phase I, Line Item began in FY 2007. This project upgrades and rehabilitates existing obsolete and unsuitable laboratory facilities into modern, efficient facilities compatible with world-class scientific research with a TEC of $18M. Construction of the 65,000 sf Research Support Building was recently completed. The new building allowed consolidation of Staff Services, Public Affairs, Human Resources, Credit Union, User Reception, and other support functions into a modern building designed for these functions. The co-location of functions allows more efficient and convenient service to BNL staff and visiting scientists. The RSB is expected to achieve a silver rating in the Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system.

BNL's future recapitalization and modernization challenges include building replacements and modernization, utility system renovations, and clean-up of excess facilities. The laboratory is working to achieve the goals for energy reduction and use of renewable energy established in the Energy Policy Act of 2005.

Department of Energy Laboratory Plan For the Office of Science's Fermi National Accelerator Laboratory

Mission and Overview

Fermi National Accelerator Laboratory (FNAL), also known as Fermilab, is the largest U.S. laboratory dedicated to research in particle physics. The University Research Association built Fermilab in 1967 for the Department of Energy and continues to operate the lab today for DOE's Office of Science. Fermilab's mission goal in high energy physics focuses on understanding matter at its deepest level to identify its fundamental building blocks and understand how the laws of nature determine their interactions. Of the 18 fundamental subatomic particles that are known so far, three have been discovered at Fermilab: the bottom quark (1977), the top quark (1995) and the tau neutrino (2000). The original Fermilab Main Ring became the world's highest energy accelerator when it started operation in 1971. The Tevatron, commissioned in 1983, was the first large proton accelerator based on superconducting magnet technology. Since 1985 Tevatron has remained the highest energy proton accelerator in the world, where antiprotons and protons collide with energy of 2 Trillion electron Volts (TeV). Unique capabilities in high energy physics are available to the scientific community that include the Booster and Main Injector pre-accelerators, and the Neutrinos at the Main Injector which operate as part of the Tevatron complex but can be used independently. Fermilab provides leadership and resources for over 2,300 researchers to conduct basic research at the frontier of high energy physics and related disciplines.

Laboratory Focus and Vision

Fermilab has a central role in the field of particle physics, both in the U.S. and worldwide. Fermilab's present and future program relies on maintaining world-leading core competencies in:

1. Construction and operation of experimental facilities for particle physics and particle astrophysics
2. Research, design, and development of accelerator technology

Lab-at-a-Glance

Location: Batavia, IL

Type: Program Dedicated Lab

Contract Operator: Fermi Research Alliance, LLC

Responsible Site Office: Fermi Site Office

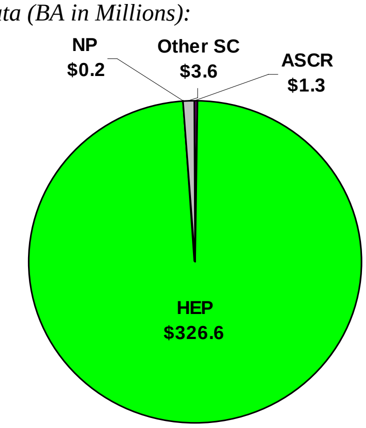
Website: http://www.fnal.gov

Physical Assets:
- 6,800 acres
- 346 buildings
- 2.3M GSF in Active Operational Buildings
- Replacement Plant Value: $608M
- Deferred Maintenance: $39.3M
- Asset Condition Index:
  - Mission Critical 0.91 (Adequate)
  - Mission Dependent 0.96 (Good)
- Asset Utilization Index: 1.0 (Excellent)

Human Capital:
- 1968 employees;
- 2310 Facility Users and Visiting Scientists, including 615 Students (Undergraduate and Graduate)

FY 2006 Total DOE Funding: $331.6M

FY 2006 DOE Funding by Source
PALS data (BA in Millions):



FY 2006 Non-DOE Funding: $0.3M

3. High-performance scientific computing and networking
4. International scientific collaboration
5. Theoretical particle physics and particle astrophysics

The Office of Science believes that these five competencies will enable Fermilab to deliver its mission and customer focus, to perform a complementary role in the DOE laboratory system, and to pursue its vision for scientific excellence and pre-eminence in the following areas of particle physics:

- The quantum vacuum, including the Higgs field, supersymmetry, and dark energy;
- The particle zoo, the collection of 57 leptons, quarks and force carriers;
- Unification phenomena, whether all of the forces can be described with a unified theory;
- Origins of space and time, including extra dimensions and quantum gravity.

Business Lines

The following capabilities, aligned by business lines, distinguish Fermilab and provide a basis for effective teaming and partnering with other DOE laboratories, universities, and private sector partners in pursuit of the laboratory mission. These business lines and the distinguishing capabilities outlined in the table below provide an additional window into the mission focus and unique contributions and strengths of Fermilab and its role within the Office of Science laboratory complex. Items in italics within the column, Distinguishing Capabilities, identify research facilities that convey particular, strategic strengths and capabilities to the Lab. Descriptions of these facilities can be found at the website noted in the Lab-at-a-Glance section of this Plan.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
Collider Physics	• US-Large Hadron Collider (LHC); • US-Compact Muon Solenoid (CMS); • *Tevatron, the Collider Detector at Fermilab (CDF) and Dzero.*	Highest energy and highest luminosity proton-antiproton accelerator in the world; Peak luminosity 3 10^{32} $cm^{-2}sec^{-1}$; sustained performance 40 inverse picobarns per week at 2TeV cm energy..	Explore the fundamental interactions of energy, matter, time, and space
Neutrinos	• *Neutrinos at the Main Injector (NuMI) facility;* • *Main Injector Neutrino Oscillation Search (MINOS);* • *MiniBOONE.*	Highest neutrino flux in the world (300kW proton power on target); unique oscillation experiments MINOS (5kton detector) and MiniBooNE (800 ton detector)	Explore the fundamental interactions of energy, matter, time, and space
Particle Astrophysics	• Sloan Digital Sky Survey; • Cryogenic Dark Matter Search; • Dark Energy Survey R&D; • Auger South.	SDSS is the most used astrophysical survey with about 1000 refereed publications and first measurement of baryon acoustic oscillation in the visible universe; CDMS best limits on direct detection of dark matter by a factor of 10. Fermilab leads the R&D for Dark Energy Survey.	Understand the cosmos
Quarks	• B-physics at the Collider Detector at Fermilab (CDF); • B-Physics at Dzero; • US Lattice Quantum ChromoDynamics (LQCD) collaboration.	Discovery of B_s oscillations (three trillion oscillations per second) limiting the range of supersymmetric models; most precise measurements of the top quark and W boson masses narrow the range of possible Higgs Boson mass.	Explore the fundamental interactions of energy, matter, time, and space

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
Accelerator R&D	• LHC quadrupoles; • LHC Accelerator R&D Program (LARP); • International Linear Collider (ILC) superconducting RF lead;	Lead institution for the US participation in the development of the LHC collider and in the LHC R&D program (LARP); lead institution in ILC R&D and Superconducting RF technology development. Record improvements in the Tevatron luminosity	Advance accelerator technology for particle physics and other sciences Develop the technology that enables future accelerators at the energy frontier and at the intensity frontier. Develop super-conducting technology for high field magnets and accelerating structures for HEP, with spin-offs for other national needs
Theory	• Human capital; • High performance computing and networking.	Unique contribution by working directly with experimenters in particle physics and astrophysics; understanding the consequences of quantum chromodynamics in the extraction of signals for new particles in Tevatron, LHC and ILC..	Explore the fundamental interactions of energy, matter, time, and space

Major Activities

Following is a set of major activities that Fermilab is pursuing to support aspects of the DOE mission and build on core strengths and capabilities of the laboratory. These activities are either currently supported or appear in the FY 2008 budget submission to Congress. The companion documents, the DOE's Five Year Plans, provide greater insights into these activities in terms of various five-year budget scenarios.

The major activities are:

1. International Linear Collider R&D
2. Evolution of Fermilab Neutrino Program
3. Foundation: The Ongoing Program

1. International Linear Collider R&D

- **Summary:** The proposed International Linear Collider would allow physicists to make the world's most precise measurements of nature's most fundamental particles and forces by colliding individual fundamental particles rather than particles with a complex structure such as protons or anti-protons. The physics investigations envisioned at the ILC are both broad and fundamental, and will both require and support a leading-edge program of research for many years.
- **Expectations:** Physicists expect that a linear collider, operating initially at energies up to 500 GeV, will be needed to understand how forces are related and the way mass is given to all particles. This is dependent upon results from the current Tevatron program and especially from the upcoming Large Hadron Collider operations.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**

- Technical: *Moderate to High risk* – The technical challenges in the project are exemplified by the transverse beam sizes at collision (a few nanometers), by the requirement of providing very high electric field gradients to achieve the large energies, and by the exceptional control of the beams needed during the acceleration process.
- Market/Competition: *Low/Moderate risk* -- as there would be only one such international facility but competition to host this facility could be significant.
- Management/Financial: *High risk* -- due to large project costs, technical risk, and international project management issues.

The shared goal for the consortium of laboratories around the world working on the International Linear Collider (ILC) is to complete the R&D and preliminary design for a new electron-positron linear collider with energy in the range of 0.5-1.0 Tera electron volt (TeV). For Fermilab, the additional goals are to prepare for a bid to host the ILC on behalf of the U.S. and to be in a position to take leading roles in developing the detector and the research program. There are many scientific, technical, political, and economic challenges to this project that must be addressed before a decision to proceed.

To improve its position as a competitor for the ILC, Fermilab must establish world-class expertise in superconducting radio frequency (SCRF) technology. All of this will need to be done in collaboration with the Global Design Effort (GDE), the temporary organization that coordinates ILC R&D worldwide. The R&D program needed to develop SCRF capability for the ILC would take place over the near term.

2. Evolution of Fermilab Neutrino Program

- **Summary:** Maintain the leading position in neutrino physics through at least the middle of next decade with the Neutrinos at the Main Injector (NuMI) beam through a combination of efforts to increase beam intensity and add new detectors which are larger and more capable.
- **Expectations:** The neutrino activity would permit a comprehensive neutrino science program over a decade or more that would include the precision measurement of neutrino mass differences and oscillation parameters, plus very possibly the measurement of matter-antimatter asymmetries (CP violation) that could connect the neutrino sector to leptogenesis as a source of the matter-antimatter asymmetry of the universe.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
  - Technical: *Moderate risk* -- With proton beam near 1 megawatt (MW), the level of power is similar to other high-intensity proton machines, such as the Spallation Neutron Source or the J-PARC facility under construction in Japan. The strategy being implemented relies on upgrading and conversion of existing accelerators currently used to store antiprotons at modest intensities into facilities that can accumulate protons at very high intensities. Issues related to high intensity operations are similar to those experienced in other high intensity proton facilities including the Main Injector at Fermilab, the AGS at BNL, and the 50 GeV accelerator under construction at J-PARC.
  - Market/Competition: *Moderate/High risk* -- The Japanese are heavily invested in neutrino physics and will be the primary source of competition in this area. However, the basic complementary approach of the Japanese and U.S. efforts affords the opportunity to adopt a cooperative/collaborative strategy, which will significantly reduce market risk.
  - Management/Financial: *Moderate to High risk* -- To mitigate risks a phased approach is being undertaken which allows for two phases aimed at 0.4 MW and 0.7 MW. The first

step is currently underway with completion scheduled for FY 2008. The second step has an advanced conceptual design and accompanying cost estimate and resource allocation plan. It is planned to execute this phase from FY 2007 until 2011.

Fermilab has one of two accelerator-produced neutrino beams operating in the world today. The Neutrinos at the Main Injector (NuMI) beam is the most powerful neutrino beam that has ever operated, with up to 0.3 MW of proton beam power directed at the NuMI target. The Main Injector Neutrino Oscillation Search (MINOS) collaboration operates two detectors, one at a distance of 730 km in the Soudan mine which are necessary to disentangle the effects of neutrino interactions with matter from the possible effects of CP violation. The sensitivity of an experiment is proportional to (beam power) x (detector mass) x (detector efficiency). Fermilab is increasing the NuMI beam intensity through a series of steps to a total beam power of 0.4 MW on target by 2010. The primary modifications to the complex include conversion of the Recycler Ring from an antiproton storage ring to a proton accumulator ring, and the conversion of the Antiproton Accumulator ring to a proton momentum stacking ring. Such conversions would allow Fermilab to continue operations of the neutrino program at the forefront of the field through the middle-to-end of the next decade. In parallel we continue to pursue a modest R&D program aimed at developing highly efficient techniques for very high intensity proton acceleration based on superconducting rf technologies. Such technologies could provide a basis for further long term performance enhancements if called for.

The first step in building better neutrino detectors is the NuMI Off-Axis ν_e Appearance **(**NOvA), a proposed detector that would be built in northern Minnesota at a location that can use the NuMI neutrino beam. The NOvA detector is much larger than MINOS and is optimized for clean and efficient identification of electron-neutrino scatters, since the oscillation of muon neutrinos into electron neutrinos has not yet been observed.

Neutrinos permeate the universe and hardly interact with matter. The recent discovery of neutrino mass has important consequences both for particle astrophysics and for unification. The Fermilab activity would maintain U.S. leadership in this important area of research.

3. Foundation: The Ongoing Program

- **Summary:** Enhance long term laboratory success by delivering scientific opportunities that are possible in the current Fermilab program with the Tevatron and the neutrino program. The laboratory's goal is to achieve the greatest sensitivity possible to discoveries of new physics, and to do so as quickly as possible.
- **Expectations:** Possible discoveries include the Higgs boson or any new physics (beyond the present theory) at the 1 TeV mass scale. These discoveries would also include supersymmetry, either through seeing supersymmetric particles or one of the five Higgs bosons that exist in supersymmetric models; extra dimensions; new dynamics (technicolor, new gauge bosons), and quark or lepton compositeness.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
  - Technical: *Moderate risk* -- It is critical to the scientific success of the program and to the future of the laboratory, that Fermilab deliver as much luminosity and as much neutrino flux as possible to the detectors every year.
  - Market/Competition: *High risk* -- the LHC, at CERN in Geneva, Switzerland, will overtake Fermilab ~2009 at the energy frontier. The neutrino program will have competition from Japan starting in 2011.

- Management/Financial: *Moderate to High risk* -- Fermilab's capability in pursuing physics in Tevatron Run II Luminosity Upgrade depends on the funding available to carry it out.

The Tevatron currently provides the only window into supersymmetry, Higgs physics, top quark physics, and quark physics with the B_s meson until the LHC turns on. The key to the success of this program is delivering integrated luminosity to the detectors. The laboratory is in the middle of a campaign to utilize luminosity upgrades and reliability improvements. The two large detectors also must operate reliably. This requires support not only from the laboratory but also from the international collaborations, which have to remain strong.

The LHC program is the largest particle physics program for the U.S. in the next 10 years. Fermilab should maintain forefront capability in detectors, accelerators, theory, and computation such that, in any area, scientists can do LHC research at Fermilab as productively as at CERN. Fermilab is the lead institution in the development of the LHC accelerator and the CMS detector in the US. In addition, Fermilab must manage the transition from the DZero and CDF collaborations to the CMS and ATLAS collaborations in a way that keeps excellent physics coming from the Tevatron program through 2009. These actions should position Fermilab to contribute to the development of the proposed accelerator and detector upgrades for increasing LHC luminosity in the next decade.

In astroparticle physics, Fermilab must complete the extended operation of the Sloan Digital Sky Survey and with it make possible new discoveries. Fermilab needs to complete the Cryogenic Dark Matter Search (CDMS) program in the Soudan mine and contribute to the design for the Super-CDMS facility. Finally Fermilab needs to complete construction of the Auger South observatory, begin operations and analyze what it tells us about the source of the highest energy cosmic rays.

These efforts seek to maximize the return on investment in Fermilab while providing a role for the laboratory in some of the most important experiments internationally. This is critical to maintaining the high caliber staff and visiting scientists that will be critical to future endeavors.

Financial Outlook

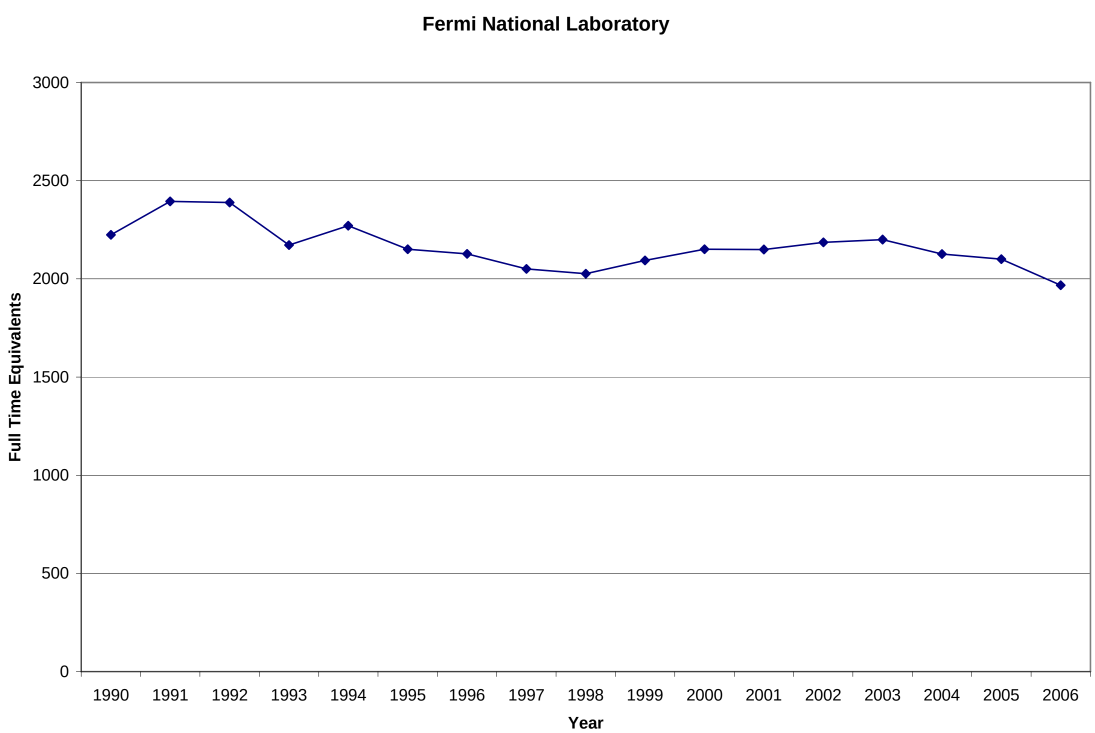
Detailed information regarding the financial outlook for the Fermi National Accelerator Laboratory is subject to 1) competition and merit review, 2) the availability of appropriated funds and 3) programmatic decisions. The first two factors can not be predicted or estimated in advance. The third, programmatic decisions, is developed in accordance with the planning targets reflected in the Department of Energy programmatic Five Year Plans, a companion document to these strategic laboratory business plans. In addition, because of the Office of Science commitment to competition and merit review, there is often a time lag between programmatic decisions and the determination of which research provider can best deliver the greatest value in conducting the research. Thus, it is not always apparent how programmatic decisions unfold for particular laboratories. Nevertheless, some decisions, such as the plans for large scientific user facilities, show clear paths to individual labs and therefore inform their business plans.

Uncertainties and Risk Management

External Factors: There are major risks that are scientific, technical, management and financial in nature. The outcome of potential negotiations on International Linear Collider (ILC), and funding uncertainty can halt the development of the rest of the program. One complication of this is the impact on foreign institutions and funding agencies that have made large investments to the current program. Fermilab has had a history of excellent relations with the surrounding communities. However, if the ILC is to be built and if it is to be located near Fermilab it will be outside the boundary of the present FNAL site. As a result, a FNAL Community Task Force was formed, including 20 members from local government, business, civic organizations, schools, and neighborhood associations. The committee made recommendations for local community participation in planning and decision-making at Fermilab. This represents a critical first step toward involving the community in having the ILC at Fermilab.

S&T Workforce: Fermilab already has the requisite human resources in all of the core competencies needed to carry out the activities described above with the exception of the experts on SCRF technology. Because of the scale and complexity of the needed R&D program, the laboratory will have to add scientists and engineers to its staff in this area.

Workforce Trends



Employee Diversity: The Laboratory works to attract a diverse workforce through a number of venues. Fermilab maintains a presence at diversity job fairs and national conferences, such as the National Society of Black Engineers (NSBE), the Society of Hispanic Professional Engineers (SHPE), the Joint Meeting of Black and Hispanic Physicists, and the Society of Women Engineers (SWE). Fermilab also conducts educational programs and offers internships designed to reach populations underrepresented in science and engineering.

In FY 2006, the laboratory director established an ad hoc committee, the Fermilab Committee on Hiring and Retention of Scientific Staff, with specific emphasis on women and minorities. Its charge is to gather information on current Fermilab practices, to study current practices at US universities and other US national laboratories, and to recommend improvements to Fermilab practices in a formal report to be submitted to the Director in FY 2007.

Fermilab has the following goals to improve its diversity profile:

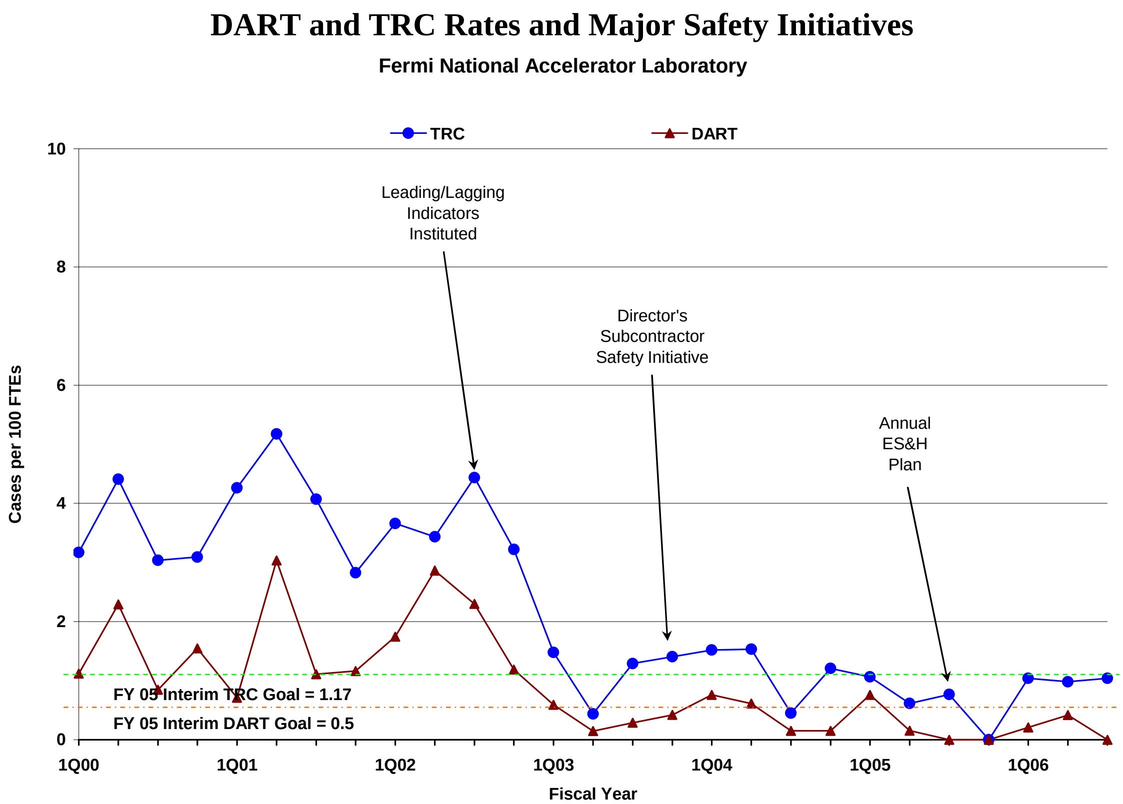
- Increase the number of underrepresented minority researchers and scientists at the Laboratory. Minorities represent 13.9% of the total; women 11.2%. Fermilab's goal is to increase the historically underrepresented minorities in the group (e.g., Black, Hispanic, and Native American) by 5% in the next 5 years.
- Recruit underrepresented minorities in the job group of Research Associates. This group serves as the feeder for scientific positions. Fermi Research Alliance (FRA) and its partner institutions will place increased emphasis on targeted recruitment efforts on the undergraduate and graduate levels.
- In FY 2007, increase the number of Masters trained underrepresented minority professionals in electrical/mechanical engineering and computer science. The laboratory will accomplish this by increasing its support of the GEM Program. This will result in a selection rate of four MS interns per year. The Laboratory's recent history with this program shows that they have an impressive ROI in attracting these interns as professional hires at the completion of their degrees.
- Increase opportunities for underrepresented minorities to participate in the research of the Laboratory through FaST. In FY 2006, the Laboratory officially became a FaST institution with the Office of Science, DOE. They will be offering FY 2007 summer research opportunities for faculty and students from minority-serving institutions.
- In FY 2007, complete the structure of the Diversity Council, select the members across the organization, and begin work on initial projects. The Council is designed to report to the laboratory director. The Council will have three functional areas: Workforce Recruitment, Retention and Development Team; Educational Outreach Team; and the Community Involvement and Outreach Team (to include employee affinity groups).

Safety: Fermilab has an ambitious and effective program to continuously improve safety in the workplace. As the following figure shows, the major benchmark accident rates have been reduced significantly over the last nine years.

Fermilab annually publishes an Annual ES&H Plan stating their ES&H Vision & Strategy for improvement for the year to come. The vision statement reads:

> *"As a result of our deep and unwavering commitment to the safety of all who work here, Fermilab will be recognized internationally and within the ranks of the U.S. national laboratories as 'best in class' in environment, safety & health. We want Fermilab to be 'First in Science & Safety.'"*

The laboratory management and staff have embraced Integrated Safety Management and have worked hard to bring the accident rates down. It is a greater challenge to integrate contractors and visiting scientists into the safety culture we maintain. Fermilab has made progress on this issue by devoting special attention to subcontractor safety training as well as safety orientation training to visiting scientists.



Fermilab has recently achieved ISO 14001 equivalent certification by DOE of its Environmental Management System. During the next couple of years, Fermilab intends to pursue ISO 14001 registration officially and to seek OHSAS 18001 (Health & Safety) international certification as well.

Physical Infrastructure: Fermi is located on a 6,800 acre Federal reservation approximately 45 miles west of Chicago, Illinois. Established in late 1967, it has 2.3M square feet of space in 346 buildings. Sixty-three percent of its space, as well as most of its utility systems and roads, is over 30 years old. Fermi's Asset Utilization Index (AUI) is 1.00 for offices, 1.00 for laboratories and 1.00 for warehouses. The replacement plant value of Fermilab's general purpose facilities is $608M.

Maintenance, recapitalization, and modernization are supported with overhead, operating, and GPP funds. Fermilab's maintenance investment index totaled 2.2% of replacement plant value (excellent) in FY 2006. This level will be continued in FY 2008 and the outyears. Fermi's deferred maintenance (DM) backlog is $39.4M. The Asset Condition Index (ACI) is 0.91 for mission critical facilities (the DOE goal is 0.964 or above) and 0.96 for mission dependent facilities (the DOE goal is 0.948 or above). ACI is computed as 1 minus the result of deferred maintenance divided by replacement plant value. To reduce the DM backlog, thereby improving the ACI, a deferred maintenance reduction initiative was initiated in FY 2006, and will be continued in FY 2008 with funding of approximately $4.3M.

DOE recently granted a public-utility easement to the City of Batavia for its power transmission needs that allows replacement of a portion of Fermi's high voltage electrical distribution system. An initiative to purchase domestic water from the City of Warrenville has eliminated the need to operate and maintain Fermi's on-site water wells.

The Fermilab FY 2008 GPP funding request is for $5.6M. Fermi's future recapitalization and modernization challenge is to continue upgrading its aging utility systems. The laboratory is working to achieve the goals for energy reduction and use of renewable energy established in the Energy Policy Act of 2005.

Department of Energy Laboratory Plan For the Office of Science's Lawrence Berkeley National Laboratory

Mission and Overview

Founded in 1931, Lawrence Berkeley National Laboratory (LBNL) was a driving force behind the launch of serious investigations into particle physics and the nature of matter and energy in our universe. From those early days, as the birthplace of nuclear science and medicine LBNL has evolved into a multidisciplinary research facility that, under the Department of Energy's (DOE's) Office of Science, has a primary mission focus that includes; understanding the complexity of biological and earth systems for energy solutions, characterizing and fabricating nanostructured materials, advancing physics and cosmology, conducting computational science of scale, and developing new scientific approaches to the understanding and prevention of disease.

On a competitive basis, LBNL provides access to critical national research infrastructure for university, industry, and government researchers. Major facilities include: the Advanced Light Source, a world center for ultraviolet and soft x-ray synchrotron-based science; the Molecular Foundry, a nanoscale science user facility; the National Center for Electron Microscopy for materials science; the 88-Inch Cyclotron for nuclear science; the National Energy Research Scientific Computing Center (NERSC), a DOE-leading provider of high-performance computing capabilities for complex scientific applications; and the DOE Joint Genome Institute. With one-third of its scientific staff jointly affiliated with university campuses, LBNL delivers a highly capable science and engineering workforce for the nation's future. Founder Ernest Lawrence was the laboratory's first Nobel Laureate and following that tradition, overall, eleven Nobel Laureates are associated with the laboratory. In addition, 68 staff are members of the National Academies.

Laboratory Focus and Vision

Six core competencies underpin activities at Lawrence Berkeley National Laboratory:

1. Sustainable energy science and technology

Lab-at-a-Glance

Location: Berkeley, CA

Type: Multi-program lab

Contract Operator: University of California

Responsible Field Office: Berkeley Site Office

Website: http://www.lbl.gov/

Physical Assets:

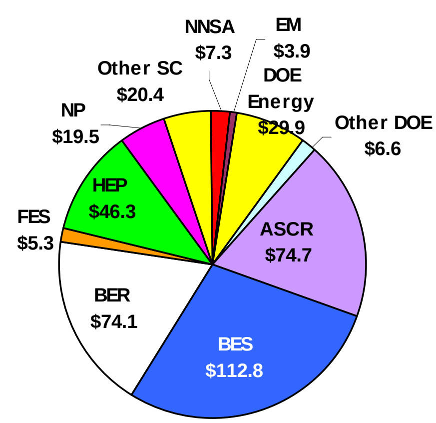
- 200 acres (leased) and 107 Buildings
- 1.5M GSF in Active Operational Buildings
- 130K GSF in Non-Operational Buildings
- Replacement Plant Value: $819M
- Deferred Maintenance: $51.9M
- Asset Condition Index:
  - Mission Critical 0.93 (Adequate)
  - Mission Dependent 0.98 (Excellent)
- Asset Utilization Index: 0.97 (Good)

Human Capital:

- 2,862 full time employees;
- 1,712 students (undergraduate and graduate);
- 3,270 facility users and visiting scientists

FY 2006 Total DOE Funding: $400.8M

FY 2006 DOE Funding by Source
PALS data (BA in Millions):



FY 2006 Non-DOE Funding: $111M
FY 2006 Dept. Homeland Security: $6.4M

2. Nanoscience, materials synthesis, and characterization
3. Multidisciplinary biology and environmental science
4. Soft x-ray and ultrafast science, photon and particle beams including those for national user facilities
5. Computational science and engineering
6. Advanced detector systems for astrophysics, high energy physics, and nuclear science

The Office of Science believes that these six competencies will enable LBNL to deliver its mission and customer focus, to perform a complementary role in the DOE laboratory system, and to pursue its vision for scientific excellence and pre-eminence in the areas of:

- Energy science, including carbon-neutral fuels from solar to chemical energy conversion;
- Nanoscience, surface science, and condensed matter physics for energy and scientific applications;
- Genomics and bioscience for understanding the complexity of living systems for energy solutions, understanding health effects of energy, and the prevention of disease;
- Particle-, nuclear-, and astrophysics to understand matter and energy in the universe;
- Earth systems research for developing energy resources, global change modeling, improving the nuclear fuel cycle, and enhanced environmental restoration, and
- Mathematics, computer science, and large-scale computational science programs.

Business Lines

The following capabilities, aligned by business lines, distinguish LBNL and provide a basis for effective teaming and partnering with other DOE laboratories, universities, and private sector partners in pursuit of the laboratory mission. These business lines and the distinguishing capabilities outlined in the table below provide an additional window into the mission focus and unique contributions and strengths of LBNL and its role within the Office of Science laboratory complex. Items in italics within the column, Distinguishing Capabilities, identify research facilities that convey particular, strategic strengths and capabilities to the laboratory. Descriptions of these facilities can be found at the website noted in the Lab-at-a-Glance section of this Plan.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
Science for a Secure and Globally Sustainable Energy Future	• Novel chemical synthesis processes; cell and molecular biology systems and pathways • Microbial organisms, genomics, and communities; • Earth systems modeling; biogeochemical changes and remediation • Efficient commercial building system designs; • Electricity reliability; • Carbon sequestration science and technologies;	National Academy of Sciences (NAS) report documents $23 Billion in energy savings from LBNL technologies; Most microbial genomes sequenced in the world; Two "Breakthroughs of the Year" for sequencing/analysis (*Science*); Lead Yucca Mountain vadose zone program; 30 NAS, 8 NAE, DOE recognition of Environmental Remediation leadership with award of "Distinguished Fellows".	Advance U.S. and global energy security and environment protection; Advance the core disciplines in basic energy sciences, including application of nanomaterials for reducing energy demands; Tap the power of biology for energy and environmental solutions, including carbon neutral sources of transportation fuels and carbon sequestration.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
	• *DOE Joint Genome Institute.*		
Leading Facilities in Vacuum-ultra-violet (VUV), Soft X-ray, and Ultrafast Science	• VUV, soft and intermediate x-ray probes for science and technology; • Chemical dynamics, photoionization, and other atomic, molecular, and optical phenomena; biological x-ray tomography, 8 crystallography beamlines • *Advanced Light Source.*	Recognized leaders in and ultrafast science experimentation and theory-1986 Nobel Prize in chemistry; Awarded design lead for next generation light source (selected to design of new Fermi light source at Trieste, Italy); Cover articles in *Science* and *Nature*; and ALS research cited for 2006 Nobel Prize in Chemistry. 15 NAS members, 7 NAE members, 3 institute of Medicine members.	Provide the resource foundations that enable great science; Advance basic sciences for energy independence.
Develop Novel Materials and Nanodevices	• Advanced catalytic, electronic, superconducting, structural, and optical materials; • Dynamic electron beam microcharacterization facilities; nanomedicine • *National Center for Electron Microscopy;* • *Molecular Foundry.*	Leader in nanoscience, biomimetic materials (Science Citation Index leader); 14 NAS members, 7 NAE members; LBNL leads national the Transmission Electron Aberration-corrected Microscope (TEAM) effort; Cover articles *Nature Materials, Physics World, Journal of Physical Chemistry, MRS Bulletin, Science, Journal of Physical Chemistry B.*	Lead the nanoscience revolution delivering controlled chemical processes, novel materials, and innovative energy technologies.
Understand, Detect, and Prevent Energy-Related and Environmental Causes of Disease	• Molecular, cellular, and tissue models of disease; • New probes and imaging systems for diagnosis; • Low-dose radiation effects and DNA damage response; • *Structural biology at the Advanced Light Source;* • *Center for Functional Imaging.*	3 Lawrence and 1 National Medal of Science Awards. 11 NAS members, 3 NAE members, 3 Institute of Medicine Recent cover articles include *Journal of Physical Chemistry B.*	Master the convergence of the physical and life sciences to deliver revolutionary technologies for health and medical applications
Matter and Energy in the Universe	• Astrophysics and neutrinos, nuclear structure; • Accelerator R&D (optical accelerators, superconducting magnets, ion sources); • RHIC and Large Hadron Collider (LHC) heavy-ion experiments; development of gamma ray detectors	Nobel Prize in Physics 2006; 8 Lawrence and 1 National Medal of Science Awards; 13 NAS members; Discovery of Dark Energy "Breakthrough of the Year" 1998 and 2004, also Shaw Prize in Astronomy 2006; Selected as science leader for national Deep Underground Science and Engineering Laboratory	Understand the cosmos and identify dark energy and dark matter; Explore nuclear matter from quarks to stars; Develop promising approaches to confining plasmas; Develop energy frontier accelerators using ultra-high

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
	including Gammasphere and GRETINA[1] and next-generation instruments; • Heavy ion drivers for high energy density physics; • *88-Inch Cyclotron.*	(DUSEL); World's highest energy optical accelerator with low dispersion beams; highest field dipole magnet.	gradient technology Provide basic science for advancing nuclear energy.
Advanced Scientific Computing for DOE Research Programs	• Scientific computing capability and connectivity; • Mathematical tools and algorithms for science. • *National Energy Research Scientific Computing Center Energy Sciences Network(ESnet)*	National leader in mathematics and computational science—4 NAS members, 4 NAE members. 2 of the only 3 awarded SIAM/ACM[2] Prizes in Computational Science; S2 Sidney Fernbach and 2 Gordon Bell Prizes; Cover articles include *Science, Physics World, Nature*.	Provide discovery-class computational tools for the U.S. scientific community; Deliver network connectivity to the DOE science community through the ESnet.

Major Activities

Following is a set of major activities that LBNL is pursuing to support aspects of the DOE mission and build on core strengths and capabilities of the laboratory. These activities are either currently supported or appear in the FY 2008 budget submission to Congress.

The major new activities being pursued are:

1. Integrated Energy Research for a Sustainable Future: Helios
2. Joint Dark Energy Mission (JDEM) R&D
3. Optical Accelerators for the Energy Frontier
4. National Energy Research Scientific Computing Center (NERSC) Upgrade

1. Integrated Energy Research for a Sustainable Future: Helios

- **Summary:** The administration has announced the *Advanced Energy Initiative*. In support of that effort, LBNL has proposed a Helios research program comprised of integrated campaigns to develop a secure and sustainable world through: (1) creating new low-carbon energy sources, (2) advancing energy efficiency technology, and (3) improving the accuracy and use of climate change prediction. Helios will control climate forcing from greenhouse gases by expanding feedstock crops, replacing fossil fuels, and reducing fuel demand.
- **Expectations**: Providing carbon-neutral energy supplies will require extraordinary science to create new materials, chemical, and biological pathways for solar energy production. The conversion of electricity to fuels based on nanotechnology-enabled solar cells and direct photochemical or photo-electrochemical processes will be developed. Cellulosic biofuels will be expanded by feedstock engineering, deconstruction, and synthesis. Biofuels

[1] The GRETINA detector (a forerunner of the GRETA detector, the gamma ray energy tracking array, is under development at Lawrence Berkeley National Laboratory) and is used to detect gamma rays in nuclear physics experiments.
[2] Society for Industrial and Applied Mathematics (http://www.siam.org/) and the Association for Computing Machinery (http://www.acm.org/)

development also requires understanding hydrological, biological, and ecosystem processes which are affected by climate. Integrated climate modeling and field studies will enable accurate prediction of green house gas and aerosol climate forcing and ecological responses. Energy efficient technology strategies that mitigate climate change will also be addressed, emphasizing new building system technologies, batteries, fuels cells, and clean combustion.

- **Benefit Perspective:** Potentially *transformational* benefits
- **Risk Perspectives:**
    - Technical: *Moderate risk* for R&D as biological systems may be difficult to fully characterize and many metabolic pathways are not known. Potential high risk for commercialization.
    - Market/Competition: *Moderate risk* as solar energy conversion, climate change and energy efficiency research is done by others, but LBNL work is complementary.
    - Management/Financial: *Moderate risk* for costs to engineer efficient conversion pathways and innovative technologies, possibly *high* commercialization risks

The integrated campaigns toward low carbon fuels, climate change modeling, and energy efficiency will support of the objectives of several DOE program offices. For the Office of Biological and Environmental Research (OBER), a Joint BioEnergy Institute (JBEI) will advance biofuels and an Integrated Earth System Model (IESM) will provide accurate predictions for climate change mitigation. IESM's next generation climate modeling capability would include biogeochemical cycles, atmospheric chemistry and aerosols, radiative forcing in cloud formation, high-resolution glacial processes, and ecosystem dynamics. For the Office of Basic Energy Sciences, LBNL will use both nanoscience and synthetic biology approaches for fuels synthesis. These include nano-photovoltaics that reach high efficiencies and can be integrated with catalytic molecules and bioengineered solar light driven proton pumps in synthetic organisms for biomass to fuel conversion. For the Office of Energy Efficiency and Renewable Energy research on energy efficient technology will place emphasis on the building sector, including new lighting systems, electrochromic windows, and integrated building control systems.

2. Joint Dark Energy Mission (JDEM) R&D

- **Summary:** Develop a competitive proposal for a space-based mission to study the dark energy and alternative explanations of the acceleration of the universe's expansion by performing systematic and highly controlled measurements.
- **Expectations:** Provide an understanding of the mechanism driving the acceleration of the universe by observing distant supernovae using a dedicated telescope in earth orbit. The satellite observatory will be capable of measuring over 2,000 distant supernovae during the three-year mission lifetime and survey over 1000 square degrees into the near-infrared.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
    - Technical: *Moderate risk* -- as the detector and associated electronics in development have good prospects for near term success, but meeting the space qualification requirements will be challenging.
    - Market/Competition: *Moderate risk* -- as delays in the program will put the laboratory's program at risk and limit their ability to compete in the JDEM down-selection process.
    - Management/Financial: *High risk* -- due to its early phase of forming mission partners and agreements.

Recent studies of Type Ia supernovae produced significant evidence that, over cosmological distances, the supernovae appear dimmer than would be expected if the universe's rate of expansion were constant or slowing down. This was the first direct experimental evidence for an accelerating universe potentially driven by an unknown dark energy. This space satellite mission would dramatically increase the discovery rate for such supernovae to eliminate possible alternative explanations, give experimental measurements of several other cosmological parameters, and put strong constraints on possible cosmological models.

As one of the possible JDEM designs, the SNAP project and collaboration is led by LBNL and includes scientists from DOE labs, National Aeronautics and Space Administration (NASA) centers, universities, and foreign institutions.

3. Optical Accelerators for the Energy Frontier

- **Summary:** Exploring centimeter-scale plasma structures that are able to accelerate high quality beams to GeV and multi-GeV energies.
- **Expectations:** Develop compact laser wakefield accelerators with multiple stages, which can produce focused, ultrafast, high-energy bunches of electrons to compete with state-of-the-art machines using conventional radiofrequency acceleration. High energy accelerators could be built on size scales that are three orders of magnitude smaller than those built today.
- **Benefit Perspective:** Potentially *transformational* benefits
- **Risk Perspectives:**
  - Technical: *Moderate risk* -- as the technology may not scale to TeV energies and high luminosity.
  - Market/Competition: *Moderate risk* -- as there is strong competition from groups in Europe, Japan, and China.
  - Management/Financial: *Moderate risk* -- as needed funding may not be available.

Laser wakefield technology offers the possibility of a compact, high-energy accelerator for probing the subatomic world, for studying new materials and new technologies, and for medical applications. Beams with 1 GeV energy have been demonstrated in three-centimeter long plasma channel structures using the L'OASIS laser system at 40 terawatt peak power. The next step would be to reach 10 GeV and beyond in one-half to one meter long accelerating structures built with plasma channels.

4. National Energy Research Scientific Computing Center (NERSC) Upgrade

- **Summary:** Upgrade NERSC to accommodate a larger number (200-300) of user projects of medium to large scale and continue to provide high-performance computing and resources to support the requirements for scientific discovery.
- **Expectations:** NERSC continues to meet the Office of Science's high-performance production computing needs.
- **Benefit Perspective:** Potentially *substantial* benefits
- **Risk Perspectives:**
  - Technical: *Low risk* -- as the activity will use technology already existing to increase capacity.
  - Market/Competition: *Low risk* -- as user demand already has and will likely continue to exceed capacity.
  - Management/Financial: *Medium risk* -- due to increasing power and building lease costs.

NERSC is the flagship multi-purpose scientific computing facility for the Office of Science. It is one of the largest facilities in the world devoted to providing high-performance computational tools and expertise for unclassified basic scientific research and supports large, interdisciplinary teams of researchers to attack fundamental problems in science and engineering that require massive calculations. NERSC continues on a path to address the increased computational needs of the Office of Science to fulfill its user facility mission by doubling the computational capacity at NERSC within projected program funding levels. For NERSC to support a large number (200 – 300) of user projects of medium to large scale, this doubling of computational capacity is required. More than 2000 computational scientists use NERSC for basic scientific research on a wide range of disciplines including: climate modeling, research into new materials, simulations of the early universe, analysis of data from high energy physics experiments, investigations of protein structure, and a host of other scientific endeavors.

Financial Outlook

The financial outlook for the Lawrence Berkeley National Laboratory is subject to 1) competition and merit review, 2) the availability of appropriated funds and 3) programmatic decisions. The first two factors cannot be predicted or estimated in advance. The third, programmatic decisions are developed in accordance with the planning targets reflected in the Department of Energy programmatic plans, in complement to these laboratory business plans. In addition, because of the Office of Science commitment to competition and merit review, there is often a time lag between programmatic decisions and the determination of which research provider can best deliver the greatest value in conducting the research. Thus, it is not always apparent how programmatic decisions unfold for particular laboratories. Nevertheless, some decisions, such as the plans for large scientific user facilities, show clear paths to individual labs and therefore inform their business plans.

Support for non-DOE funded work is a vital role of our national laboratories, contributing to national security, energy security, environmental stewardship, scientific discovery, and more fundamentally, the competitiveness of the U.S. economy. This is no exception for Lawrence Berkeley National Laboratory where the Office of Science is supportive of this work.

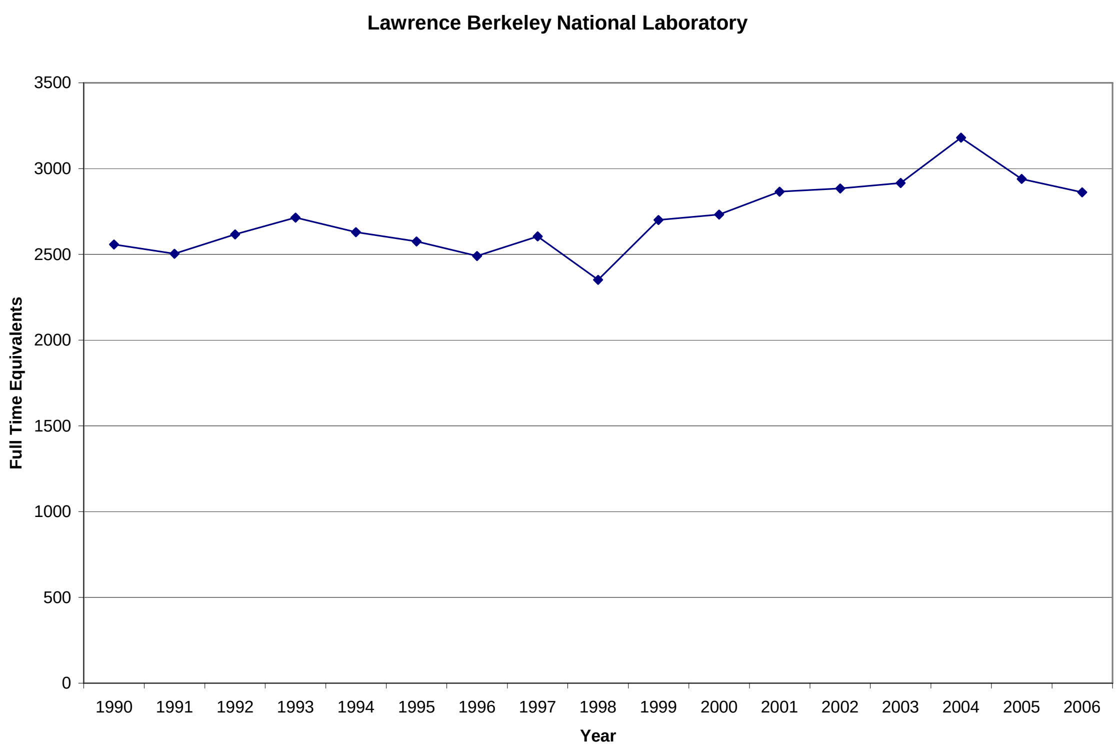
Current non-DOE federally funded activities at LBNL are primarily supported by the National Institutes of Health (NIH), the Department of Defense (DoD), the Department of Homeland Security (DHS), and NASA. NIH is the largest non-DOE funding organization and supports research in cancer biology, structural biology, DNA repair, and diagnostic imaging. DoD is expected to continue to sponsor breast cancer research, the use of particle beams to simulate space radiation, and detector development. It is anticipated that the DHS will sustain programs to develop neutron sources and detectors that scan for nuclear materials, indoor air quality monitoring, cyber-security systems, and other security instrumentation. NASA support for the Joint NASA/DOE Dark Energy Mission may grow. The laboratory is expected to continue to receive support for research from the California Energy Commission, the Environmental Protection Agency and other state agencies, universities, and the private sector. One example of special emphasis is in the area of carbon-neutral transportation fuels with industry and university sponsors. LBNL will also use funds received from authorized technology transfer activities (e.g., licensing of inventions and software) to support the research mission of the Laboratory. A portion of the net proceeds is allocated to the inventors, with the majority of the funds available for research, science education, or technology transfer.

Uncertainties and Risk Management

External Factors: Over the next five years, LBNL will face uncertainties and risks driven by external change. Primary among these is the Federal science budget outlook and unfunded mandates. LBNL will pay close attention to matching the level of science support services to the level of incoming financial resources. With the large user population at scientific facilities, increased security requirements may act as a barrier for qualified users to access scientific facilities. Mitigation strategies will need to be developed to handle each one of these risks, to sustain our vitality, core competencies, and mission accomplishments. LBNL has adopted an integrated approach to security management which combines oversight of site and cyber protection, balancing science and security based on cost and risk.

S&T Workforce: LBNL's workforce has the ability to develop new science innovations and to design, construct, and manage projects for complex, state-of-the-art scientific advances. These capabilities were built up in previous major DOE activities, and as a result, teams of highly skilled specialists were formed. With the potential for stable or declining funding, the workforce levels and expertise in areas such as advanced detectors, superconducting magnets, and precision optical instrumentation face the challenge of "use it or lose it." LBNL will work with the Office of Science to address this risk, including coordinating projects and engaging in underlying engineering and advanced instrumentation research.

Workforce Trends

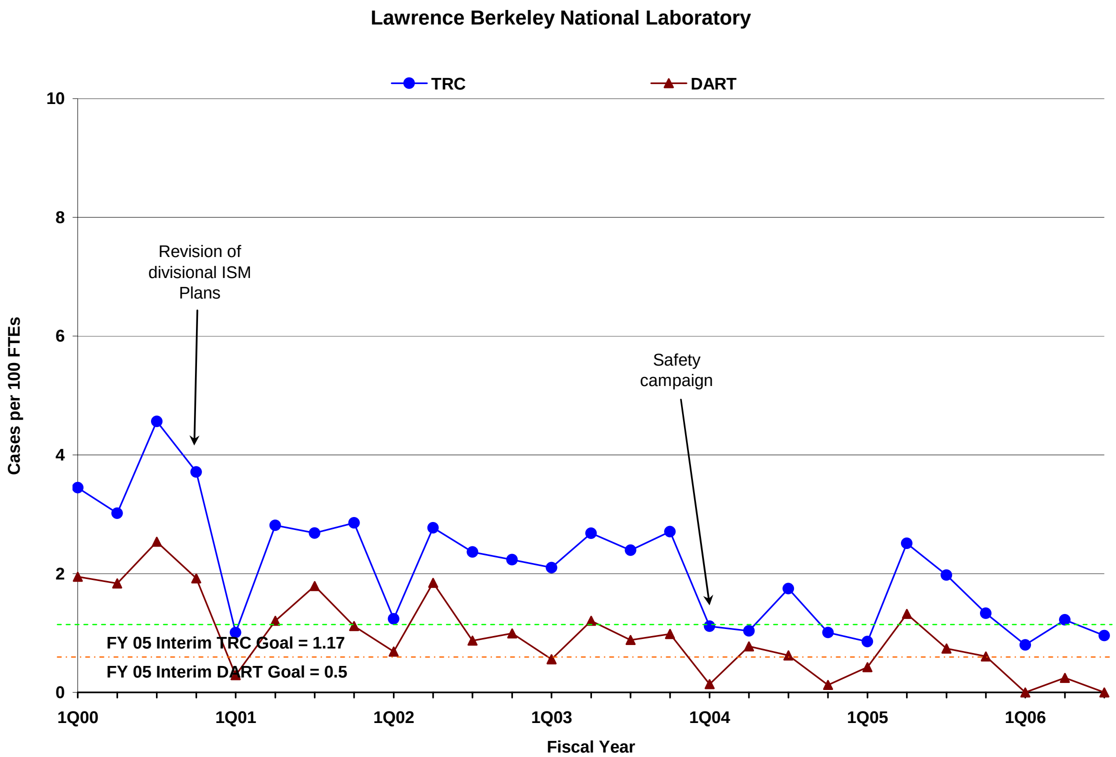


Employee Diversity: LBNL plans to strengthen the recruitment and retention of populations currently under-represented in the workforce, particularly African American and Hispanic scientific staff and women in the scientific workforce. This effort will focus on creating a diverse workforce through a comprehensive model that includes education and training, employee engagement, and workforce recruitment. Our objective is to develop our internal capacity to tap all segments of the candidate pool easily and efficiently and to gain benefits of integrating talented professionals into our current workforce. LBNL has been developing and implementing new outreach, work environment surveys, and actions tailored to the workforce of every division that enhance the diversity of applicant pools and job hires. Lawrence Berkeley National Laboratory's enhanced diversity initiative takes into consideration the uniqueness of each of our research divisions with respect to diversity strategies to improve their activity. As a whole, the laboratory has developed a compendium of diversity best practices and strategies related to strategic recruitment, mentoring/scientific human capital pipeline and training/awareness. The compendium is intended to be a tool for divisions to enrich their diversity activities.

To address workforce goals, scientific divisions prepare Division Diversity Plans and Strategic Recruitment plans and engage in extensive outreach activities. Many approaches are applied, tailored to fields of science, and recruitment is statewide when it is necessary to broaden the applicant pool beyond the local area in order to get a diverse qualified pool. Recruitment is nationwide for job groups with high levels of responsibility and/or expertise and therefore a national search is necessary to yield the strongest candidate pool. LBNL is active at regional and national job fairs and in minority scientific societies such as the National Society of Black Physicists and the National Organization of Black Chemists and Chemical Engineers, and the Hispanic Engineers and Scientists. LBNL also provides mentored research experiences and educational outreach that help carry minority students into graduate school and tracks students to follow their developing scientific careers. HBCU faculty are specifically supported and encouraged to access programs of common interest and to contact their peers at LBNL. The laboratory implemented its first-ever comprehensive workplace climate survey in fiscal year 2006. The survey measures focused on several important retention issues, including job satisfaction, physical working conditions, peers, supervision/management, diversity, respect/civility and work/life balance.

Safety: LBNL attention to safety performance and Integrated Safety Management (ISM) has led to a long term reduction in recordable illness and injuries. In FY 2006, LBNL reduced these rates to below contractual targets: Total Reportable Cases (TRC) 1.09 actual/1.17 target, Days Away, Restricted, or Transferred (DART) 0.24 actual/0.5 target (TRC = Total Recordable Cases per 100 Full Time Equivalents, DART = Days Away, Restricted, or Transferred per 100 Full Time Equivalents). This performance represents a reduction of the total number of recordable illnesses and injuries from 50 in FY 2005 to 36 in FY 2006. In striving to achieve the extremely aggressive contractual targets for FY 2007 (TRC = 0.65, DART = 0.25) and to continue progress in keeping employees from getting ill or injured, LBNL plans to focus on several areas: 1) Continue with an aggressive, multi-faceted strategy for reducing ergonomic injuries since this represents greater than 50% of the recordable injuries, 2) Advance laboratory leadership's commitment to safety as a collective responsibility, reinforced through communications, training, and skill building, 3) Continue to emphasize the importance of sharing and reporting errors or conditions that can lead to illness or injury through communications, training, and re-designing key management systems, 4) Consolidate and implement the recommendations from the ISM Peer Review (February, 2006) and the Evaluation of ISM at LBNL (November, 2006). With respect to environmental matters, LBNL plans to continue aggressively implementing our Environmental Management System through identification of environmental aspects that provide opportunities for pollution prevention and energy conservation.

DART and TRC Rates and Major Safety Initiatives



Physical Infrastructure: Established as a Federal laboratory in the 1940s, LBNL has over 1.7M square feet (sf) of space in 107 buildings; 65% of the building space, as well as many of the utility systems and roads, are 40 years old or older. In order to meet programmatic needs, LBNL also leases over 287,000 sf off site and has contractual rights to an additional 72,000 sf of space on the UC Berkeley campus. LBNL's Asset Utilization Index (AUI) is 0.98 for offices and laboratories (excellent) and 1.0 for warehouses (excellent). The replacement plant value of LBNL's general purpose facilities is $819M in 2007.

Maintenance, recapitalization, and modernization are supported with overhead, operating, and GPP funds and with line item funding. LBNL attained a maintenance investment index of 2% of replacement plant value (excellent) in FY 2007. It is anticipated that this level will be continued in FY 2008 and the outyears.

LBNL's deferred maintenance (DM) backlog is $51.9M for 2007. The Asset Condition Index (ACI) is 0.93 for mission critical facilities (the DOE goal is 0.964) and 0.98 for mission dependent facilities (the DOE goal is 0.948 or above). ACI is computed as 1 minus the result of deferred maintenance divided by replacement plant value. To reduce the DM backlog, thereby improving the ACI, LBNL has a deferred maintenance reduction effort with a projected $6M of funding in FY 2008.

The Department has begun the clean up and removal of the de-activated Bevatron accelerator which will provide nearly 5 acres of land for re-development around FY 2011.

The FY 2008 GPP funding request is for $4.5 million. A new line item project was funded in FY 2007 – the Seismic and Structural Safety of Buildings, Phase I, TEC $17M. This project addresses the seismic vulnerability of DOE assets, in which high life-safety risks have been identified. LBNL's future recapitalization and modernization challenges include building replacements and renovations, seismic upgrades, and utility renovations. The laboratory has reduced energy consumption by 6.3% compared to the 2003 baseline as defined by the Energy Policy Act of 2005, and is further working to reach the EPACT goals for energy reduction and renewable energy use.

Department of Energy Laboratory Plan
For the Office of Science's
Oak Ridge National Laboratory

Mission and Overview

Oak Ridge National Laboratory (ORNL) is the Department of Energy's largest science and energy laboratory. Managed since April 2000 by UT-Battelle, a partnership of the University of Tennessee (UT) and Battelle Memorial Institute, ORNL was established in 1943 as a part of the Manhattan Project. During the 1950s and 1960s, ORNL became an international center for the study of nuclear energy and related research in the physical and life sciences. The 1970s led to an expansion of ORNL's research programs into the areas of energy production, transmission, and conservation. Today, under the Department of Energy's Office of Science, ORNL has the primary mission focus of conducting research in neutron science, energy, high-performance computing, systems biology, materials science, and national security that will lead to innovative solutions to complex problems. As an international leader in a range of scientific areas supporting DOE's basic research, energy, national security, and environmental missions, ORNL is actively engaged in a broad range of national and international partnerships with industry and educational institutions. As a DOE steward of critical national research infrastructure, the laboratory provides access to university, industry and government researchers on a competitive basis. The Laboratory is home to 2,478 facility users and visiting scientists every year. The $1.4 billion Spallation Neutron Source (SNS), completed in 2006, will make ORNL the world's foremost center for neutron science research.

Laboratory Focus and Vision

Six core competencies underpin activities at Oak Ridge National Laboratory:

1. Neutron science including structure and dynamics of materials in extreme conditions, and on nanometer length scales

Lab-at-a-Glance

Location: Oak Ridge, TN

Type: Multi-program lab

Contract Operator: UT-Battelle

Responsible Field Office: Oak Ridge Office

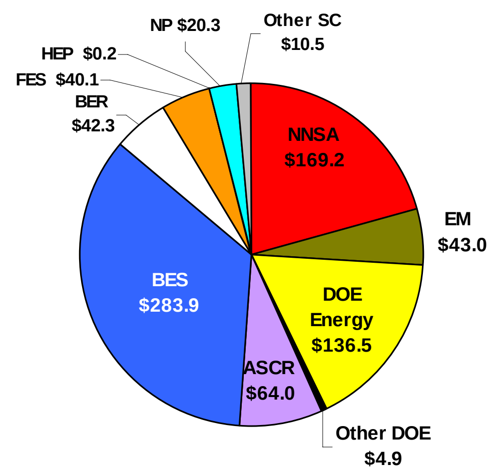
Web site: http://www.ornl.gov/

Physical Assets:
- 1,100 acres and 248 buildings
- 3.4M GSF in Active Operational Buildings
- 243K GSF in Non-Operational Buildings
- Replacement Plant Value: $842.4B
- Deferred Maintenance: $158.4M
- Asset Condition Index:
  - Mission Critical 0.82 (Poor)
  - Mission Dependent 0.75 (Poor)
- Asset Utilization Index: 0.97 (Good)

Human Capital:
- 4146 employees;
- 2456 Undergraduate and Graduate Students
- 2478 Facility Users and Visiting Scientists

FY 2006 Total DOE Funding: $814.9M

FY 2006 DOE Funding by Source
PALS data (BA in Millions):



FY 2006 Non-DOE Funding: $186.9M
FY 2006 Dept. of Homeland Security: $72.4

in soft and hard materials
2. Leadership computing and simulation science
3. Engineering sciences, including electric power systems, combustion and thermal engineering, plasma physics, and radiochemical technology
4. Comprehensive design, synthesis and characterization of advanced materials and interfacial chemical processes
5. Biological and environmental systems
6. Counter-terrorism and nonproliferation detection systems

The Office of Science believes that these six competencies will enable ORNL to deliver its mission and customer focus, to perform a complementary role in the DOE laboratory system, and to pursue its vision for scientific excellence and preeminence in the following areas:

- Delivering and sustaining the world's foremost center for neutron scattering
- Dramatically accelerate scientific discovery through computation by delivering unparalleled capability in computational and data solutions applied to major problems in energy, environment, and national security
- Understanding and controlling nanoscale physical and chemical phenomena for the discovery of materials and interfacial processes with tailored properties through sustained leadership in synthesis, characterization, and theory.
- Providing leadership in microbial and plant systems biology and environmental science, producing sustainable solutions to challenges in bioenergy, climatic change, and remediation
- Develop next-generation fusion and fission energy systems and energy-efficient technologies for transportation, buildings and the electric power grid.
- Delivering innovative technologies to limit or prevent the spread of materials, technologies, and weapons of mass destruction expertise, including developing new knowledge discovery tools, algorithms, materials, and open architecture detector systems to increase situational awareness

Business Lines

The following capabilities, aligned by business lines, distinguish ORNL and provide a basis for effective teaming and partnering with other DOE laboratories, universities, and private sector partners in pursuit of the Laboratory mission. These business lines and the distinguishing capabilities outlined in the table below provide an additional window into the mission focus and unique contributions and strengths of ORNL and its role within the Office of Science laboratory complex. Items in italics within the Distinguishing Capabilities column identify research facilities that convey particular strategic strengths and capabilities to the Laboratory. Descriptions of these facilities can be found at the web site noted in the Lab-at-a-Glance section of this plan.

Typical of our multi-program laboratories, ORNL supports work for several large customers. The Office of Science is the primary sponsor for work in the business lines of Neutron Scattering; Computational Science and Engineering; Materials Synthesis, Design, Characterization and Processing; Molecular Biology and Ecology; and Fusion Science and Technology. In support of these areas, ORNL is one of the world's broadest and most capable materials science and technology laboratories, achieving significant integration between basic and applied technology research. For the business line of Arms Control and Nonproliferation, DOE's National Nuclear Security Administration (NNSA) and the Department of Homeland Security are primary customers, and the Defense Threat Reduction Agency is a secondary customer. In particular, the NNSA contributes significant resources to ORNL to provide technical leadership to prevent the spread of nuclear materials and technology. ORNL is the single largest provider of support for materials protection and control programs. In the Energy Technology business line, primary customers include the DOE's Offices of Energy Efficiency and Renewable Energy, Nuclear Energy, and Electricity Delivery and Energy Reliability. ORNL has, perhaps, one of the world's largest and broadest public energy research and development portfolios. This portfolio includes expertise in buildings, transportation, and industrial end-use efficiency; electric transmission and distribution with strengths in superconducting transmission; and nuclear energy and space nuclear power.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
Neutron Scattering	• Pulsed at the Spallation Neutron Source (SNS) and steady-state at the High Flux Isotope Reactor (HFIR) neutron beams for research and industrial development • Next-generation instrumentation • Applications for science and engineering • *16 instruments by 2012 at Spallation Neutron Source* • *11 instruments by 2012 at High Flux Isotope Reactor*	By 2008, SNS and instrumentation will provide capability at 10 to 100 times the current state of the art; computer benchmarking of instrument performance has been confirmed by the commissioning studies. HFIR will provide unsurpassed capabilities for steady state, cold brightness of 1013 neutrons/cm2/sec/steradian/angstrom, equal to the Institut Laue-Langevin High Flux Reactor	Advance core disciplines of basic energy sciences Lead nanoscale science revolution Master control of energy-relevant complex systems
Computational Science & Engineering	• Methods and tools for advanced architecture supercomputers • Early research in new technologies and architectures • Advanced science and engineering models • Scientific Discovery through Advanced Computing • *Leadership Computing Facility*	The Leadership Computing Facility (LCF) is expected to become one of the world's leading centers for capability computing. The LCF success will be measured against the metrics specified by the Advanced Scientific Computing Advisory Committee (ASCAC) sub-panel (chaired by Gordon Bell and Jim Hack) that examined the issues of science-based performance metrics for the present and proposed computational facilities for the Office of Science, and as evidenced by the unprecedented, demonstrated, sustained performance on key DOE scientific applications (materials, 36%; geosciences, 11-16%; CFD, 13%; biology, 15%; etc.)	Advance discovery through computer science and math Advance scientific simulation through new computational models Deliver leadership computing resources in support of science and energy mission
Materials Synthesis, Design, Characterization and Processing	• Tailored design, synthesis, and characterization of nanoscale materials • Synthesis, characterization, and processing of alloys, ceramics, carbon-based materials and polymers • Advanced tools for characterizing nanoscale materials and chemical processes	Nation's largest BES and EERE materials research program covering materials science and engineering, condensed matter physics, and materials chemistry. World record resolution of 0.6 angstroms in electron microscopy	Advance core disciplines of basic energy sciences Lead scientific research and user environment for nanoscale science Apply fundamental advances in materials and molecular processes to high-impact energy applications

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
	• Understanding and controlling interfacial molecular processes • Chemistry and materials theory • *High Temperature Materials Lab* • *Shared Research Equipment Program (SHaRE)* • *Center for Nanophase Materials Sciences*		
Energy Technology	• Energy-efficient transportation, industrial, and building technologies • Fusion energy concepts, plasma theory, and heating and fueling technologies • Fission reactor separations, fuels, and materials technologies • Electric transmission and grid technologies • *Radiochemical Engineering Development Center* • *Irradiated Fuels Examination Laboratory* • *Buildings Technology Center* • *National Transportation Research Center* • *U.S. ITER project office*	A series of technological breakthroughs that has reduced energy usage by >70% in air conditioners and refrigerators and has replaced CFC's a refrigerants (DOE Energy Research, *Was it Worth It?,* NAS Report, 2001, pg 96 forward). In partnership with industry, developed the world's first commercial application for superconducting cables.	Develop technologies that foster a diverse supply of reliable, affordable, and environmentally sound energy and that improve our mix of energy options and our energy efficiency Manages the U.S. commitment to the ITER Project Understand fusion plasma behavior and determine the most promising confinement configurations Develop new materials and technologies to enable advanced nuclear reactors and fusion energy power systems Develop nuclear fuel reprocessing technologies for closing the fuel cycle
Biological and Environmental Sciences	• Physical and computational methods for biological and environmental science • Genomics and proteomics of microbes and plants • Terrestrial ecology and carbon cycle science • Microbial ecology focusing on environmental impact • Subsurface science focusing on the biogeochemistry of fate and transport • *Center for Structural Molecular Biology*	Led the international Poplar genome consortium. Leadership for Laboratory Science Program within the Joint Genome Institute. Journal of Proteome Research paper (2006) on proteome of Rhodopseudomonas palustris is on the American Chemical Society's list of most cited papers. Proceedings of the National Academy of Sciences paper (2005) on forest productivity in a CO2 enriched environment (result of FACE facility) provides benchmark to evaluate predictions of ecosystem global models Science (2006) review article on "the path forward for biofuels and biomaterials" co-authored by Davison, Mielenz, Tschaplinski (2006)	Tap power of genomics for our nation's energy and environment Unravel the mysteries of Earth's changing climate and protect our living planet Develop science for remediation of contaminated sites Understand the environmental impacts of microbes

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
Arms Control & Non-proliferation	• Safeguarding materials • Detecting illicit production of nuclear materials • Radiological dispersal devices (for DHS)	National Laboratory that is the nation's largest National Nuclear Security Administration provider of support for materials protection, control, and accounting program. Recognition by sponsor of outstanding results in meeting commitments under the 2005 Bratislava Nuclear Security Initiative.	Provide technical leadership to limit or prevent spread of materials, technology, and weapons of mass destruction expertise
Nuclear Physics	• Nuclear structure and astrophysics with radioactive beams • Neutron physics • Accelerator R&D in high power targets • *Holifield Radioactive Ion Beam Facility*	Nation's only facility for producing both proton- and neutron-rich post-accelerated beams SNS is the world's most powerful source of pulsed neutrons and low-energy neutrinos for particle physics	Understand the structure of the nucleon and nucleonic matter Investigate nuclear astrophysics, including understanding largest supernovae and synthesis of heavy elements in the universe Measure fundamental properties of the neutron Investigate nature of neutrino

Major Activities

The following is a set of major activities that ORNL is pursuing to support aspects of the DOE mission and build on core strengths and capabilities of the Laboratory. These activities are either currently supported or appear in the FY 2008 budget submission to Congress.

The major activities are as follows:

1. Neutron Scattering Defining the State of the Art
2. Theory, Modeling, and Simulation
3. Materials to Energy
4. Systems Biology
5. Advanced Energy Technologies

1. Neutron Scattering Defining the State of the Art

- **Summary:** Sustain world leadership in the science and technology of neutron scattering and the facilities and instruments that support such research.
- **Expectations:** Sustain U.S. leadership in neutron scattering and materials research and development; generate innovative new materials for energy and national security applications; and develop foundational biology data to support bioengineering for energy and health care.
- **Benefit Perspective:** Potentially *transformational* benefits
- **Risk Perspectives:**
  - o Technical: *Low risk* -- as expectations are that SNS will meet design goals and HFIR cold source will function as expected.
  - o Market/Competition: *Moderate risk*-- since competitive Asian or European neutron scattering center will be developed over time, necessitating ongoing enhancements to

maintain lead.
    - Management/Financial: *Moderate risk* -- due to funding uncertainties associated with the second target station and to management, regulatory, security, and infrastructure issues with HFIR that could impact reliability and cost.

The Instruments focus of the neutron scattering activity is to deliver the world's most capable neutron scattering center, which includes the Spallation Neutron Source (SNS) and the cold source at the High Flux Isotope Reactor (HFIR); extend our leadership with new instruments, the SNS power upgrade, and the SNS long-wavelength target station; and build the world's foremost neutron scattering research program.

The corresponding programs and capabilities will enable fundamental discoveries in materials research in the areas of superconductivity, magnetism, phase transitions, and structure and dynamics, as well as enable fundamental advances in biology (membranes, protein structure, and dynamics). They will also facilitate optimization of engineering materials through in situ studies and nondestructive measurements.

2. Theory, Modeling and Simulation

- **Summary:** Sustaining world leadership in theory, modeling, and simulation through application of the most powerful computing capability that is possible.
- **Expectations**: Sustain U.S. leadership in computational science and engineering; reduce risk and increase scientific productivity from major Office of Science user facilities; and provide new energy technologies in such areas as engines, fuel cells, or fusion power reactors.
- **Benefit Perspective:** Potentially *transformational* benefits
- **Risk Perspectives:**
    - Technical: *Moderate risk* -- due to uncertainties with regard to present and future architectures and their ability to meet expectations.
    - Market/Competition: *High risk* -- International competition for fastest supercomputer is intense.

The core of this activity is to build and operate a premier leading-edge computational facility for the research community; develop multiscale methods for modeling of complex systems; and develop modeling and simulation tools that enable scientific and technological breakthroughs in key application areas. Key elements include the Leadership Class Facility (LCF) hardware and operations; possibly components of advanced architecture R&D; simulation science; and methods, algorithms, and tool development. This activity builds on current capabilities at ORNL.

Investment in this activity will transform discoveries in materials science, biology, climate science, plasma physics, astrophysics, energy technologies, and other areas and will enable the investigation of experimentally inaccessible natural and engineered systems, from supernovae to the dynamics of the electric grid.

3. Materials to Energy

- **Summary:** Sustain leadership in understanding and designing materials properties and interfacial processes at the nanoscale through synthesis, characterization and theory, and make key capabilities available to the use community through the Center for Nanophase Materials Sciences.

- **Expectations:** Provide the fundamental breakthroughs needed to realize revolutionary new materials and interfacial chemical processes for future energy requirements.
- **Benefit Perspective:** Potentially *transformational* benefits in fundamental knowledge relevant to energy applications.
- **Risk Perspectives:**
  - Technical: *Low risk* -- as expectations are that fundamental breakthroughs in novel tailored materials relevant to energy will be realized
  - Market/Competition: *Moderate risk* -- due to risks of success in response to solicitations in solar, hydrogen, advanced nuclear, and other energy-inspired fundamental materials and chemical science areas.
  - Management/Financial: *Low risk* -- due to increasing capabilities and number of users at the Center for Nanophase Materials Sciences (CNMS), continuing fundamental advances in materials and molecular processes and ongoing developments in advanced characterization tools.

This activity will focus on nanoscale level tailoring of materials and interfacial processes to achieve desired properties and functions, based on a basic understanding of how materials respond in the nanoscale form. This activity will exploit leading capabilities in neutron scattering, atomic and chemical imaging, computing, and nanoscale synthesis to provide insight into the structure and properties of nanophase materials and associated interfacial processes. Further, coupled with the CNMS, this activity will provide world-leading capabilities to users. The materials-to-energy activity will allow ORNL to build a strong bridge between fundamental and applied energy research; support the enhancement of the CNMS; and extend the Laboratory's capabilities in synthesis and characterization of novel materials and interfacial chemistry that will lead to revolutionary new technologies of high relevance to energy production, storage, and utilization.

4. Systems Biology

- **Summary:** Apply and further develop the entire suite of cutting edge genomics and proteomics tools together with molecular and chemical imaging, and computational models to develop a systems level understanding of microbes and microbial communities, and plants and their interaction with the environment.
- **Expectations:** Provide fundamental breakthroughs enabling sustainable production of biofuels; provide the basis for determining the response of ecosystems to climate change.
- **Benefit Perspective:** Potentially *transformational* benefits: displacement of fossil transportation fuels; sustainable biomass supply; stabilization of atmospheric CO_2; environmental management.
- **Risk Perspectives:**
  - Technical: *Low risk* – as novel analytical tools and advancement in computational power provide unprecedented insights in the functioning of biological systems from the molecular to the organism and community levels.
  - Market/Competition: *Moderate risk* – due to risks of success in response to solicitations for proposals, e.g., Genomics:GTL program
  - Management/Financial: *Low risk* – due to increasing capabilities in the biophysical and biochemical sciences, strategic new hires in microbiology, plant science and molecular biophysics, recent successes in securing research funds and equipment, and the development of partnerships and research infrastructure, e.g., the UT/ORNL Joint Institute for Biological Sciences funded by the State of Tennessee.

This activity will integrate unique capabilities and facilities in the physical and computational sciences at ORNL with leading expertise in biology and environmental sciences to significantly advance our understanding of biological systems from the molecular to the ecosystem level, thereby enabling sustainable and effective solutions to energy security and climate change challenges.

5. Advanced Energy Technology

- **Summary:** Create breakthroughs in energy supply, efficiency, and transmission technologies by applying nanoscience, neutron science, systems biology, and leadership-class computing in combination with leading-edge engineering research capabilities.
- **Expectations:** Accelerated innovation in current and new technologies that will increase the efficiency and reduce emissions of transportation vehicles; increase capacity, security, and reliability of the electric grid; establish an economical, and proliferation-resistant nuclear power system for the future; demonstrate the technological viability of fusion power systems and improve the efficiency of buildings technology and industrial processes.
- **Benefit Perspective:** Potentially *sustaining/substantial* benefits
- **Risk Perspectives:**
  - Technical: *Low risk* -- associated with price targets for fuels, engines, or materials.
  - Market/Competition: *Low risk* -- recognizing that international leadership in energy technology is "up for grabs" in transportation and other areas.
  - Management/Financial: *Moderate risk* -- due to lack of new investment in energy technology.

This activity will apply leadership-class computing and the experimental capabilities of the Radiochemical Engineering Development Center (REDC) and the Irradiated Fuels Examination Laboratory to develop new scientific insights into the performance of advanced burner reactors and fuel reprocessing plants for closing the nuclear fuel cycle. Materials science in combination with applied power electronics research will continue to advance high-temperature superconducting power systems and plasma heating and control systems for fusion. Nanotechnology for catalysis, advances in materials synthesis, systems biology for biofuels, and combustion engineering science will lead to development of advanced internal combustion engines and vehicular systems, and alternative transportation fuels. Advanced computing science will assist in generating new fundamental understanding of magnetically confined plasmas, the dynamics of the electric power grid, and the performance of irradiated materials and fuels in extreme conditions. This activity will also draw upon ORNL's core engineering science and instrument science capabilities and strengths in materials technology, nuclear engineering research, and energy systems analysis.

With successful deployment of this activity, there will be innovation in next-generation nuclear and fusion energy technologies; high-efficiency, low-emissions transportation vehicles and engines; low-cost, low-net-carbon liquid fuels; high-efficiency building technologies, real-time control of the electric grid; and higher temperature, more efficient industrial processes.

Financial Outlook

Detailed information regarding the financial outlook for the Oak Ridge National Laboratory is subject to 1) competition and merit review, 2) the availability of appropriated funds and 3) programmatic decisions. The first two factors cannot be predicted or estimated in advance. The third, programmatic decisions are developed in accordance with the planning targets reflected in the Department of Energy programmatic five-year plans, a companion document to these strategic laboratory business plans. In addition, because of the Office of Science commitment to competition and merit review, there is often a time lag between programmatic decisions and the determination of which research provider can best deliver the greatest value in conducting the research. Thus, it is not always apparent how programmatic decisions unfold for particular laboratories. Nevertheless, some decisions, such as the plans for large scientific user facilities, show clear paths to individual labs and therefore inform their business plans.

Support for non-DOE-funded work is a vital role our national laboratories, contributing to national security, energy security, environment stewardship, scientific discovery, and more fundamentally, the competitiveness of the U.S. economy. For the Oak Ridge National Laboratory, this is no exception. The Office of Science is supportive of this work, and although it is not addressed in any detail within the accompanying five-year plans, the Office of Science believes it is sufficiently important and appropriate to address within this strategic laboratory business plan. A brief perspective and financial outlook is therefore provided.

The major ORNL non-DOE funded activities are primarily supported by the Department of Defense (DoD), Nuclear Regulatory Commission (NRC), Department of Homeland Security (DHS), National Aeronautics and Space Administration (NASA), and the Department of Health and Human Services/National Institutes of Health (DHHS/NIH). The work for DoD is focused on national defense in such areas as chemical/biological detection, adaptive planning systems, sensor technology, materials, and nonproliferation activities. The NRC activities revolve around reactor pressure vessel integrity, aging and environmental effects on containment, high-burn-up fuel issues for storage and transport of spent fuel, advanced reactor physics, and instrumentation and controls technology. DHS supports research in biological, chemical, and radiological/nuclear countermeasures and threat, vulnerability, and test assessment, while NASA supports activities related to fission power systems for space exploration with an emphasis on human exploration of the Moon and Mars. The DHHS/NIH research is in the areas of bioanalytical chemistry, biomedical engineering and bioimaging, biomaterials, genomics, metabolomics and proteomics.

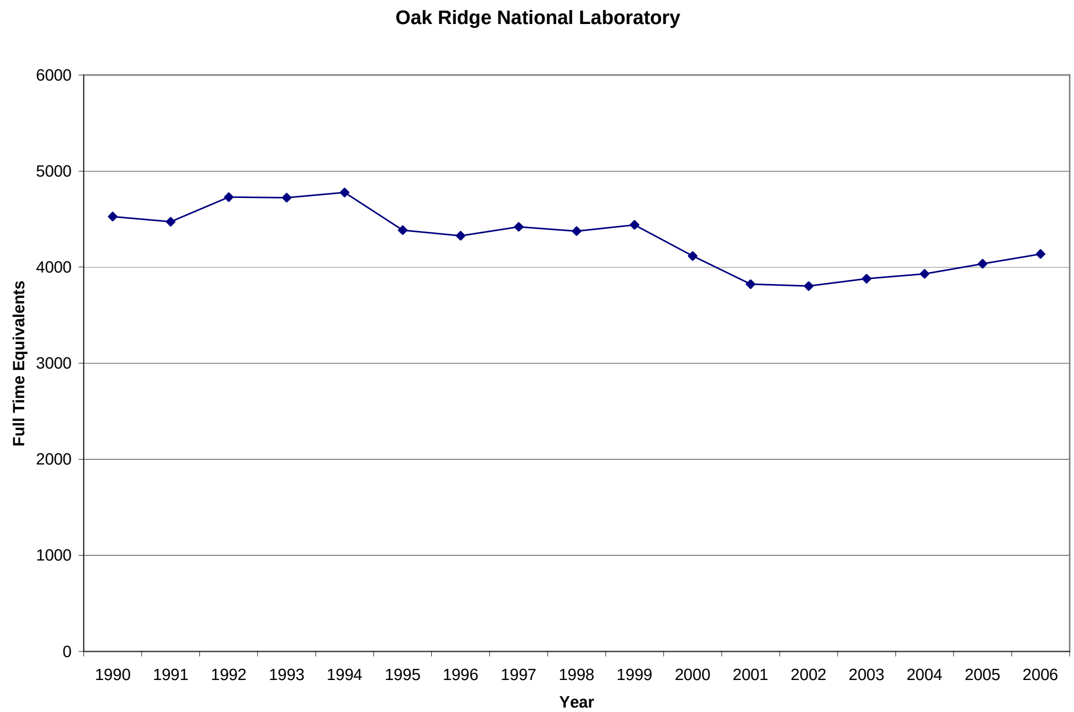
Support from DHS and NASA is expected to remain stable over the next five years, while an increase in DoD funding is expected in several key areas, including development of adaptive planning systems and WMD defense capabilities. Growth in NIH funding is anticipated through 2010 in many areas including mammalian genomics. Reactor licensing activities for the NRC Office of New Reactors are expected to increase beginning in 2007.

Uncertainties and Risk Management

External Factors: Over the next five years, ORNL will have a number of concerns driven by external forces. One significant issue is increasing energy costs. Additionally, the rising cost of health care and workers compensation will continue to impact the Laboratory. ORNL carefully watches the earning performance of their pension plan assets to ensure adequate funds are available to cover current and future liabilities. Increasing costs are likely as cyber security and worker safety and health are being handled in an increasingly complex regulatory and reporting environment. Finally, ORNL faces a significant challenge in rationalizing its extensive nuclear infrastructure, including consolidation from ten to four nonreactor nuclear facilities, involving the decontamination, decommissioning, and removal of multiple contaminated facilitates.

S&T Workforce: ORNL employs roughly 4137 full-time equivalent (FTE) research and support staff. In keeping with its strategy of the last several years, ORNL intends to increase technical staff more rapidly, and support staff less rapidly, than the overall Laboratory budget.

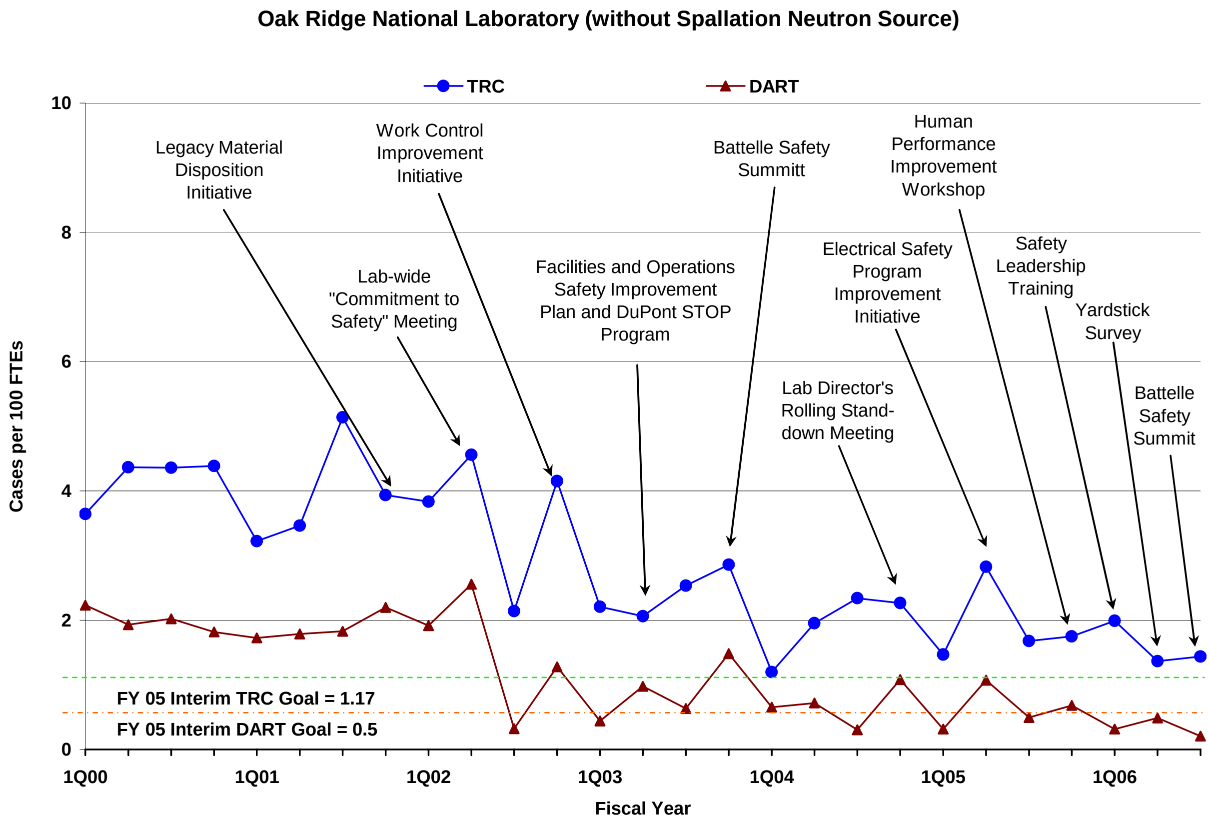
Workforce Trends



Workforce Diversity: The recruitment and retention of women and minorities will not only be a critical focus, but also a business imperative for ORNL. The challenge for ORNL, as with most DOE labs, is to invest in educational opportunities that will prepare for greater diverse representation in science and technology by creating a pipeline that features science as a rewarding career for women and minorities. Toward that end, ORNL will ensure broad-scale deployment of educational outreach activities, such as the National Consortium for Graduate Degrees for Minorities in Engineering and Science (GEM), Research Alliance in Math and Science (RAMS), and maintain a network and exposure to potential candidates through internships and co-ops. In addition, ORNL will continue extensive outreach efforts at conferences and job fairs that target minority and women professionals, such as the Society of Women Engineers and National Society of Black Engineers. ORNL's long-term diversity and inclusion strategy is within the framework of a succession planning process, which focuses on the development and empowerment of leadership in focused areas of science and technology and business operations. ORNL's most recent workforce analysis indicates a significant percentage of staff members are reaching retirement eligibility, and ensuring the continuity of expert knowledge and scientific expertise will become a priority. Again, our focus will be on increasing the representation of women and minorities in upper and senior management and individual contributor positions. ORNL is committed to making diversity and inclusiveness a fundamental part of how they do business.

Safety: ORNL has made significant progress in reducing the number of injuries at the Laboratory. During FY 2006, serious injuries were reduced by 60% over the previous year. Since the year 2000, these injuries have been reduced by 85%, an improvement that is nothing short of dramatic. Placed in human terms, 57 fewer ORNL employees experienced a serious injury in FY 2006 than in 2000. While lowering the number of serious injuries is paramount, the goal is to eliminate all injuries. In FY 2006, the number of less serious injuries dropped by a more modest 18%. However, less serious injuries have been reduced by 52% since the year 2000. In FY 2006, the Laboratory implemented a Safety Leadership Improvement Program that included safety leadership training for all managers and supervisors. In addition, a Management Observation program was initiated that required all managers and supervisors to spend at least 2 hours per month observing work activities and looking for opportunities to prevent injuries. During the year, more than 800 observations were completed. About one-third of these observations identified some form of improvement that could be made to ensure safety, which translates into about 240 opportunities to improve facility conditions or work processes that might have resulted in an injury. ORNL believes that the Safety Leadership Improvement Program is making great strides toward reinforcing our fundamental belief that all injuries are preventable.

DART and TRC Rates and Major Safety Initiatives*



** Does not include statistics for the Spallation Neutron Source*

Physical Infrastructure: ORNL is located on a 34,000-acre Federal reservation near Knoxville, Tennessee. Established in the 1940s as part of the Manhattan project, the Laboratory has 3.4 million square feet of space in 248 operating DOE SC buildings. Forty-eight percent of its space as well as most of its utility systems and roads are over 40 years old. ORNL's site Asset Utilization Index (AUI) is 0.97 (good).

Maintenance, recapitalization, and modernization are supported with overhead (maintenance and Institutional GPP), operating, and GPP funds and with line item funding. ORNL will continue to attain a maintenance investment level of 2% of replacement plant value (excellent). ORNL's deferred maintenance backlog is $176 million. To address this backlog, ORNL will continue the facility and infrastructure modernization started in 2000. Old, expensive-to-maintain buildings will be vacated, and staff will be relocated other facilities.

The proposed FY 2008 funding for the cleanup and demolition of excess facilities funding is $2.374 million, including $874K of direct funding. There remains an estimated backlog of approximately $11.8 million of cleanup and demolition projects proposed to SC; an additional $370.7 million of cleanup and demolition projects have been proposed to EM for funding. The FY 2008 GPP funding request is for $7.1 million. The Laboratory has a strong Institutional GPP program with planned expenditures of $14 million in FY 2007 and $14 million in FY 2008.

Line item funding is being sought to rehabilitate the Materials and Chemistry Building Complex (Buildings 4500N and 4500S). This facility houses 30% of ORNL's wet and industrial laboratories, as well as 25% of ORNL's on-site staff. Its condition and configuration do not support modern research, and it is roughly four times less energy efficient than the newly constructed buildings. In addition the complex is experiencing system failures at an increasing rate.

Department of Energy Laboratory Plan
For the Office of Science's
Pacific Northwest National Laboratory

Mission & Overview

The Pacific Northwest National Laboratory (PNNL) was created in 1965 and has a broad focus in energy security, national security, and the environment. In its early days PNNL brought nuclear science and engineering expertise to the surrounding Department of Energy (DOE) Hanford Site to tackle projects focused on designing reactors, fabricating reactor fuel, and protecting the environment. Since then, PNNL has evolved into a leading multi-disciplinary national laboratory providing scientific discoveries and developing innovative technologies under DOE's Office of Science (SC). It is unique in the SC complex as SC is a minority funding partner. The Laboratory's mission focus is on the biological, chemical, computational, environmental and materials sciences; technologies to detect and mitigate weapons of mass destruction and counter acts of terrorism; and technologies for energy and environmental security. It also operates the Environmental Molecular Sciences Laboratory (EMSL), a national scientific user facility dedicated to providing integrated experimental and computational resources for discovery and technological innovation in the environmental molecular sciences to support the needs of DOE and the nation.

Laboratory Focus and Vision

Six core competencies underpin activities at PNNL:

1. Microbial and cellular biology and applied proteomics
2. Environmental sciences in biogeochemistry; climate physics and atmospheric science; subsurface science; and, integrated assessment of energy and environmental impacts
3. Analytical and interfacial chemical and materials sciences

Lab-at-a-Glance

Location: Richland, WA

Type: Multi-program lab

Contract Operator: Battelle Memorial Institute

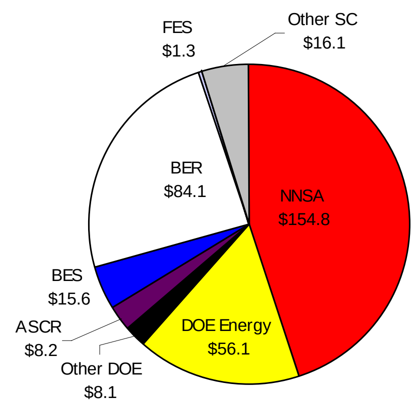
Responsible Site Office: Pacific Northwest Site Office

Website: http://www.pnl.gov/

Physical Assets:
- 380 acres
- 2.037M GSF; DOE owns 750K (Office of Science 200K, EM 550K), Battelle owns 494K, and 793K is leased.
- Replacement Plant Value: $70.1M
- Deferred Maintenance: $.023M
- Asset Condition Index:
  - Mission Critical 1.0 (Excellent)
  - Mission Dependent N/A
- Asset Utilization Index: 1.0 (Excellent)

Human Capital:
- 4,196 employees;
- 2,136 Facility Users
- 681 Students

FY 2006 Total DOE Funding: $344.3M *PALS data (BA in Millions):*



FY 2006 Non-DOE Funding: $101.6M
FY 2006 Dept. of Homeland Security: $107.7M

4. Radiological sciences
5. Information analytics and visualization
6. Sensing and measurement technologies and systems, for energy, national security and environmental applications

The Office of Science believes that these six competencies will enable PNNL to deliver its mission and customer focus, to perform a complementary role in the DOE laboratory system, and to pursue its vision for scientific excellence and pre-eminence in the areas of:

- Improve global and regional climate predictions, and assessment of related impacts.
- Predict environmental change and damage from intentional or unintentional release of contaminants.
- Control chemical and physical processes at the nanoscale to increase the performance of chemical and energy-intensive systems.
- Enhance the nation's capabilities in data-intensive, high performance computing to accelerate scientific discovery and security analysis involving very large, heterogeneous and dynamic data sets.
- Convert domestic hydrocarbons to fuels and chemicals and create carbon capture technologies that when fully implemented will decrease reliance on imported oil while sustaining the environment.
- Develop next-generation threat detection and prevention systems to reduce nuclear proliferation and terrorism.
- Deliver integrated experimental and computational resources through the Environmental Molecular Sciences Laboratory for discovery and technological innovation in environmental molecular sciences.

Business Lines

The following capabilities, aligned by business lines, distinguish PNNL and provide a basis for effective teaming and partnering with other DOE laboratories, universities, and private sector partners in pursuit of the Laboratory mission. These business lines and the distinguishing capabilities outlined in the table below provide an additional window into the mission focus and unique contributions and strengths of PNNL and its role within the Office of Science laboratory complex. Items in italics within the Distinguishing Capabilities column identify research facilities that convey particular, strategic strengths and capabilities to the Lab. Descriptions of these facilities can be found at the website noted in the Lab-at-a-Glance section of this Plan.

Typical of DOE's multi-program laboratories, PNNL performs work for several major customers. For the National and Homeland Security Business line, the primary customers are National Nuclear Security Administration (NNSA), Department of Homeland Security (DHS), Department of Defense (DoD), and the intelligence community. In particular, the NNSA contributes significant resources to PNNL to develop next-generation threat detection and prevention systems in support of nuclear nonproliferation. Secondary customers include National Institute for Allergies and Infectious Diseases (NIAID) and private industry. The advanced analytical capabilities in EMSL are an essential resource for this business line and PNNL brings particular capabilities to bear including decades of expertise in the technical aspects of nuclear materials production and detection (e.g., the nuclear fuel cycle, weapons material production, environmental monitoring, transuranic waste management, and safeguards, detection, and measurement technologies), as well as in such complex social and technical matters as economic diversification and international relations. For the business line of Foundational Science, the primary customers are the DOE's Office of Science, specifically the

Offices of Biological and Environmental Research, Basic Energy Sciences, and Advanced Scientific Computing Research. Secondary sponsors include the National Institute for General Medical Sciences (NIGMS) and the National Heart, Lung and Blood Institute (NHLBI). For the Environmental Science and Technology business line, the primary customers are DOE-EM (Environmental Management) and its contractors, Environmental Protection Agency (EPA), and the Corps of Engineers. Secondary sponsors include the National Aeronautics and Space Administration (NASA), the National Oceanic & Atmospheric Administration (NOAA), and private industry. Finally, for Energy Science and Technology, the third largest business line, primary customers are DOE's Offices of Energy Efficiency and Renewable Energy (EERE), Fossil Energy (FE), Nuclear Energy (NE), Electricity Delivery and Energy Reliability (OE); secondary customers include NASA, the U.S. Nuclear Regulatory Commission (NRC) and private industry.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
Foundational Science	• **Environmental microbiology & biogeochemistry;** • **Field-scale subsurface research;** • **Climate physics & atmospheric sciences;** • **Chemical physics & analytics;** • Unique suite of NMR spectrometers; extensively used ultra high resolution infrared spectra database • **Catalysis and oxide materials;** • **Materials in extreme environments;** • **Computational Chemistry;** • **High performance computing;** • ***Environmental Molecular Sciences Laboratory*;** • ***Life Sciences Laboratory;*** • ***Research Aircraft Facility.***	DOE lead for biogeochemistry; PNNL in the top 1% of institutions in ISI citation rate for chemistry, physics, materials science, engineering, geosciences, environment/ecology and clinical medicine; Fastest time to solution for computational chemistry problems; Scientific leadership and program management/integration as technical director for the DOE Atmospheric Radiation Measurement Program Climate Research Facility; Lead provider of analytical tools, scenario analysis and integrated assessment for DOE's Climate Change Technology program; Over 250 invited book chapters, conference papers, reports and peer reviewed journal articles in last 5 years; Scientific leadership for research on radiation damage to materials.	Fundamental science to advance scientific frontiers and to deliver high-impact science based solutions in energy, security and environment.
Energy S&T	• **Solid Oxide Fuel Cells;** • **Hydrogen storage and safety;** • **Catalyst and process engineering;** • **Power grid technology;** • *Electricity Infrastructure Operations Center.* • *Biological Sciences and Engineering Laboratory*	DOE's program lead for: Solid State Energy Conversion program; Chemical Hydrogen Storage (co-lead); Bioproducts; GridWise program; and Global climate change technology.	Promote clean, secure, reliable and affordable energy

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
National and Homeland Security S&T	• **Radiation detection;** • **Radioanalytical chemistry & radiochemical processing;** • **Visual analytics;** • **Critical infrastructure simulation & cyber security.** ▪ ***Ultra-trace Detection Laboratory*** ***Radiological Standards Laboratory***	Over 50 years programmatic funding and leadership in ultra-trace detection; Lead for national Radiation Portal Monitoring project - Currently scanning 90% if entering cargo and approaching 1000 sensors deployed; DHS program lead for National Visual Analytics Center; Lead developer of cyber security simulation systems for federal systems.	Reduce proliferation of global nuclear threat and prevent terrorism against the homeland
Environmental S&T	• **Subsurface science and contaminate modeling;** • **Chemical and radiochemical process engineering, waste separations and waste forms;** • **Integrated assessment and risk analysis;** • **Environmental and human health and safety** • **Ecological science;** • ***Marine Sciences Laboratory*;** • ***Radiochemical Processing Laboratory;*** • ***Applied Process Engineering Laboratory.***	Over 250 technical reports and 300 peer reviewed journals since 2000; Largest single provider of science and technology for DOE-EM and its contractors; More than 100 patents in environmental science and technology.	Predict, assess and cost-effectively mitigate environmental damage and threat

Major Activities

Following is a set of major activities that PNNL is pursuing to support aspects of the DOE mission and build on the core strengths and capabilities of the Laboratory. These activities are either currently supported or appear in the FY 2008 budget submission to Congress.

1. Predictive Biological and Environmental Science
2. Nanoscale Control of Chemical Processes and Materials Synthesis
3. Threat Detection & Prevention
4. Transformational Energy Science and Technology

<u>1. Predictive Biological and Environmental Science</u>

Summary: PNNL will predict and design the behavior of complex biological systems including microbial communities for energy production and carbon management; and advance the prediction of complex environmental systems including the climate system and subsurface environments.

- **Expectations:** Fundamental improvements in understanding biological and environmental systems will lead to large-scale bio-based technologies for energy production, reliable predictions of the effects of environmental contamination (intentional or unintentional); secure approaches for carbon management; improved models governing global and regional climate change; and, development of biomarkers that accurately predict changes in environmental and human health.

- **Benefit Perspective:** Potentially *Transformational* benefits
- **Risk Perspectives:**
    - Technical: *Moderate risk* because PNNL core capabilities and technology lead already exist.
    - Market/Competition: *Moderate risk* because while many other organizations will be competing in the same area, PNNL currently has leading technology, programs and core capabilities required for broad impact.
    - Management/Financial: *Moderate risk* given diversity of funding needed.

Current models of complex biological and environmental systems are characterized by significant uncertainty, limiting their use for economically competitive technologies or policy decisions. Key to improving our ability to predict and design complex biological and environmental systems is the integration of data-intensive laboratory data, large-scale field measurements and multiscale computational modeling. PNNL is enhancing its core capabilities in microbial and cellular biology and environmental science through investments in systems biology, aerosol-climate interactions, and environmental biomarkers to accelerate this activity.

2. Nanoscale Control of Chemical Processes and Materials Synthesis

- **Summary:** Control chemical and physical processes in nanostructured materials to achieve a ten-fold increase in the performance of catalytic processes and materials used in energy and security applications.
- **Expectations:** Understanding the fundamentals of how geometric and electronic structure control chemical and physical properties at the nanoscale will lead to design of new catalytic processes with controlled reactivity and selectivity; new multifunctional and structural materials; and new materials for the detection and remediation of dispersed chemical, radiological and biological agents.
- **Benefit Perspective:** Potentially *Substantial* benefits
- **Risk Perspectives:**
    - Technical: *Moderate risk* because PNNL core capabilities already exist.
    - Market/Competition: *High risk* because many other organizations will be competing in the same area.
    - Management/Financial: *Moderate risk* given diversity of funding needed.

PNNL will develop new experimental methods to study dynamics at single sites under standard operating conditions, synthesize homogeneous nanostructured materials, and develop new multiscale computational methods that accurately describe the influence of condensed phases and interfaces on local properties and processes. These methods will be applied to real-world materials and situations. For example, future energy systems will require an understanding of catalytic processes for efficient production, storage and use of fuels such as hydrogen. In addition, new nanoscale materials will increase our ability to detect and specify radiological, chemical, and biological agents. These methods will increase carbon capture capacity by orders of magnitude over the current levels and reduce the cost to commodity prices. This activity builds on and strengthens PNNL’s core capabilities in analytical and interfacial chemical and materials science.

3. Threat Detection & Prevention

- **Summary:** Develop advanced threat prediction, detection and characterization methods to greatly reduce threats and potential risks associated with weapons of mass destruction and effect.
- **Expectations:** Development of threat detection and prevention methods will lead to early prediction of terrorist threat through advances in predictive information analytics; increasingly effective detection and characterization of clandestine nuclear weapon materials production or movement; improved safeguarding of special nuclear materials in foreign countries; and robust, multi-threat detection systems to prevent events of mass effect.
- **Benefit Perspective:** Potentially *Substantial* benefits
- **Risk Perspectives:**
  - Technical: *Moderate risk* because PNNL core capabilities are strong.
  - Market/Competition: *High risk* because a large number of other players exist.
  - Management/Financial: *Low risk* because the cost/benefit ratio is high.

Global terrorism, increased opposition to U.S. interests, greater global pursuit of nuclear power, and increased access by adversaries to sophisticated technologies and materials are creating more dynamic and complex threats to national and homeland security. PNNL will provide field-deployable advanced information-analysis and knowledge-discovery systems to better predict threats before they are executed; proliferation resistant technology for next generation nuclear power plants; vastly improved radiation and explosives detection capability through the discovery and use of new materials and deployment methods; and ability to more rapidly and effectively respond to events of mass effect through tools that better coordinate, integrate, analyze and present information across sources in real time. This activity builds on and integrates across PNNL's core capabilities in radiological sciences, information analytics and visualization, and sensing and measurement technologies and systems.

4. Transformational Energy Science and Technology.

- **Summary**: In support of national initiatives and in partnership with private industry when appropriate, PNNL will generate scientific and technology advances in the areas of transportation efficiency, real-time grid control, advanced lighting and fuel cell technologies and will develop technology and engineering approaches that enable higher energy conversion efficiencies and CO2 capture and sequestration.

- **Expectations**: This activity will expand domestic energy supply while reducing emissions and advance the efficiency of end use technologies within the decade.

- **Benefit Perspective:** Potentially *Substantial* benefits

- **Risk Perspectives:**
  - Technical: *Moderate to high risk* because lower cost and higher performance technical approaches must be developed in carbon capture, hydrocarbon conversions and synthesis, high temperature gasification chemistry, and gas separations.
  - Market/Competition: *Moderate to High risk* because industry adoption of technologies is uncertain.
  - Management/Financial: *Low risk* because this activity fits within existing PNNL and DOE priorities and capabilities.

This activity directly supports the DOE Advanced Energy Initiative and the objective to change the way we fuel our vehicles and power our homes and business. Accomplishing these objectives requires innovation and advances in fuel-to-energy conversions, energy storage and carbon capture and sequestration. This activity will continue to support the development of clean high efficiency vehicles, advanced hydrogen storage materials, advanced energy storage, high efficiency fuel cells and organic light emitting diodes. It will enable new innovations to convert domestic fuel supplies efficiently with no carbon dioxide emission to fuels and other useful products. Utilizing high performance computing, PNNL will continue to advance the science and technology needed to operate our nations grid in real-time to increase efficiency and reduce generation. This activity will build on PNNL's direct support of the nation's Freedom Car and FutureGen Initiatives; distinguishing capabilities in EMSL, catalysis, chemical physics, computational chemistry and bioproducts; and on strong public private partnerships including full utilization of the new Biological Science and Engineering Laboratory in partnership with Washington State University.

Financial Outlook

Detailed information regarding the financial outlook for the Pacific Northwest National Laboratory is subject to 1) competition and merit review, 2) the availability of appropriated funds and 3) programmatic decisions. The first two factors cannot be predicted or estimated in advance. The third, programmatic decisions are developed in accordance with the planning targets reflected in the Department of Energy programmatic Five Year Plans, a companion document to these strategic laboratory business plans. In addition, because of the Office of Science commitment to competition and merit review, there is often a time lag between programmatic decisions and the determination of which research provider can best deliver the greatest value in conducting the research. Thus, it is not always apparent how programmatic decisions unfold for particular laboratories. Nevertheless, some decisions, such as the plans for large scientific user facilities, show clear paths to individual labs and therefore inform their business plans.

Support for Non-DOE funded work is a vital role our national laboratories, contributing to national security, energy security, environment stewardship, scientific discovery, and more fundamentally, the competitiveness of the U.S. economy. The Office of Science is supportive of this work and although it is not addressed in any detail within the accompanying Five Year Plans, the Office of Science believes it is sufficiently important and appropriate to address within this strategic laboratory business plan. A brief perspective and financial outlook is therefore provided.

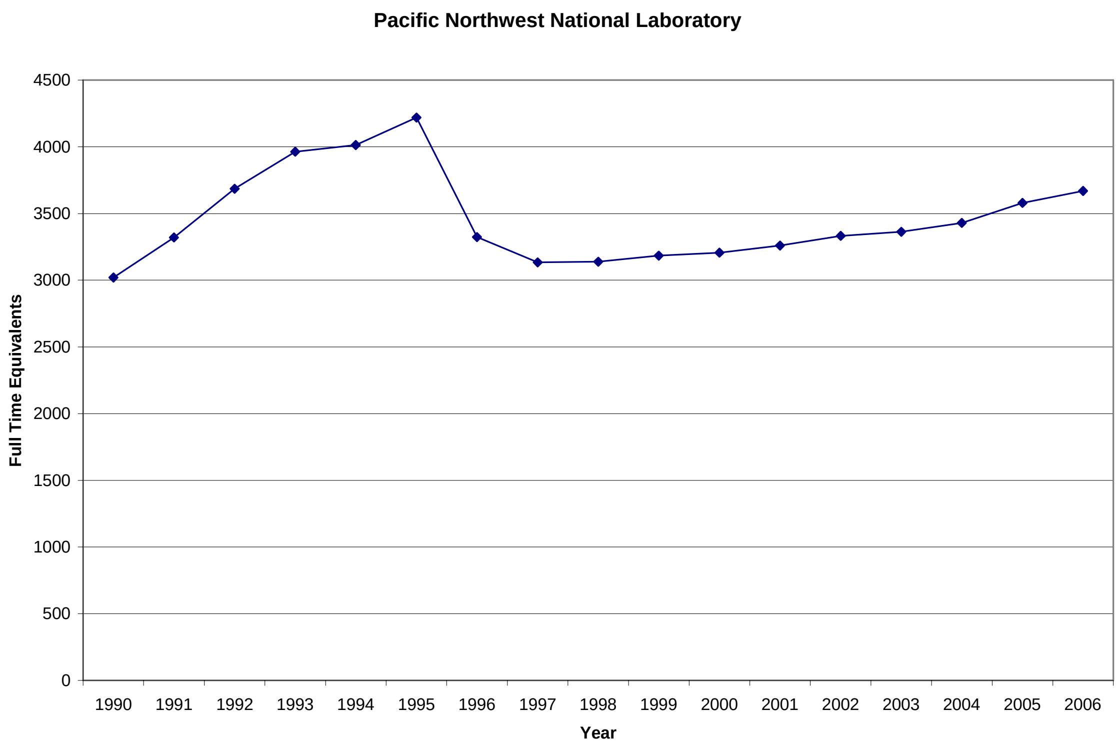
The Department of Homeland Security (DHS), Department of Defense (DoD), and the Department of Health and Human Services (DHHS) primarily support the major PNNL non-DOE federally funded activities. For DHS, the Laboratory is primarily developing and deploying technologies to counter terrorist threats, including sensor technologies for the detection of chemical, biological, radiological, and nuclear threats; as well as providing capabilities for protecting critical infrastructures. PNNL also leads the Radiation Portal Monitoring Project (RPM) to install radiation detectors at U.S. ports of entry. For DoD, the Laboratory is working on improved methods of radar detection and imaging, chem/bio/nuclear sensing for mobile applications, materials development, durable and portable energy sources, and software for cyber security and operational support. PNNL also receives significant funding from DHHS (NIH), the Nuclear Regulatory Commission (NRC), and funding directly from private and public entities under a Private Use Permit. The RPM project is expected to increase by 30-120% over the next three years before it declines and closes out after FY 2012. Other WFO funding is expected to increase modestly over FY 2006 levels in all program areas over the next 5 years.

Uncertainties and Risk Management

External Factors: The primary risk to PNNL's immediate viability is the desire to transition out of some of the 30% of its total laboratory space (40% of its laboratory-intensive space), which is located in facilities slated for cleanup on the Hanford Site. .

S&T Workforce: Recruiting and retaining scientific staff and maintaining relationships with external partners (universities, other labs, private industry) are vital to PNNL's core science and technology programs. PNNL shares with other laboratories challenges to recruiting, including a decline in numbers of students graduating in S&T fields from U.S. schools and difficulties in hiring suitable foreign nationals. Nonetheless, PNNL is growing its workforce and has a strong record of staff retention.

Workforce Trends

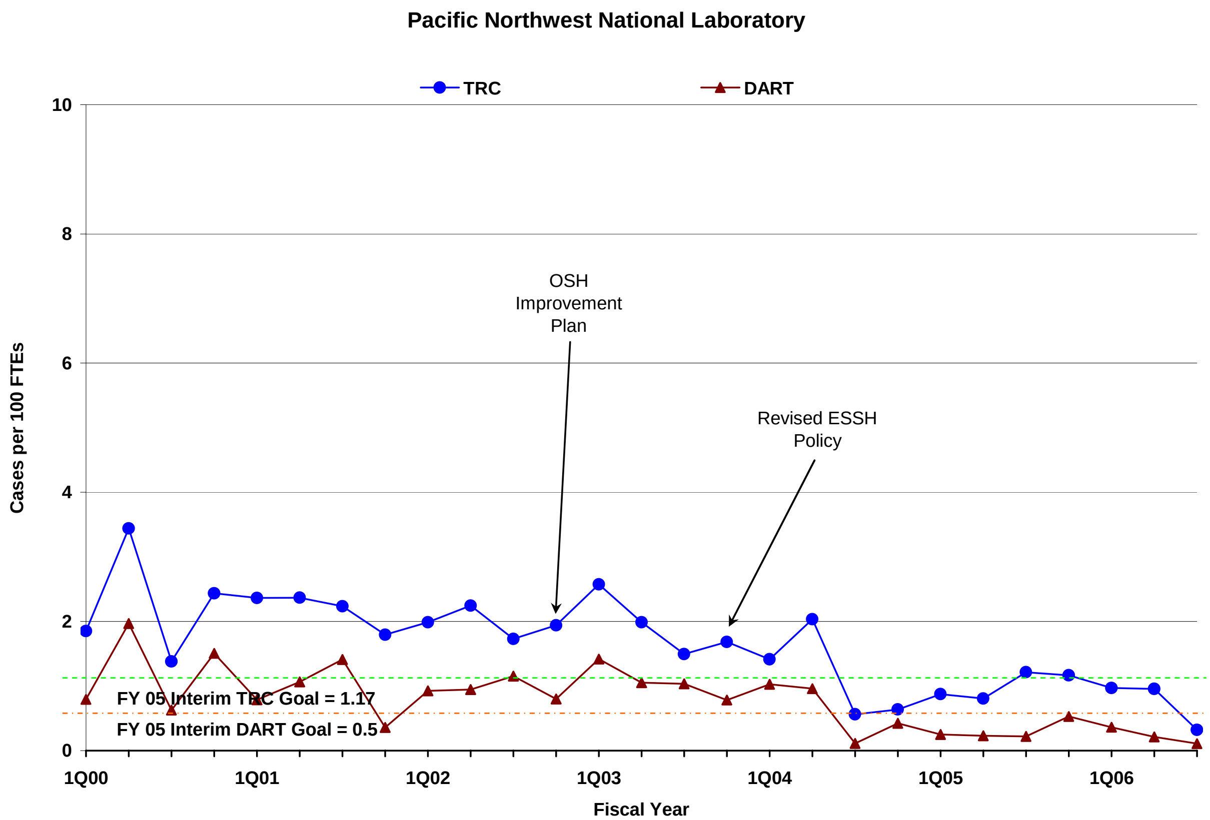


Workforce Diversity: As with most DOE labs, PNNL must make significant progress in the recruitment and retention of under-represented populations. PNNL's strategy with regard to selection and placement of minorities and women has resulted in an increase in minority representation. PNNL has two ongoing diversity initiatives to: 1) to create a pipeline for minority hires specifically focused in the National Security and nuclear areas and 2) increase the overall pipeline for minorities in the post masters and post doctorate areas across the Laboratory. The goal of the diversity programs is to create a "pipeline" of scientists and engineers who have positive experiences at the Lab from which to recruit.

Overall hiring in 2006 increased significantly, due to increase visibility and awareness around the minority initiatives.

Safety: PNNL recently completed a three year Safety Performance Improvement Plan to enhance the safety leadership skills of managers, provide more avenues for greater worker involvement (especially around the topic of injury prevention), and continued targeted improvements in the safety program (see figure below). The current effort is built upon PNNL's success in achieving a validated Integrated Safety Management (ISM) program, Voluntary Protection Program (VPP) Star status, ISO 14001 registration, and EPA Performance Track membership. These standards together demonstrate excellence nationally and internationally in integrating environment, safety, and health practices in the workplace. These collective efforts have resulted in DART and total recordable case (TRC) performance that is approaching world-class status. PNNL's FY 2006 DART rate (0.31) met the FY2006 target (0.37) and is approaching the DOE/Office of Science FY 2007 target of 0.25. PNNL's TRC rate of 0.92 was slightly above the DOE/Office of Science FY 2006 target of 0.87. In FY2007 and beyond, PNNL plans to incorporate elements of human performance to further strengthen the safety culture and program to help staff achieve an injury-free career.

DART and TRC Rates and Major Safety Initiatives



Physical Infrastructure: PNNL was established in 1965 in the split-up of the original Hanford Works contract. As part of the split-up, PNNL inherited use of 550,000 sf of buildings in the Hanford 300 Area, and was provided land south of the 300 Area. Battelle has subsequently constructed numerous facilities primarily on its property adjacent to the land south of the 300 Area to conduct its own private as well as DOE work (494,000 sf, 880 people). In addition to federal facilities in the 300 Area, PNNL has one other Federal facility in the land south of the 300 Area, namely, the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL), a national scientific user facility

(200,000 sf, 373 people). PNNL also leases space in the Richland and other areas (793,000 sf, 2,330 people). PNNL's AUI is 1.0 (excellent) for the EMSL facility.

DOE is assessing the renovation and or replacement of some facilities in the 300 Area that PNNL is using. The no-longer operating portions of the 300 Area are slated for remediation under the River Corridor Clean-up Project.

Maintenance, recapitalization, and modernization are supported with overhead (maintenance and Institutional General Plant Projects), operating, and GPP funds and with line item funding. Because of the impending closure of some of the 300 Area facilities, maintenance investments in the 300 Area are currently focused on those facilities that may be retained into the future and work that is necessary to ensure safe operations through planned closure in 2011.

For the remaining Federal facility, namely EMSL, PNNL will attain a maintenance investment level of 2.0% of replacement plant value (excellent). PNNL has no deferred maintenance backlog, thus the ACI is 1 (excellent) for the EMSL facility. The FY 2008 GPP funding request is $4.5M. PNNL has initiated use of Institutional General Plant Project funding to support development of the new campus.

Department of Energy Laboratory Plan For the Office of Science's Princeton Plasma Physics Laboratory

Mission and Overview

The Princeton Plasma Physics Laboratory (PPPL) is a collaborative national center for plasma and fusion science. It is the only Department of Energy (DOE) Laboratory devoted primarily to plasma and fusion research and is the leading U.S. institution investigating the physics of magnetic fusion energy. Plasma is hot ionized gas in which significant levels of nuclear fusion can occur under the appropriate conditions of constituent gas, temperature, density, and confinement in a magnetic field. PPPL's mission focus is to make the scientific discoveries and develop the key innovations that will lead to an attractive new energy source. Associated missions include conducting world-class research along the broad frontier of plasma science and technology and providing the highest quality of scientific education.

For over five decades PPPL has been a leader in magnetic confinement experiments and theory. PPPL is a partner in the U.S. Contributions to the ITER Project and leads multi-institutional collaborative work on two on-site advanced fusion devices – the National Spherical Torus Experiment (operating) and the National Compact Stellarator Experiment (under construction). The Laboratory hosts smaller experimental facilities used by multi-institutional research teams and also sends researchers and specialized equipment to other fusion facilities in the U.S. and abroad. To support these activities, the Laboratory maintains a nationally leading program in plasma theory and computation.

Laboratory Focus and Vision

Three core competencies underpin business line activities at the Princeton Plasma Physics Laboratory:

1. Experimental plasma physics in the areas of: operation of unique fusion facilities, diagnostic development of plasma measurement techniques, and neutral-beam and radio-frequency plasma heating, enabling experimental research in all facets of the physics of magnetized plasmas.

Lab-at-a-Glance

Location: Princeton, NJ

Type: Single-program lab

Contract Operator: Princeton University

Responsible Field Office: Princeton Site Office

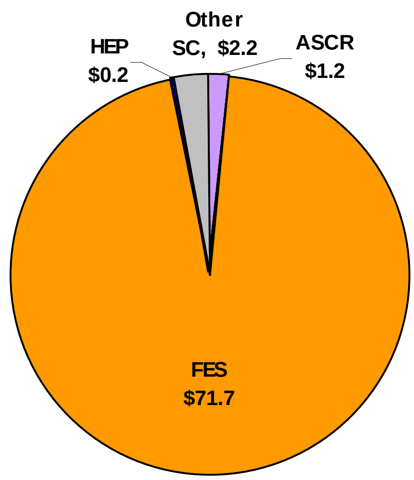
Website: http://www.pppl.gov/

Physical Assets:
- 88 acres; 36 buildings
- 722 GSF in Active Operational Buildings
- 1K in Non-Operational Buildings
- Replacement Plant Value: $302M
- Deferred Maintenance: $10.7M
- Asset Condition Index:
  - Mission Critical 0.98 (Excellent)
  - Mission Dependent 0.91 (Adequate)
- Asset Utilization Index: 0.97 (Good)

Human Capital:
- 408 employees
- 35 graduate students; ~250 Facility Users and Visiting Scientists

FY 2006 Total DOE Funding: $75.3M

FY 2006 DOE Funding by Source
PALS data (BA in Millions):



FY 2006 Non-DOE Funding: $2.0M

2. Theoretical plasma physics in the areas of: computational turbulence studies; nonlinear extended magnetohydrodynamics; fast-ion induced instabilities; and national theory coordination for the Spherical Torus and Stellarator initiatives. These are supported by computational capabilities in the areas of: algorithm development, massive parallelization, portability, visualization, and maintenance of a national code library.
3. Engineering capabilities in the area of specialized fusion confinement facility design and construction, plasma heating systems design and construction, plasma diagnostic systems design and construction, and safe and environmentally benign operation of such facilities.

The Office of Science believes that these three competencies will enable PPPL to deliver its mission focus, to perform a unique role in the DOE laboratory system, and to pursue its vision for scientific excellence and pre-eminence in the areas of experimental and theoretical research, as well as fusion engineering supporting:

- The investigation of burning plasmas in order to demonstrate the scientific and technological feasibility of fusion energy;
- Science and innovation to increase fusion power at given size and field, including both the capability to produce high fusion power density and also the capability to handle the resulting high heat flux, in order to further the practicality of fusion power;
- Science and innovation to achieve compact efficient steady-state operations which require minimal recirculating power to sustain the plasma configuration in order to further the practicality of fusion power; and
- Fundamental understanding of plasma behavior, sufficient to provide predictive capabilities for design of fusion energy systems.

Business Lines

The following capabilities, aligned by business lines, distinguish PPPL and provide a basis for effective teaming and partnering with other DOE laboratories, universities, and private sector partners in pursuit of the laboratory mission. These business lines and the distinguishing capabilities outlined in the table below provide an additional window into the mission focus and unique contributions and strengths of PPPL and its role within the Office of Science laboratory complex. The PPPL Business Lines are aligned with the DOE 2006 Strategic Plan. The PPPL items specifically address Goal 3.1, Scientific Breakthroughs and the strategy, "Increase research to advance the knowledge of plasma and fusion energy sciences to the point where a determination of commercial feasibility of one or more leading designs is possible." Items in italics within the column, Distinguishing Capabilities, identify major research facilities. Descriptions of these facilities can be found at the website noted in the Lab-at-a-Glance section of this Plan.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
Burning Plasma Physics	• Proven experimental research capability in all facets of physics of magnetically confined plasmas; • Proven engineering capability to construct, operate, and decommission a high-power deuterium-tritium (D-T) fusion experiment - TFTR;	•The Tokamak Fusion Test Reactor was one of two fusion experiments that could use tritium (the second being JET in England). TFTR operated with tritium from 1993 until 1997 achieving world record results during that time frame. Results were documented in multiple peer-reviewed journals. •Success in design and construction is supported by the design, construction and	Demonstrate with burning plasmas the scientific and technological feasibility of fusion energy.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
	• Proven capability in developing diagnostics, neutral-beam and radio frequency heating, and current drive systems in a D-T environment; • Engineers and designers with proven expertise in electromagnetic, structural, thermal and neutronics analysis and design; • *Partnership in the U.S. Contributions to the ITER Project.*	operation of the Tokamak Fusion Test Reactor. This was the largest fusion experiment in the US. It was also the only machine in the US that was qualified to use tritium. The machine was designed. TFTR operated above at and above its design parameters (e.g., designed for 5.2 Tesla and operated at 5.8 Tesla; designed for 2.5 MA and operated at 3.0 MA). •More than 50% of the PPPL staff has been designated as APS Fellows (APS has a goal of 10%). PPPL Scientists have also received numerous awards resulting in the research of plasmas (e.g., James Clerk Maxwell Prize for Plasma Physics, Presidential Early Career Award for Scientist and Engineers, Katherine Weimer Award for Women in Plasma Physics, etc). •Many PPPL diagnostics and heating systems have been adapted by collaborators around the world. Indeed, PPPL has been chosen by the US ITER Team to lead the diagnostic effort. PPPL staff has also worked extensively with our collaborators in Japan to improve their heating systems. The PPPL systems are unique since they have been tested in a D-T facility (TFTR) one of two in the world for fusion research.	
Increased Fusion Power at Given Size and Field	• Experimental research in all facets of physics of magnetized plasmas; • Most powerful fusion site in the U.S. in terms of line power, energy storage capabilities and power conditioning systems; • Most powerful plasma heating systems and current drive systems of any U.S. fusion site; • High beta (ratio of plasma pressure to magnetic field pressure); • Unique world leading diagnostic tools; • *National Spherical Torus Experiment (NSTX) (operating).*	Fusion power at a given size and field scales as the quantity, toroidal, NSTX has achieved world-leading results for toroidal. Leading experimental and theoretical/ computational research in all facets of physics of magnetized plasmas; World-leading high beta results (ratio of plasma pressure to magnetic field pressure) which permit the achievement of high fusion power at given size and field leading to increased practicality of fusion power. Well-developed understanding of the physics properties of low-aspect-ratio magnetic confinement systems.	Determine the most promising approaches and configurations to confining hot plasmas for practical fusion energy systems. Demonstrate with burning plasmas the scientific and technological feasibility of fusion energy. NSTX both studies the Spherical Torus Configuration as a fusion system and supports burning plasmas through its unique physics contributions.
Compact Efficient Steady-State Operation	• Experimental research in all facets of physics of magnetized plasmas;	Successful design of world-leading compact configuration for efficient continuous operation.	Determine the most promising approaches and configurations to confining hot plasmas for practical fusion energy systems.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
	• Optimized compact design with quasi-axisymmetry for good confinement, high theoretical beta limit, capable of continuous operations with little recirculating power; • Powerful site capable of supporting National Compact Stellarator Experiment (NCSX) operation in parallel with NSTX operation. • *National Compact Stellarator Experiment.*	Completed construction of complex non-axisymmetric vacuum vessel to required 5 mm tolerance. Completed construction of 6 of 18 complex 3-D modular coils to 0.5 mm tolerance.	Demonstrate with burning plasmas the scientific and technological feasibility of fusion energy. NCSX both studies the Compact Stellarator configuration as a fusion system and supports burning plasmas through its unique physics contributions.
Theoretical and Computational Understanding	• Computational turbulence studies; • Computational macro-stability studies; • Understanding fast ion induced instabilities and macrostability; • Algorithm development; • Massive parallelization; • Visualization.	Leading computation in: plasma turbulence; plasma macro-stability; and fast ion induced instabilities studies; Successful parallelization and visualization of major fusion codes on the most advanced computation platforms. PPPL succeeded in running the GTC code on 10,386 processing cores on the ORNL Cray XT3 (Jaguar). PPPL Scientist was able to advance 5.4 billion particles per step per second, a 13% improvement over previous record of 4.8 billion particles per second on the Japanese Earth Simulator. This achievement was highlighted in HPC wire: http://www.hpcwire.com/hpc/943289.html	Develop a fundamental understanding of plasma behavior sufficient to provide a reliable predictive capability for fusion energy systems.

Major Activities

Following is a set of major activities that PPPL is pursuing to support aspects of the DOE mission and build on core strengths and capabilities of the laboratory. These activities are either currently supported or appear in the FY 2008 budget submission to Congress.

The major activities are:

1. ITER
2. National Spherical Torus Experiment (NSTX)
3. National Compact Stellarator Experiment (NCSX)

1. ITER

- **Summary:** ITER is an international collaboration to construct a fusion research facility capable of producing 500 MW of fusion power for over 400 seconds with only 50 MW of plasma heating power. The ITER facility will be located in Cadarache, France. PPPL and Savannah River are currently the only partner laboratories with ORNL in the U.S. contributions to the ITER project. The U.S. ITER Project Office is located at ORNL.

- **Expectations:** PPPL is to lead the R&D, design and construction of the U.S. diagnostic systems for ITER, and the U.S. contributions to the Steady-State Power Network. PPPL will provide support in other areas such as magnet design and R&D.
- **Benefit Perspective:** Potentially *Transformational* Benefits. ITER is to demonstrate the scientific and technological feasibility of fusion power, an unlimited non-CO_2-emitting energy source.
- **Risk Perspectives:**
  - Technical: *High risk* - ITER will be pushing many state-of-the-art technologies to their limits.
  - Market/Competition: *Low risk* -- provided the U.S. participates in the experiment and gains the knowledge needed to build fusion power plants in the future.
  - Management/Financial: *High risk* -- due to the collaboration of multiple countries with different approaches to project management, the complex arrangements for contributions in kind, and the magnitude of funding required.

An experienced national team has been assembled to mitigate the technical risks of the U.S. Contributions to the ITER project, which arise from pushing state-of-the-art technologies to their limits. The PPPL team will support the U.S. and International Teams by building hardware and supplying individuals who will assure the success of this project. This support will include secondees to the International Team in France.

PPPL will strongly support ITER not only through its contributions to the U.S. Contributions to ITER project, but also through theoretical and computational efforts and experimental work at on and off-site experimental facilities. These efforts are coordinated through the U.S. Burning Plasma Organization and the International Tokamak Physics Activity.

2. NSTX

- **Summary:** Study the physics principles of spherically shaped plasmas using the National Spherical Torus Experiment (NSTX). Results from this innovative magnetic fusion device will both advance the ST concept for future fusion applications and also provide unique scientific input to the ITER Project.
- **Expectations:** NSTX will continue to lead the world in developing fusion systems with very high beta (ratio of plasma pressure to magnetic field pressure), allowing cost-effective magnets to contain powerful fusion plasmas. NSTX will address issues of fusion science relevant to ITER, including energetic particle physics, inaccessible in any other device worldwide. Research on NSTX will also address compact, efficient continuous operation through innovative approaches to plasma current drive.
- **Benefit Perspective:** Potentially *Transformational* Benefits. NSTX leads the world in spherical torus research.
- **Risk Perspectives:**
  - Technical: *Moderate risk* -- due to the complexity of the devices and the potential for coil failure. Risk is mitigated by having long lead items available to build new components if necessary.
  - Market/Competition: *Low risk* -- due to a strong lead in the world. Other facilities cannot match NSTX's heating, diagnostic, and control capabilities.
  - Management/Financial: *Low risk* -- due to proven financial and management systems and current operation.

NSTX produces plasma that is shaped like a sphere with a hole through its center, different from the "donut" shaped plasmas of conventional tokamaks. This innovative plasma configuration has several advantages, a major one being the ability to confine a higher plasma pressure for a given magnetic field strength leading to more cost-effective fusion systems, since plasma pressure gives rise to fusion power and magnetic field strength gives rise to system costs. This capability was theoretically predicted and has now been experimentally confirmed. The use of spherically shaped plasmas could allow the development of smaller, more economical fusion power plants, as well as a cost effective Component Test Facility. The important differences between NSTX and more conventional tokamaks allow unique perspective on key scientific issues for ITER. Examples include instabilities driven by energetic particles, factors controlling the temperature and density profiles near the edge of the plasmas, and the physics of instabilities at the plasma edge. Strong theoretical and computational efforts support the understanding of NTSX results, and their extension to ITER and other projects, such as NHTX.

3. National Compact Stellarator Experiment (NCSX)

- **Summary:** A new experimental facility, the National Compact Stellarator Experiment (NCSX), is under construction as the centerpiece of the U.S. effort to develop the physics and determine the attractiveness of the compact stellarator as the basis for a fusion power reactor. NCSX is currently ~2/3 complete.
- **Expectations:** NCSX will help lead the world in developing fusion systems that operate continuously with very little power required to sustain the plasma configuration. The NCSX configuration is optimized for high quasi-axisymmetry for tokamak-like plasma confinement, high beta limits, and compact configuration – unique features in the world stellarator program. Research on NCSX will thus address not only efficient continuous operation but also increased fusion power at given size and field. Like NSTX, NCSX provides unique capabilities to test physics issues of high relevance to ITER. Examples include the effects of non-symmetry on internal magnetic structure and the physics of disruptions.
- **Benefit Perspective:** Potentially *Transformational* Benefits. The energy requirement for steady-state current drive and the impacts of disruptions may make the tokamak impractical for fusion power systems. The stellarator naturally resolves these issues.
- **Risk Perspectives:**
  - Technical: *Moderate risk* -- due to the complexity of the device and cutting edge technologies. Risks are mitigated with intentional redundancies in research and production of complex elements. The vacuum vessel construction is now completed, as are 6 out of the 18 complex non-planar modular coils. The remaining substantive risk is in the assembly of the complex components to high tolerance.
  - Market/Competition: *Low risk* -- due to a lack of comparable research elsewhere.
  - Management/Financial: *Moderate risk* -- due to the complexity of the configuration.

The NCSX will be built at the Princeton Plasma Physics Laboratory in partnership with Oak Ridge National Laboratory. The NCSX is now ~2/3 of the way through construction. First plasma is scheduled for 2009. NCSX will lead the world in developing fusion systems that operate continuously with very little power required to sustain plasma configuration. It will also contribute to the goal of high power production at given size and magnetic field, and provide unique data in support of ITER. Experimental results from NCSX will provide strong tests of the theoretical and computational basis on which it was designed to operate with excellent confinement and stability properties.

Financial Outlook

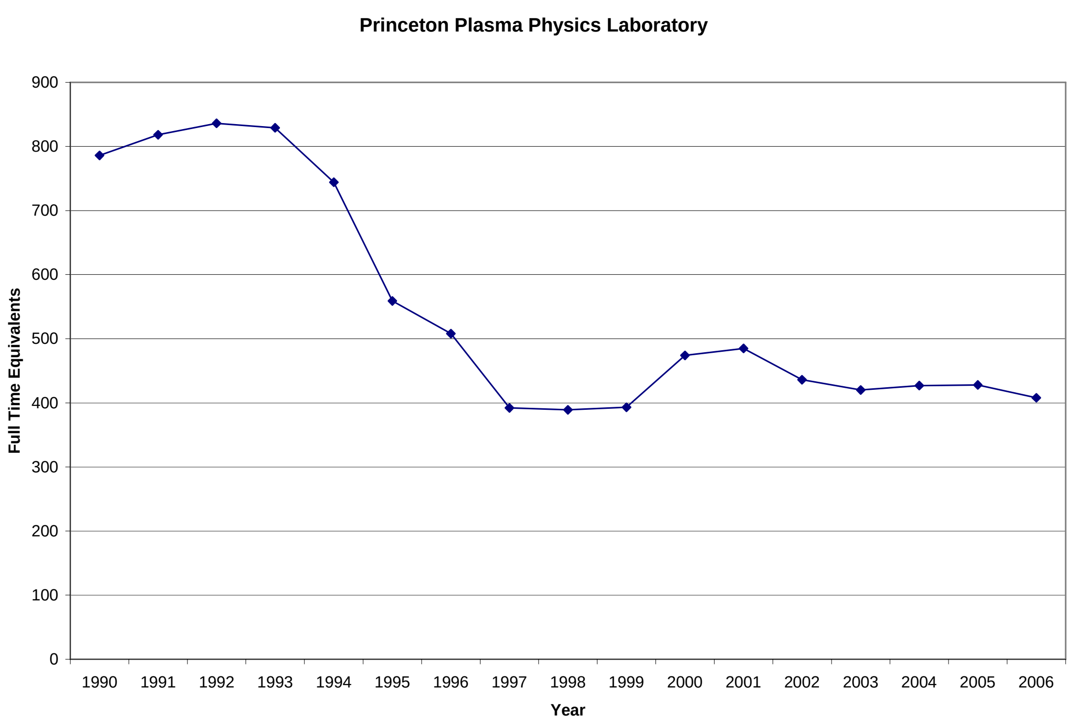
Detailed information regarding the financial outlook for the Princeton Plasma Physics Laboratory is subject to 1) competition and merit review, 2) the availability of appropriated funds and 3) programmatic decisions. The first two factors cannot be predicted or estimated in advance. The third, programmatic decisions are developed in accordance with the planning targets reflected in the Department of Energy programmatic Five Year Plans, a companion document to these strategic laboratory business plans. In addition, because of the Office of Science commitment to competition and merit review, there is often a time lag between programmatic decisions and the determination of which research provider can best deliver the greatest value in conducting the research. Thus, it is not always apparent how programmatic decisions unfold for particular laboratories. Nevertheless, some decisions, such as the plans for large scientific user facilities, show clear paths to individual labs and therefore inform their business plans.

Uncertainties and Risk Management

External Factors: Over the next five years, PPPL will have concerns driven by external forces. Primary among these is the budget outlook for the Laboratory. Other concerns include: impacts of the recently announced competition for the Management and Operations contract for PPPL, costs for implementation of directives, the cost of meeting the DOE 2% Maintenance Investment Index Goal, and the cost of reducing PPPL's deferred maintenance backlog.

S&T Workforce: The workforce for PPPL has remained relatively stable over the last few years. Based on the budget submitted to Congress, no reduction in force or downsizing is anticipated over the next five years. Projected full time equivalent employees may increase slightly if major activities identified above are funded.

Workforce Trends



Diversity: Diversity continues to be an important goal at PPPL, however, the decline and leveling of the number of staff has challenged implementation. PPPL must make significant progress in the recruitment and retention of under-represented populations. Critical to the success of this commitment is realization of funding projections as well as success of a diverse workforce development pipeline.

PPPL will continue and strengthen a number of educational outreach activities to ensure long-range goals in increasing the availability of women and minorities in science and technology by developing and enhancing feeder programs initiatives including:

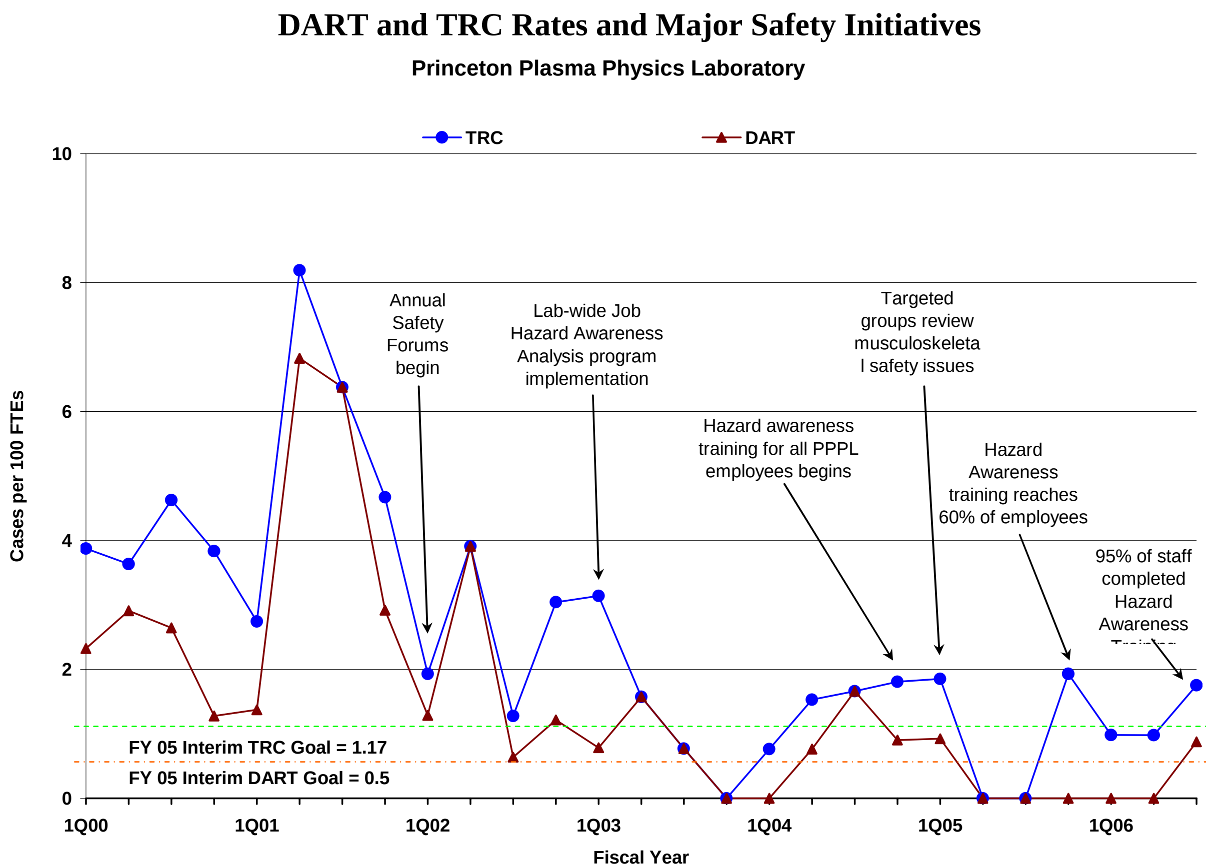
- Educational and Research Experiences—via the National Undergraduate Fellowship Program and the Student Undergraduate Laboratory Internship Program;
- K-12 Science Education Program—learning opportunities at PPPL encouraging women and underrepresented minorities to explore science as a career;
- Target recruiting of minority and women candidates; and
- Continue to achieve diversity representation in postdoctoral research, focusing on increasing the numbers of women and minorities (based on funding and the ability to hire post docs).

In FY 2005, PPPL implemented a Staff Search Report requirement before an offer of employment can be extended. The hiring manager, employment manager and Deputy Director must sign off and agree that an earnest effort was made to diversify the pool of candidates and fill the position with a qualified woman or minority. The goal of this review is to assure that diversity at PPPL is improved. This action has resulted in a significant improvement of hiring minorities and women in FY 2005 and FY 2006 (e.g., twice as many hired in FY 2006 *vs.* FY 2002).

This level of commitment from the Director's Office has sent a clear message about the seriousness and business relevance of the issue of diversity. There is a stated expectation that resulted in more involvement and commitment from senior management and their staffs. PPPL also conducts an annual review of minority and women promotions and salary. No inequities have been found to date; however, if they are identified in the future, PPPL will correct the problem and ensure equity.

The focused activities on recruiting, developing, promoting and retaining will have long-term impacts on ensuring a diverse workplace that recognizes and rewards all staff.

Safety: Safety continues to be a top priority at PPPL. During FY 2006, PPPL experienced eight TRC cases and two DART cases. The number of incidents at the laboratory had steadily decreased during the previous 4 years, and had actually achieved a milestone of 17 consecutive months (>1.2 million hours worked) without an injury involving lost time or work restriction (11/23/04-5/4/06). During the second half of the year, there was an increasing injury trend. The injuries consisted primarily of hand lacerations and joint sprains/strains, but any injury is considered preventable. As a result, a number of activities are being employed to improve this level of performance during FY 2007 including: continuation of Hazard Awareness Training; increased awareness of the use of Personal Protective Equipment, the initiation of Human Performance Training; and possible enrollment in the DOE's Voluntary Protection Program.



Physical Infrastructure: PPPL is located on 88 acres of Princeton University land near Princeton University (outside of Princeton, N.J.). Established as a Federal laboratory in the 1960s, PPPL has over 722,000 square feet of space in 36 buildings; 35% of the space as well as many of the utility systems and roads are 40 years old or older. PPPL's Asset Utilization Index (AUI) is 1.00 for offices, laboratories and warehouses (excellent). The replacement plant value of PPPL's general purpose facilities is $302.7M.

Maintenance, recapitalization, and modernization are supported with overhead, operating, and GPP funds, and with line item funding. PPPL attained a maintenance investment index of 2% of replacement plant value (excellent) in FY 2006. This level will be continued in FY 2008 and the outyears. PPPL's deferred maintenance (DM) backlog is $10.7M. The Asset Condition Index (ACI) for mission critical facilities is 0.98 (the DOE goal is 0.964 or above) and 0.91 for mission dependent facilities (the DOE goal is 0.948 or above). ACI is computed as 1 minus the result of deferred maintenance divided by replacement plant value. To reduce the DM backlog, thereby improving ACI, PPPL has initiated a deferred maintenance reduction effort with $464,872 of funding in FY 2008.

The FY 2008 GPP funding request is for $1.9M. Improvements are being made over the next three years to some existing buildings to prepare them for the National Compact Stellarator Experiment, and at the same time some older buildings are being demolished in order to consolidate occupied space and reduce costs. PPPL's future modernization challenge is to renovate nine 40-year-old buildings to extend their life and increase their versatility and flexibility for upcoming mission work. The technical infrastructure of the Laboratory, including the major electrical and HVAC systems, is also in need of refurbishment. The laboratory is working to achieve the goals for energy reduction and use of renewable energy established in the Energy Policy Act of 2005.

Department of Energy Laboratory Plan For the Office of Science's Stanford Linear Accelerator Center

Mission and Overview

The Stanford Linear Accelerator Center (SLAC) was founded in 1962 and has gained international recognition for research and the operation of major user facilities in photon science and particle physics. Operated by Stanford University, SLAC supports the Office of Science research objectives through its primary mission focus of designing, constructing, and operating state-of-the-art electron accelerators and related experimental facilities for use in photon science and high-energy physics research. Major user facilities at SLAC include the Stanford Positron Electron Accelerator Ring (SPEAR3), a synchrotron light source providing a resource for probing the structure of matter at the atomic and molecular scale, and the B-factory, a high energy electron-positron collider. The B-factory uses the two-mile long linear accelerator, or linac, on the SLAC site as its injector. The linac will be an integral part of the Linac Coherent Light Source (LCLS), currently under construction at SLAC. LCLS will be the world's first x-ray free-electron laser and positions the lab to become the world leader in the exciting new scientific field that it will enable. Approximately 3000 students, postdoctoral researchers, and scientists from the U.S. and abroad make use of SLAC's accelerator-based instrumentation and techniques for their research in photon science, particle physics and particle astrophysics. Six scientists have been awarded the Nobel Prize for work carried out at SLAC and 10 members of the SLAC faculty are in the National Academies.

Laboratory Focus and Vision

Six core competencies underpin activities at SLAC:

Lab-at-a-Glance

Location: Menlo Park, CA

Type: Program Dedicated Lab

Contract Operator: Stanford University

Responsible Field Office: Stanford Site Office

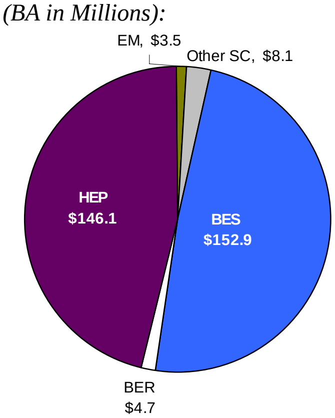
Website: www.slac.stanford.edu

Physical Assets:
- 426 acres
- 115 buildings
- 1.7M GSF in Active Operational Buildings
- Replacement Plant Value: $807M
- Deferred Maintenance: $30.7M
- Asset Condition Index:
  - Mission Critical 0.96 (Good)
  - Mission Dependent 0.97 (Good)
- Asset Utilization Index: 1.0 (Excellent)

Human Capital:
- 1546 employees;
- 128 graduate students;
- 3000 Facility Users and Visiting Scientists

FY 2006 Total DOE Funding: $315.3M

FY 2006 DOE Funding by Source
PALS Data (BA in Millions):



FY 2006 Non-DOE Funding: $12.8M

1. Developing new and innovative concepts for electron-based accelerators and their generation of photons, instrumentation, detectors and computing to both enhance existing facilities and to pioneer research using the next generation of such facilities.
2. Designing, engineering, constructing, and commissioning complex, cutting-edge electron-based accelerator facilities with rapid delivery of peak performance.
3. Designing, engineering, constructing and operating advanced instrumentation to study objects that span a vast length scale: from subatomic particles to the structure of materials to dark matter in the universe.
4. Efficiently and safely operating, at very high performance levels, world-class scientific user facilities.
5. Designing and operating petabyte computing enterprises for users distributed worldwide.
6. Developing innovative techniques for data analysis, modeling, and simulation.

The Office of Science believes that these six competencies will enable SLAC to deliver its mission and customer focus, to perform a complementary role in the DOE laboratory system, and to pursue its vision for scientific excellence and pre-eminence in the areas of:

- Discovering new scientific frontiers within the physical and life sciences by probing the ultra small and ultra fast world of materials, molecules and atoms with high brightness X-rays and;
- Understanding the fundamental physics of the birth and evolution of the universe by conducting theoretical studies and experiments in the interrelated disciplines of particle and particle astrophysics.

Business Lines

The following capabilities, aligned by business lines, distinguish SLAC and provide a basis for effective teaming and partnering with other DOE laboratories, universities, and private sector partners in pursuit of the laboratory mission. These business lines and the distinguishing capabilities outlined in the table below provide an additional window into the mission focus and unique contributions and strengths of SLAC and its role within the Office of Science laboratory complex. Items in italics within the column, Distinguishing Capabilities, identify research facilities that convey particular, strategic strengths and capabilities to the Lab. Descriptions of these facilities can be found at the website noted in the Lab-at-a-Glance section of this Plan.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
Photon Science	• Ultrafast X-ray science; • Complex/correlated & magnetic materials science; • Molecular, environmental & interface science; • Nano- & atomic-scale structural biology; • Strong coupling and integration with outstanding research university (Stanford), providing leadership and vision across a range of disciplines. • *Linac Coherent Light Source, LCLS*	Successful SPEAR3 upgrade on time, within budget, makes the Stanford Synchrotron Radiation Laboratory (SSRL) a 3rd generation synchrotron light source; Will deliver the world's first X-ray free electron laser in 2009, providing unprecedented brightness, coherence and short pulses of X-rays enabling revolutionary new discoveries (LCLS).	Advance core disciplines of basic energy sciences and biological and environmental research; Contribute to science and technology that advances the energy security and health of our nation; Master convergence of physical and life sciences for health and medicine.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
	• *Stanford Synchrotron Radiation Laboratory, SPEAR3*		
Particle Science	• CP violation in B mesons, precision particle physics at the electron energy frontier, and non accelerator tests of the Standard Cosmological Model through investigations of Dark Matter and Dark Energy; • Strong integration with outstanding research university (Stanford). • *B Factory, PEP-II, BaBar, GLAST*	World's highest luminosity electron-positron storage rings – *shared with KEK;* State of the art gamma ray detector, soon to be in space, to investigate dark matter and cosmic acceleration mechanisms.	Explore and discover the laws of nature as they apply to the basic constituents of matter, and the forces between them; Advance accelerator technology for the benefit of particle science and other disciplines for which accelerators are a primary tool.
LCLS	• Ultrafast X-ray science; • Complex/correlated & magnetic materials science; • Molecular, environmental & interface science; • Structural biology. • *Linac Coherent Light Source*	World's first X-ray free electron laser.	Lead nanoscale science revolution; Master control of energy-relevant complex systems.
Accelerator Science and Technology	• Accelerator R&D using low emittance, high energy electron beams • Facilities and expertise in high power RF technologies for future accelerators • FFTB/SABER; NLCTA; Klystron and RF technologies, Future Injector Test Facility	World's highest energy, low emittance electron beams from SLAC Linac.	Advanced accelerator technology for the benefit of photon and particle science and other disciplines for which accelerators are a primary tool.
Advanced Scientific Computing	• Techniques for data mining and exploitation of Petabyte-class data samples Numerical solution and visualization for complex systems in accelerator physics, photon science, particle physics, astrophysics and cosmological applications	Providing efficient access to world's largest data sample for particle physics – *shared with KEK.*	Extraction of forefront science from large survey and/or very rapidly acquired data samples Simulation and design of present and future state-of-the-art accelerator facilities

Major Activities

Following is a set of major activities that SLAC is pursuing to support aspects of the DOE mission and build on core strengths and capabilities of the laboratory. These activities are either currently supported or appear in the FY 2008 budget submission to Congress.

The Major activities are:

1. Linac Coherent Light Source (LCLS)
2. International Linear Collider (ILC) R&D
3. Foundation: the Ongoing Program

4. Crosscutting – Accelerator R&D and Supporting Technologies

1. Linac Coherent Light Source (LCLS)

- **Summary:** LCLS will produce X-ray laser pulses that are coherent and ultra-short (100-200 femtoseconds and eventually even shorter) to perform atomic-level stop-action photography, revealing the motion of atoms in the midst of chemical processes and physical transformations of materials. Each pulse will be 10^{10} higher in peak X-ray brightness than those from any existing synchrotron sources.
- **Expectations:** LCLS will for the first time allow direct observations of: atoms as they change states of excitation; molecules in the instants of time when new chemical bonds are broken or formed; the interiors of dense plasmas or materials in extreme magnetic fields, in quasi-static and transient conditions; and *single* molecules essential to life processes, determining at or near atomic resolution those structural features critical to their function.
- **Benefit Perspective:** Potentially *Transformational* Benefits.
- **Risk Perspectives:**
  - Technical: *Moderate risk* -- The LCLS will be the world's first X-ray free electron laser. SLAC has used the world's brightest, ultra-short, pulse X-ray source (SPPS) for ultrafast structural dynamics studies that are central to development of ultrafast X-ray science – the foundation for the LCLS activity.
  - Market/Competition: *Low risk* -- The LCLS will be best in class. However, two competing facilities (one at SPring-8, in Japan, and the other at the German Electron Synchrotron [DESY]) are currently expected to begin operation in 2010 and 2013 respectively. The number of experiment stations at the DESY facility, and hence the capacity to serve users, will outstrip that of the LCLS when it begins operation in 2013. SLAC's strategy for managing this risk is embodied in expansion plans for LCLS, the initial phase of which can be readily accommodated within the current LCLS conventional facilities.
  - Management/Financial: *Moderate risk* -- The LCLS takes advantage of the existing infrastructure at SLAC. However, the early productivity of the LCLS depends on the timely funding and completion of additional LCLS scientific instruments that are part of a proposal for a "major item of equipment" project called the LCLS Ultrafast Science Instruments.

This strategic component of the photon science business line at SLAC involves the development of a completely new class of "unconventional" light sources based upon electron linacs rather than circular storage rings. The first step in this direction was the SPPS experiment which used the SLAC linac to deliver 80 femtosecond pulses of electrons that then produce X-rays. The SPPS collaboration provided first experience with the application of X-ray scattering and absorption techniques to study properties of materials on this very short time scale. The next major step is the construction of the LCLS, scheduled to become operational in 2009. LCLS takes advantage of the existing infrastructure at SLAC by initially utilizing the last 1/3 of the existing 3 km linear accelerator. LCLS is a research tool with discovery potential that comes along perhaps once in a generation.

The science program of LCLS will evolve and grow as driven by scientific opportunity and demand. Recognizing this inevitability, significant performance enhancements are being planned into the project for implementation beyond the baseline design without requiring any significant reconstruction of conventional facilities (and hence fully preserving the initial capital investment). Examples of these are the production of much shorter (femtosecond and below) bunches, the implementation of seeding approaches for the control of temporal coherence, and infrastructure that will readily accommodate a five- to ten-fold growth in the number of photon beam lines.

LCLS is being constructed with headroom for expansion of its performance capabilities and the complex of instruments associated with it. It is SLAC's goal to seize the leadership in the emerging area of ultrafast science using x-rays and to maintain this leadership role throughout the next decade.

2. International Linear Collider (ILC) R&D

- **Summary:** The proposed International Linear Collider (ILC) would allow physicists to make the world's most precise measurements of nature's most fundamental particles and forces by colliding individual fundamental particles rather than particles with a complex structure such as protons or anti-protons. The physics investigations envisioned at the ILC are both broad and fundamental, and will both require and support a leading-edge program of research for many years.
- **Expectations:** Physicists predict that the linear collider, operating initially at energies up to 500 GeV, will be needed to understand how forces are related and the way mass is given to all particles. This is dependent upon conclusive experimental results from the Tevatron at Fermilab and especially the Large Hadron Collider at CERN.
- **Benefit Perspective:** Potentially *Transformational* Benefits.
- **Risk Perspectives:**
    - Technical: *Moderate to High risk* – The technical challenges in the project are exemplified by the transverse beam sizes at collision (a few nanometers), by the requirement of providing very high electric field gradients to achieve the large energies, and by the exceptional control of the beams needed during the acceleration process.
    - Market/Competition: *Low risk* -- as there would be only one such international facility.
    - Management/Financial: *High risk* -- due to large project costs, technical risk, and international project management issues.

The shared goal for the consortium of laboratories around the world working on the International Linear Collider (ILC) is to complete the preliminary design and R&D of a new electron-positron linear collider with energy in the range of 0.5-1.0 Tera electron volt (TeV). There are many scientific, technical, political, and economic challenges to this project that must be addressed before a decision to proceed. While SLAC is not a candidate host laboratory for the proposed ILC, it will nonetheless play an important role in the development of the ILC project should it proceed.

3. Foundation: The Ongoing Program

- **Summary:** Enhance and maintain the necessary capabilities to support the growing and evolving needs of (a) the Stanford Synchrotron Radiation Laboratory through operation of state-of-the-art facilities including the SPEAR3 synchrotron light source and its beam lines, (b) the B-factory and (c) the Large Area Telescope/Gamma-Ray Large Area Space Telescope (LAT/GLAST).
- **Expectations:** The B-factory will sustain the current world leading studies of Charge-Parity (CP) violation in heavy flavors. New SPEAR3 capabilities will provide the photons, beam lines and instrumentation for research over a range of scientific disciplines, serving the well-established and growing needs of SSRL's research community. The GLAST/LAT project will be completed on schedule and launched into space in 2007.

- **Benefit Perspective**: Potentially *Substantial to Transformational* Benefits for B-factory and LAT/GLAST; *Significant/Sustaining* Benefits for SPEAR3 and SSRL Synchrotron program.
- **Risk Perspectives:**
    - Technical: *Low* -- technical risk is seen for continued operation of the B-factory and SPEAR3*; Moderate to Low* technical risk for the LAT/GLAST.
    - Market/Competition: *Moderate to High risk* – There is significant market competition in B-Physics from a similar facility in Japan. SPEAR3 is one of several new machines worldwide in its intermediate energy class. The market risk will be mitigated by continued innovation in the scientific applications, user support and beam line development programs. LAT/GLAST market risk is *Low* because it is a unique space mission.
    - Management/Financial: *Moderate to High risk* – The B-factory and SPEAR3 business lines clearly depend on sustained funding for core operations from DOE's Office of High Energy Physics and Office of Basic Energy Sciences (BES).

Accelerator based particle science at SLAC will be gradually reduced in the future as the primary accelerators on the site become facilities for cutting edge photon science. Expanded operation of SPEAR3 beam lines and instrumentation will allow this upgraded facility to be more widely available to academic, national laboratory, and industrial user base for "conventional" synchrotron radiation. This ongoing program in photon science, coupled with the LCLS described in Section 1 above, uniquely positions SLAC to have a world leadership position in delivering state-of-the-art accelerator-based synchrotron and x-ray laser radiation for scientific experiments. SLAC's goal is to maintain this leadership throughout the coming decade by continuing to develop forefront instrumentation on both SPEAR3 and LCLS and attracting and retaining the top intellectual talent in science and engineering to advance the program.

Stanford Positron Electron Accelerator Ring-3 (SPEAR3), SLAC's new 3rd generation synchrotron light source, was installed and commissioning completed in March 2004. The upgrade of its existing complement of beam lines is expected to complete by 2008. This upgrade capitalizes on the major investment in SPEAR3 and optimizes synergy with LCLS in technical and scientific areas. SPEAR3 is living up to expectations, and investments are being repaid in capabilities that will be equal to the best available for quite a few years. A BES survey of light sources has determined that SSRL has the largest potential for additional beamline development of any of the four BES light sources. SLAC continues to develop plans for new SSRL beam lines based on proposals for new activities and to more robustly support the growing user base.

To make progress in understanding the fundamental mystery of why the universe is dominated by matter and not anti-matter, a comprehensive study of the CP violation in heavy flavor is necessary. The B-factory activity is a chain of particle accelerators feeding a particle detector, BaBar. The BaBar experiment, using the most advanced particle detection and computing technology, has made major progress towards understanding why the universe is made exclusively of matter and what happened to the anti-matter that must have existed in equal quantities as matter at the creation of the universe. Maintaining the operation of the B-factory will allow this successful matter-anti-matter experiment to continue and the facility will then ramp down by the beginning of FY 2009.

The Large Area Telescope on the Gamma Ray Large Area Telescope mission, a space based detector soon to be launched, will allow the study of dark energy. It will measure the energy and direction of celestial gamma-rays with good resolution over a wide field of view to study the mechanism of particle acceleration in astrophysical sources, determine high energy behavior of gamma ray bursts and transient sources, and search for dark matter candidates. This is important to understanding the laws of nature as they apply to the basic constituents of matter and the forces between them.

4. Crosscutting – Accelerator R&D and Supporting Technologies

- **Summary:** Fundamental accelerator research and advanced scientific computing to enable full exploitation of petabyte-sized scientific data samples are activities that are crosscutting to the Photon Science and Particle Science Business Lines.
- **Expectations:** Critical investments that underpin the other business lines and activities and benefit much of the Office of Science Portfolio. R&D investments in accelerator R&D and scientific computing have paid off handsomely in terms of facility performance and scientific output for the B-factory and SPEAR3, to name two recent examples. Future investment is essential to fully recognize the value of the investment in the LCLS construction, and to continue to provide world-leading user facilities through the next decade.
- **Benefit Perspective:** *Substantial/Sustaining* Benefits.
- **Risk Perspectives:**
  - Technical: *Moderate risk* – The technical risks for picosecond pulses from the SPEAR3 and LCLS Injector Test Facility part of the accelerator research activity may all be considered low to moderate. However, risk is high for future accelerators. Risks in the computing activity are considered moderate.
  - Market/Competition: *Low risk* – The facilities and personnel resources at SLAC are unique for this type of accelerator R&D. The market competition risk is moderate to high in the area of computing for data intensive science.
  - Management/Financial: *Moderate risk* -- This research is somewhat vulnerable to the future funding prospects for accelerator research within the Office of Science.

Accelerator Research at SLAC is focused on three different time scales. Research focused on significant improvement in facility performance or current facility construction projects typically has immediate impact. In the midterm, the program includes R&D aimed at potential future facilities such as the proposed International Linear Collider and a possible upgrade of the LCLS such as an Injector Test Facility for LCLS gun development. Over the long-term, to make the next generation of accelerators feasible and affordable in decades to come requires fundamental R&D into advanced acceleration mechanisms. Such R&D will search for paths to high-energy and high brightness beams well beyond the reach of the ILC and LCLS. This proof of principle research requires dedicated facilities for R&D. To continue this kind of research which has been very productive, SLAC will propose to replace the Final Focus Test Beam (dismantled for the construction of the LCLS) with a new 30 GeV facility, the South Arc Beam Experimental Region or SABER, capable of delivering high quality, high energy, short pulse electron beams to the user community for advanced accelerator investigations.

The design and operation of petabyte computing enterprises is a core competency at the laboratory. Scientific computing is an enabling tool for discovery in many areas of research at SLAC. SLAC is currently a leader in specific areas of the "science of scientific computing" in support of experimental detector and accelerator simulation. SLAC is also a leader in "computing for data intensive science" specializing in scalable data management presently driven by the B-factory's science program, but also foreseen as critical for future science programs at ATLAS and LCLS. SLAC's goals are to sustain the development of leadership in these areas, further integrating techniques and capabilities to apply across different areas of science, and, in targeted areas, to develop new paradigms from the hardware to the science in the areas of data intensive science. Computing and simulations are also integral to enabling the most rapid scientific progress on data from LCLS and SPEAR3, especially in the areas of non-periodic nano and sub-nano scale imaging of non-periodic samples, high energy density matter and femtochemistry/biology.

Financial Outlook

Detailed information regarding the financial outlook for the Stanford Linear Accelerator Center is subject to 1) competition and merit review, 2) the availability of appropriated funds and 3) programmatic decisions. The first two factors cannot be predicted or estimated in advance. The third, programmatic decisions are developed in accordance with the planning targets reflected in the Department of Energy programmatic Five Year Plans, a companion document to these strategic laboratory business plans. In addition, because of the Office of Science commitment to competition and merit review, there is often a time lag between programmatic decisions and the determination of which research provider can best deliver the greatest value in conducting the research. Thus, it is not always apparent how programmatic decisions unfold for particular laboratories. Nevertheless, some decisions, such as the plans for large scientific user facilities, show clear paths to individual labs and therefore inform their business plans.

Support for non-DOE funded work is a vital role of our national laboratories, contributing to national security, energy security, environment stewardship, scientific discovery, and more fundamentally, the competitiveness of the U.S. economy. For the Stanford Linear Accelerator Center, this is no exception. The Office of Science is supportive of this work and although it is not addressed in any detail within the accompanying Five Year Plans, the Office of Science believes it is sufficiently important and appropriate to address within this strategic laboratory business plan. A brief perspective and financial outlook is therefore provided.

The current SLAC non-DOE funded activities are primarily sponsored by National Aeronautics and Space Administration (NASA), National Institute for Health (NIH), private foundations, and collaborative partners. All of the activities complement the DOE support of the research programs and/or the operation of experimental facilities at SLAC, and are well-aligned with the SLAC mission and its science-oriented business lines. Funding from NASA and some of the funding from NIH are under joint-agency partnerships with the DOE. NASA provides funding, together with DOE and an international collaboration, for the fabrication of the Large Area Telescope (LAT), of the NASA Gamma-Ray Large Area Space Telescope (GLAST) mission, for particle astrophysics research. The NIH funding for the SSRL structural molecular biology program supports macromolecular crystallography spectroscopy and scattering experiments. Funding from the Moore Foundation provides for the fabrication of a new SPEAR3 beam line for macromolecular crystallography and a Keck Foundation grant funds research in the area of ultrafast X-ray science. SLAC’s collaborative partners, in the U.S. and from abroad, provide support to the fabrication and operation of experimental facilities for Photon Science and Particle Science research.

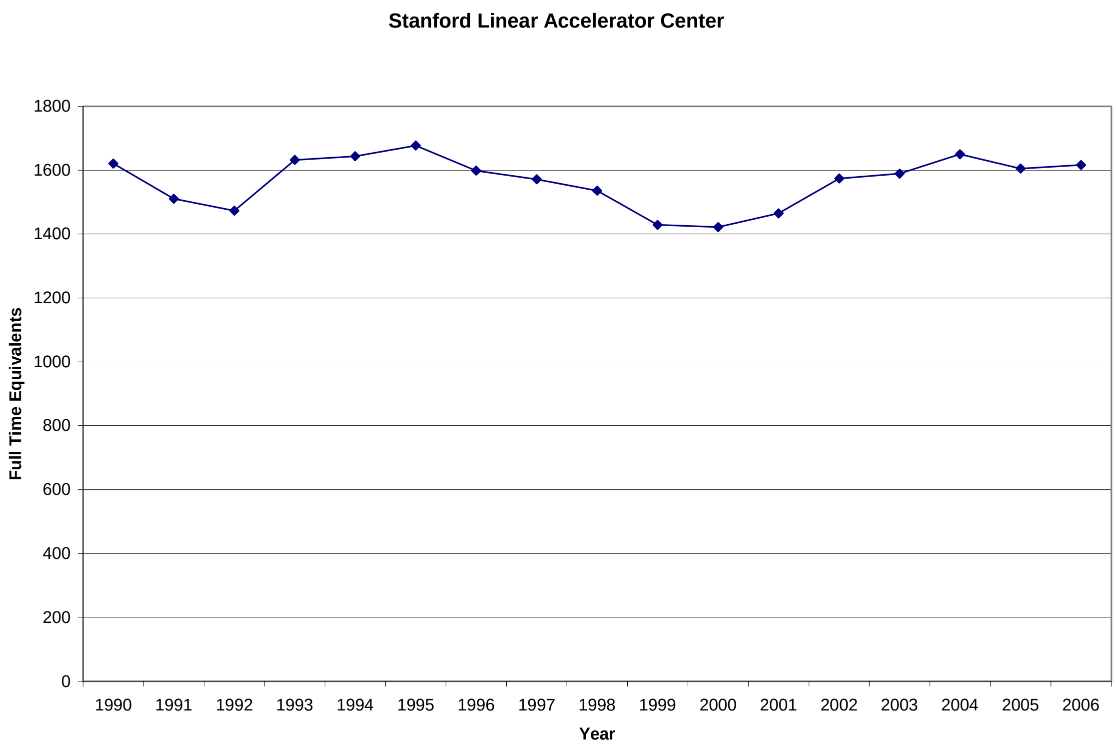
As the LAT progresses through its testing phase to prepare for the launch in 2007, the NASA supported effort at SLAC will be decreasing, to almost zero in FY2008. Depending on SLAC’s success in securing third-party funding for new activities in the next five years, the non-DOE funded activities at SLAC could decrease by FY 2008 to about a third of the level of FY 2006 with NIH being the primary sponsor.

Uncertainties and Risk Management

External Factors: Over the next five years, SLAC will have a number of concerns driven by external forces. Primary among these is the budget outlook for the Laboratory. With the large user population for the scientific facilities, the possible implications of foreign visits and assignments requirements provide challenges to operations. Risk mitigation strategies will need to be developed to handle each one of these significant items.

S&T Workforce: SLAC conducted a work force analysis and found no significant skill mismatches between current staff and future needs. The analysis did, however, identify a shortage of engineering and engineering management talent. To address the program needs, including those of the LCLS, during FY 2006 SLAC has hired seventeen engineers, with five in engineering management.

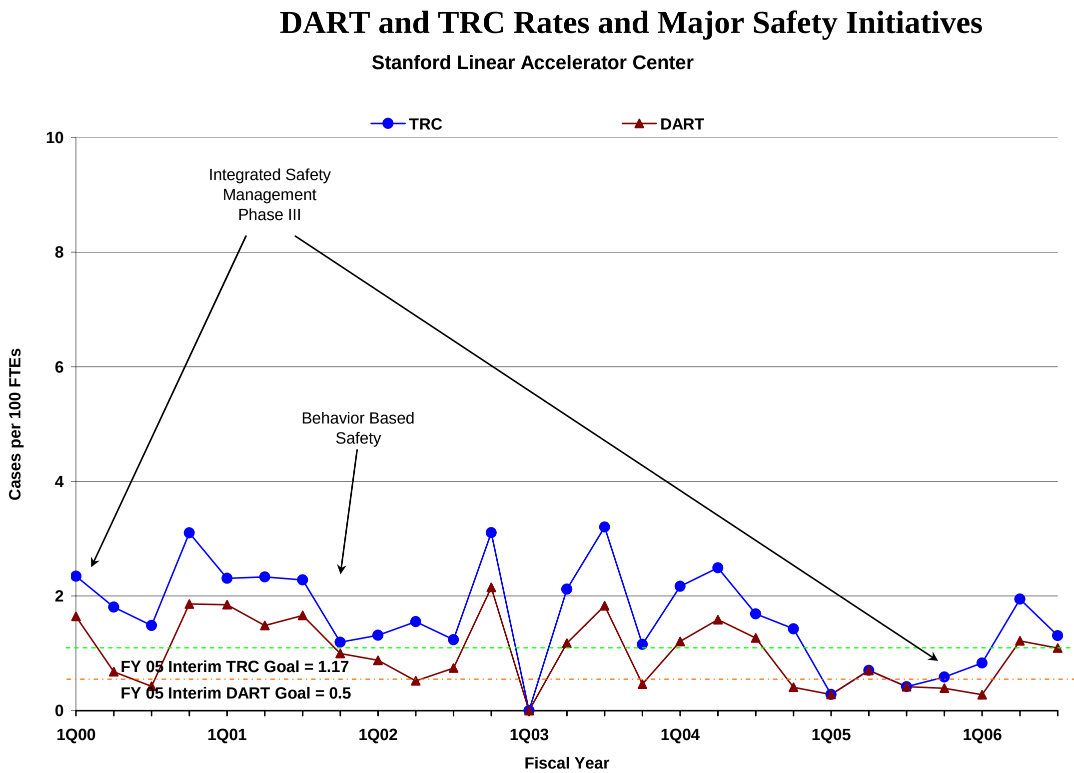
Workforce Trends



Employee Diversity: SLAC reviewed its practices for their value in attracting and retaining women and minorities in the workforce. As a result, on-line advertising has been expanded. SLAC has also increased its presence at local area job fairs focused on minority recruiting, and national meetings and conventions held by national minority organizations. Through contacts at Historically Black Colleges and Universities, SLAC has been successful in recruiting minority and female participants for its programs targeted at encouraging young people into the physical sciences. These programs include the Science Undergraduate Laboratory Internship program (SULI) and the National Consortium for Graduate Degrees for Minorities in Engineering and Science program (GEM). For most faculty hires, Stanford University requires a concerted effort to expand the applicant pool to be as diverse as possible.

Safety: SLAC is three years into the process of fundamental cultural change in the ES&H values, attitudes, and behaviors of every staff member at SLAC. Two foundational thrusts are the catalyst for this change – the intimately integrated adoption and execution of the first four Integrated Safety Management (ISM) core functions, and an institutional embrace of lessons-learned from accidents, injuries, and close-calls (the fifth ISM core function) at SLAC and other institutions. The central lesson-learned is that almost all SLAC's incidents result from a lack of sufficient attention, working while distracted, working while on "auto-pilot", or hasty (spur-of-the-moment) decision-making. SLAC's injury prevention campaign is based on ISM core function #5: feedback and improvement. Their focus is to instill constant ES&H awareness at all levels of the organization using a wide variety of programs.

The number of TRC and DART injuries at SLAC in FY 2006 was fewer than in four out of the five preceding years. The long-term trend in general is down. However, since TRC and DART statistics are lagging indicators, SLAC is more focused on the fundamental causes of injuries, which remain unchanged, and hence drive SLAC's intense focus on injury prevention.



Physical Infrastructure: SLAC is located on 426 acres of Stanford University land, adjacent to the Stanford University campus in Palo Alto, California. Established as a Federal laboratory in the 1960s, SLAC has over 1.7M square feet of space in 115 buildings; 56% of the space, as well as many of the utility systems and roads, are 40 years old or older. SLAC's Asset Utilization Index (AUI) is 1.00 for offices, laboratories and warehouses (excellent). The replacement plant value of SLAC's general purpose facilities is $807M.

Maintenance, recapitalization, and modernization are supported with overhead, operating, and GPP funds and with line item funding. SLAC attained a maintenance investment index of 1% of replacement plant value (RPV) in FY 2006. This level reflects SLAC's accelerator tunnels and interaction halls that are expensive to build but require much less maintenance than comparable office and laboratory facilities that house staff. Over one-half of SLAC's RPV is composed of tunnels and interaction halls. SLAC is developing sustainment models tailored to these unique facilities to better ascertain the annual maintenance funding needed to assure long-term availability for mission activities. Maintenance investment levels will be adjusted as necessary in FY 2008 and outyears to reflect the long-term requirements.

SLAC's deferred maintenance (DM) backlog is $30.8M. The Asset Condition Index (ACI) is 0.96 for mission critical facilities (the DOE goal is 0.964 or above) and 0.97 for mission dependent facilities (the DOE goal is 0.948 or above). ACI is computed as 1 minus the result of deferred maintenance divided by replacement plant value. To reduce the DM backlog, thereby improving the ACI, SLAC has initiated a deferred maintenance reduction effort with $686,333 of funding in FY 2008.

The FY 2008 GPP funding request is for $2.8M. One line item project is currently underway – the Safety and Operational Reliability Improvements project. This project includes underground utility upgrades (replacement of deteriorated sections of pipes for cooling water, low conductivity water, sanitary sewer, storm water, natural gas, compressed air, and fire protection) and seismic upgrades to strengthen various building structures to better assure worker safety in the event of an earthquake.

SLAC's future recapitalization and modernization challenges include rehabilitation and upgrade of the electrical distribution system, trailer replacements, building renovations, and laboratory space modernization. The laboratory is working to achieve the goals for energy reduction and use of renewable energy established in the Energy Policy Act of 2005.

Department of Energy Laboratory Plan
For the Office of Science's
Thomas Jefferson National Accelerator Facility

Mission and Overview

The Thomas Jefferson National Accelerator Facility (TJNAF), located in Newport News, Virginia is a program-dedicated laboratory for Nuclear Physics under the Department of Energy's Office of Science. Currently operated by the Jefferson Science Associates, LLC for the Office of Science, TJNAF began operations in 1995 with the completion of the Continuous Electron Beam Accelerator Facility (CEBAF), a unique international electron-beam user facility for the investigation of nuclear and nucleon structure based on the underlying quark structure. TJNAF research and engineering staff are world experts in superconducting radio-frequency technologies. CEBAF has an international user community of 1,175 researchers whose work has resulted in scientific data for 123 experiments, more than 194 *Physics Letters* and *Physical Review Letters* published, and 568 publications in other refereed journals. Collectively, there have been over 10,000 citations for work done at CEBAF. Research at TJNAF and CEBAF has also contributed to thesis research material for about one-fourth of all U.S. Ph.D.'s awarded annually in Nuclear Physics.

Laboratory Focus and Vision

TJNAF occupies a position of world leadership in the field of nuclear physics. This leadership is built upon the unique properties of the CEBAF accelerator, notably its high energy, polarization and duty factor, as well as outstanding array of experimental facilities and strong theoretical support. It is essential to the continuation of this world leadership that core competencies be maintained and enhanced in:

1. Hadronic Physics
2. Superconducting Accelerator Technologies

The Office of Science believes that these core competencies will enable TJNAF to deliver its mission and customer focus, to fulfill a complementary role in the DOE laboratory system, and to pursue its vision for scientific excellence and pre-eminence in the areas of nuclear physics:

Lab-at-a-Glance

Location: Newport News, VA

Type: Program Dedicated Lab

Contract Operator: Jefferson Science Associates, LLC (JSA)

Responsible Site Office: Thomas Jefferson Site Office

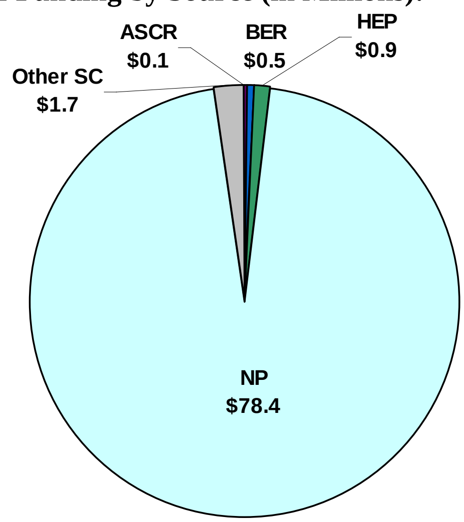
Website: http://www.jlab.org

Physical Assets:
- 206 Acres (includes SURA land)
- 64 Buildings
- 477K GSF in DOE Buildings
- Replacement Plant Value: $139M
- Deferred Maintenance: $8.8M
- Asset Condition Index:
  - Mission Critical 0.95 (Good)
  - Mission Dependent 0.82 (Poor)
- Asset Utilization Index: 1.0 (Excellent)

Human Capital:
- 628 Employees
- 230 Students (Undergraduate and Graduate);
- 2,200 Facility Users and Visiting Scientists

FY 2006 Total DOE funding: $81.7M

DOE Funding by Source (in Millions):



FY 2006 Non-DOE Funding: $9.4M

- The structure of the nuclear building blocks including: the nucleon's charge and magnetization distribution; the separation of the individual quark contributions to those distributions of charge and magnetization; the degrees-of-freedom governing the nucleon's excitation; the internal structure of the nucleon in the valence region, notably the distribution of momentum and spin on the valence quarks ; and the experimental and theoretical tools necessary to carry out a program of nucleon tomography.
- The structure of nuclei including: the nuclear interior with controlled impurities; short-range component of the nucleon-nucleon interaction in nuclei; the neutron radius of ^{208}Pb; and the underlying quark-gluon structure of the nucleus.
- Symmetry tests in nuclear physics, including the weak charge of the proton, to test predictions of the Standard Model.
- Enabling technologies and emerging fields - photon science and electron-light ion colliders – including advance radiofrequency superconductivity, 2K cryogenic engineering technology (ERL), advanced high power free electron lasers, energy recovering linacs, and electron-light ion collisions at ultra-high luminosity.

Business Lines

The following capabilities, aligned by business lines, distinguish TJNAF and provide a basis for effective teaming and partnering with other DOE laboratories, universities, and private sector partners in pursuit of the laboratory mission. These business lines and the distinguishing capabilities outlined in the table below provide an additional window into the mission focus and unique contributions and strengths of TJNAF and its role within the Office of Science laboratory complex. Items in italics within the column, Distinguishing Capabilities, identify research facilities that convey particular, strategic strengths and capabilities to the Lab. Descriptions of these facilities can be found at the website noted in the Lab-at-a-Glance section of this Plan.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
Nuclear Physics – 6 GeV Research	• Continuous beams of polarized high-energy electrons for studies of the quark structure of matter; • State-of-the-art Equipment & Detectors; • *Continuous Electron Beam Accelerator Facility, Hall A,* ***Hall B (CLAS), Hall C***	World-wide unique user facility for studies of nuclei and nucleons using the electromagnetic probe, with spatial resolutions from large nucleus to a fraction of a nucleon's diameter; Highest intensity in the world for highly polarized continuous electron beams with the energy and helicity correlated properties necessary to explore the details of nucleon and nuclear structure; Fulfilled 8 of the 10 OMB Office of Science milestones in Hadronic Physics; CEBAF cited as top construction priority in 1995 NSAC Long Range Plan "…and now provides electron beams of unprecedented intensity and quality for probing the inner structure of the nucleus and the nucleon." "12 GeV Upgrade of the unique CEBAF facility is critical for our	Explore Nuclear Matter- from Quarks to Stars – Understand the structure of the nucleon and nuclear matter Probe the limits of the Standard Model in the quest for new physics

		continued leadership in the study of hadronic matter." Upgrade listed as #4 recommendation from 2002 NSAC Long Range Plan (p. 16) (source: 2002 NSAC Long Range Plan). 12 GeV upgrade cited as near term priority of DOE "Facilities for the Future of Science: A Twenty-Year Outlook" (p. 20); Responsible for the production of about one-fourth of all U.S. Ph.D.'s awarded annually in Nuclear Physics; Produced three of the most highly cited papers in SPIRES database (>500 citations); Detector and data acquisition capabilities coupled with these beams provide the highest luminosity (10^{39}/eN/CM^{2}/S) capability in the world for these experiments.	
Nuclear Physics – Theory Center	• High Performance Computing Effort in Lattice Quantum Chromodynamics (LQCD).	World-recognized theory group; Strong phenomenological support of the experimental program from the concept to the analysis and interpretation of the data. Establishment of Excited Baryon Analysis Center: Appointment of Theory Center member as GlueX Experiment Theory coordinator. Collaborative Theory/Experimental analysis of world data on strange-quark contributions to the electric and magnetic properties of the nucleon; Software development used worldwide (Chroma); largest award under the DOE's 2007 INCITE initiative for project centered on JLab physics using Chroma. Adopted by UKQCD collaboration in the UK; sponsored visits by JLab Theory Group members to provide tutorials to UK theorists; First calculations of moments of General Parton Distributions.; PRL (96052001 (2006)) on the axial-vector charge of nucleon. Calculation showing the contribution to the spin of the nucleon from the orbital angular momentum is negligible.	Understand the structure of the nucleon and nucleonic matter; Deliver computing for the frontiers of science.
Superconducting Radio Frequency (SRF) and Related Accelerator Physics	• Experience building SRF for CEBAF & SNS; • Energy Recovery Techniques; • World-wide unique capability in 2K Cryogenic technology; • *The Testlab and Applied Research Center.*	Large-grain Niobium operating at an accelerating field of 45 MV/m -world record achieved with minimal processing; Benchmarking exercise, concluded that JLab is a world leader par with German Electron Synchrotron (DESY) as demonstrated by the first test of a fully JLab-processed TESLA cavity,	Understand the structure of the nucleon and nuclear matter; Provide the resource foundations that enable great science – from nuclear and particle physics to medical and basic energy sciences.

		which performed in the 90th percentile of DESY tests during the past 18 months; World record in Energy Recovery Linac Technology demonstrated via operating a 1MW class electron beam with 10 mA current and 100 MeV energy with only tens of kilowatts of klystron power.	
Photon Science and Technology	• ERL-based Free Electron Laser; • Potential kW to MW class lasers; • Micromachining; • *Infrared Free Electron Laser.*	Unique assets of ultra-fast pulses with broad tunability at unprecedented power levels with continuous/high repetition rate operation; World record of 15 kW average power laser at infrared wavelengths with a few hundred femtosecond pulse length.	Provide the resource foundations that enable great science. Contributes to national security

Major Activities

Following is a set of major activities that TJNAF is pursuing to support aspects of the DOE mission and build on core strengths and capabilities of the laboratory. These activities are either currently supported or appear in the FY 2008 budget submission to Congress.

The major activities are:

1. 12 GeV upgrade of the Continuous Electron Beam Accelerator Facility (CEBAF) (PED)
2. Excited Baryon Analysis Center
3. Lattice Quantum Chromodynamics (LQCD)
4. International Linear Collider R&D

1. 12 GeV Upgrade (PED)

- **Summary:** Upgrade CEBAF, a unique research facility and world leader in hadronic physics. The scope of the proposed project includes doubling the accelerator beam energy, adding a new experimental Hall and associated beam line, and upgrading the capabilities in existing experimental Halls.
- **Expectations:** The upgrade would allow experimental study of the confinement of quarks and address the question, “why are quarks never found alone?” Confinement is a remarkable and not understood feature of quantum chromodynamics (QCD) and is one of the major gaps in our understanding of nature. Gluonic excitation, in the form of exotic mesons, is a prediction of QCD that is expected to provide key insights into the nature of confinement. The only planned or existing facility that can test this prediction is the 12 GeV CEBAF.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
  - Technical: *Low risk* – superconducting radio frequency (SRF) work on other projects has significantly reduced the technical risks of this project.
  - Market/Competition: *Low risk* – CEBAF is a unique facility.
  - Management/Financial: *Moderate risk* - due to federal budget uncertainties. Construction funds have not yet been requested for this project.

CEBAF occupies a racetrack-shaped footprint. Each straight section contains a linac made up of 20 cryomodules. To recirculate the beam, magnetic transport channels making up the curved sections, the so-called arcs, connect these linacs. Several factors contribute to make the 12 GeV Upgrade cost effective. First, on average, the existing critical components of the accelerator exceed their design specifications by 50% resulting in the capability to run at 6 GeV electron beam energy rather than the originally specified 4 GeV. Second, continued efforts have led to the development of a new cryomodule type capable of exceeding the original CEBAF specifications by a factor of five. Third, for reasons of project construction history, each linac contains five empty slots with most of the ancillary provisions ready to accept the new high performance cryomodules. Fourth, the radius of the arcs was generously designed to avoid serious emittance degradation that might have precluded ever achieving higher energies.

In the new experimental Hall D, a tagged coherent bremsstrahlung beam – created using the full 12 GeV beam energy - and solenoid detector would be constructed for a program of gluonic spectroscopy to experimentally test our understanding of quark confinement. Additional experimental equipment proposed for the Upgrade project will optimize the scientific capabilities and takes full advantage of apparatus developed for the present program. All three existing Halls will be able to receive the full 5-pass beam energy. Critical Decision Zero (CD-0) was approved in March 2004 and Critical Decision One (CD-1) in February 2006. The Project Engineering and Design (PED) phase of the project began in summer 2006. A construction decision has not been reached for this project.

2. Excited Baryon Analysis Center

- **Summary:** World-recognized theory group provides critical foundation for experimental program; activity in Excited Baryon Analysis Center allows enhanced analysis and understanding of experimental results.
- **Expectations:** Success in this activity will lead to a profound understanding of the spectrum of excited baryons and hence the nature of confinement, including the way excited hadronic matter modifies the nonperturbative QCD vacuum.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
  - Technical: *High risk* -- It is an extremely challenging problem for theoretical physics.
  - Market/Competition: *Moderate risk* – Other groups are also working in this area.
  - Management/Financial: *Moderate risk* -- This effort requires a sustained commitment. Human Capital is critical to this effort.

The Office of Science's Strategic Plan for Nuclear Science states that connecting the observed properties of baryons with the underlying framework provided by QCD is one of the central challenges of modern science. In order to address this question the Excited Baryon Analysis Center (EBAC) was established under the Theory Center of TJNAF in January of 2006. The objective is to develop state of art theoretical tools for extracting the properties of excited states of the nucleon from the meson production data and providing their interpretations within QCD. A team of theorists with expertise in developing reaction models was formed at EBAC in June 2006 to perform dynamical coupled-channel analysis of worldwide data, in particular the data from CLAS of TJNAF. An immediate advance made by this team was to develop a novel numerical method for dealing with the complex three-particle final states which dominate the reaction cross sections but have been poorly treated in all recent analyses. The analyses of one-meson and two-meson production data are now proceeding rapidly at EBAC with close collaborations with the CLAS collaboration. The goal is to map out the structure of the excited states of the nucleon with masses below about 2 GeV by the year of 2009.

The EBAC has also started to build a network of all relevant theoretical and experimental groups world-wide to develop a coherent analysis program for establishing our knowledge of the excited states of the nucleon by the year of 2012. In an anticipation of the need of new theoretical tools for analyzing the data from the proposed 12-GeV upgrade of CEBAF, EBAC has started new research projects for developing reaction models directly in terms of quark-gluon degrees of freedom.

3. Lattice Quantum Chromodynamics (LQCD)

- **Summary:** High Performance Computing Effort in Lattice Quantum Chromodynamics (LQCD) to understand QCD in the confinement regime and contribute to the national scientific computing enterprise.
- **Expectations:** Calculate the consequences of nonperturbative QCD with unprecedented accuracy in order to test its predictions against the precise new data provided by the 12 GeV Upgrade.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
  - Technical: *Low risk* -- Progress in this area has been promising
  - Market/Competition: *Moderate risk* -- Risk reduced through collaboration and the unique capabilities of CEBAF, though Brookhaven Lab is also involved in QCD studies
  - Management/Financial: *Low risk* – Small investments are involved.

Lattice QCD currently provides our only means of solving QCD in the low-energy regime. Under the auspices of the Department of Energy's Scientific Discovery through Advanced Computing (SciDAC) activity, the U.S. theory community developed the software infrastructure and hardware prototypes to employ lattice QCD to solve a spectrum of problems in nuclear and particle physics. Since 2006, a new national computing project has operated production clusters at TJNAF and Fermi National Laboratory (FNAL), as well as the QCDOC (QCD-on-a-Chip) at BNL. TJNAF, through both the Theory Center and the High-Performance Computing Group, plays a pivotal role in the SciDAC QCD project and national facilities projects, and is now exploiting this role to address key questions across the TJNAF program.

With the renewal of the SciDAC grant in FY 2006 and the continuation of the facilities project, TJNAF will continue its central role in national and international lattice activity over the next four years with a focus on exploiting the technology for the world's most precise computations of hadron properties. To optimize the physics output in relation to the proposed 12 GeV upgrade, this activity requires additional investments, which TJNAF is well placed to exploit since it is exploring clusters of commercial computers for high performance computing that are currently more cost effective for LQCD.

4. International Linear Collider (ILC) R&D

- **Summary:** Develop enabling technologies in support of the proposed International Linear Collider (ILC). Since the announcement in 2004 of the technology choice for the ILC, TJNAF has been actively engaged in preliminary discussions on the ILC project and as a member of numerous ILC Working Groups including a recent formal role in the ILC Global Design Effort and in MOUs with the principal ILC coordinating lab in the US, FNAL.
- **Expectations:** The TJNAF's experience and expertise in Superconducting Radiofrequency (SRF)

technology will enable future scientific accelerators (ILC, etc.), as well as accelerators for basic science, defense, bioscience and nano-technology, and potential commercial materials processing (Free Electron Laser).

- **Benefit Perspective:** *Significant/Sustaining* Benefits
- **Risk Perspectives:**
  - Technical: *Moderate risk* – Work for CEBAF Upgrade, SNS, and DOD has given TJNAF a great deal of experience and world-leadership in this technology. The 12 GeV Upgrade will further enhance this position.
  - Market/Competition: *High risk* – Many U.S. and international labs are interested in this part of the ILC R&D effort. TJNAF is currently in a leadership position but this could change and international negotiations will be a factor.
  - Management/Financial: *High risk* -- Due to tight federal budgets and the high project costs and long construction period for the ILC should it be built.

TJNAF has submitted and been successful in being awarded grants on multiple proposals to the Office of Science's High Energy Physics (HEP) division in support of ILC dealing with new materials R&D involving single crystal/large grain niobium, studies of cavity processing and their control to make robust production of cavities with predictable performance, development of specific value-engineered high gradient superconducting cavities and cryomodules, and preparations for industrialization of SRF technology in support of the ILC. This scope of work will substantively reduce the project's technical risks and costs and will be the hallmark of TJNAF's contributions to this challenging international project. Simultaneously, intense effort on high gradient and low-loss cavity R&D has already led to the ground-breaking large- and single-grain cavity fabrication and testing leading to the achievement of the highest gradient possible in niobium.

To date, TJNAF's contributions in validating the electropolishing as a consistent step towards producing SRF cavities with specified gradients have added much value to the design and project advancement. Investigation on single crystal/large grain niobium as a material for higher performance at a reduced processing cost is also advancing well.

TJNAF has established a productive partnership with FNAL in support of their development of an SRF infrastructure that will benefit FNAL as the primary HEP lab taking ILC responsibility at large. The Lab is also arranging for FNAL scientific, engineering and, in particular, technical staff to come to TJNAF for extended stays to immerse themselves in the details of the technology. Our expectation is that this will not only speed FNAL acquisition of the technology, but also provide additional resources for the programs and projects undertaken by TJNAF. It is TJNAF's vision to remain an essential partner and collaborator and be the consolidator of SRF developments in support of the ILC, including the eventual industrialization of the technology. TJNAF plans to design and prototype a model-integrated cryomodule production plant suitable for technology transfer to U.S. industry.

Also, TJNAF is leveraging its SRF core competency in a major activity, a 100 kW IR upgrade to its Energy Recovered Linac (ERL)-based 10 kW Free Electron Laser funded by DoD. Additionally, SRF ERL-based technology R&D for an electron light ion collider and light source is ongoing. An electron light ion collider at a center-of-mass energy of 30 GeV could achieve an ultra-high luminosity of 10^{35} $cm^{-2}s^{-1}$ reaching the limit where possible color glass condensates of quarks and gluons could be observed and study quark-gluon plasma not only at high temperatures but at high densities. An ERL-based light source would provide the highest achievable spectral brilliance of photons and shortest pulses achievable not only at x-ray wavelengths but also at longer wavelengths of infrared and THz.

Financial Outlook

Detailed information regarding the financial outlook for the Thomas Jefferson National Accelerator Facility is subject to 1) competition and merit review, 2) the availability of appropriated funds and 3) programmatic decisions. The first two factors cannot be predicted or estimated in advance. The third, programmatic decisions are developed in accordance with the planning targets reflected in the Department of Energy programmatic Five Year Plans, a companion document to these strategic laboratory business plans. In addition, because of the Office of Science commitment to competition and merit review, there is often a time lag between programmatic decisions and the determination of which research provider can best deliver the greatest value in conducting the research. Thus, it is not always apparent how programmatic decisions unfold for particular laboratories. Nevertheless, some decisions, such as the plans for large scientific user facilities, show clear paths to individual labs and therefore inform their business plans.

Support for Non-DOE funded work is a vital role for our national laboratories, contributing to national security, energy security, environment stewardship, scientific discovery, and more fundamentally, the competitiveness of the U.S. economy. For the TJNAF, this is no exception. The Office of Science is supportive of this work and although it is not addressed in any detail within the accompanying Five Year Plans, the Office of Science believes it is sufficiently important and appropriate to address within this strategic laboratory business plan. A brief perspective and financial outlook is therefore provided.

The current TJNAF non-DOE funded activities are primarily funded by the Department of Defense (Navy, Air Force and Army) and focus on technology development to scale Free-Electron Lasers (FELs) to 100kW-MW power class, to study laser materials damage and atmospheric propagation, to construct and commission a 1kW UV FEL for materials science and processing, and to commission a far-infrared (THz) beam-line and User Lab for THz spectroscopy and imaging.

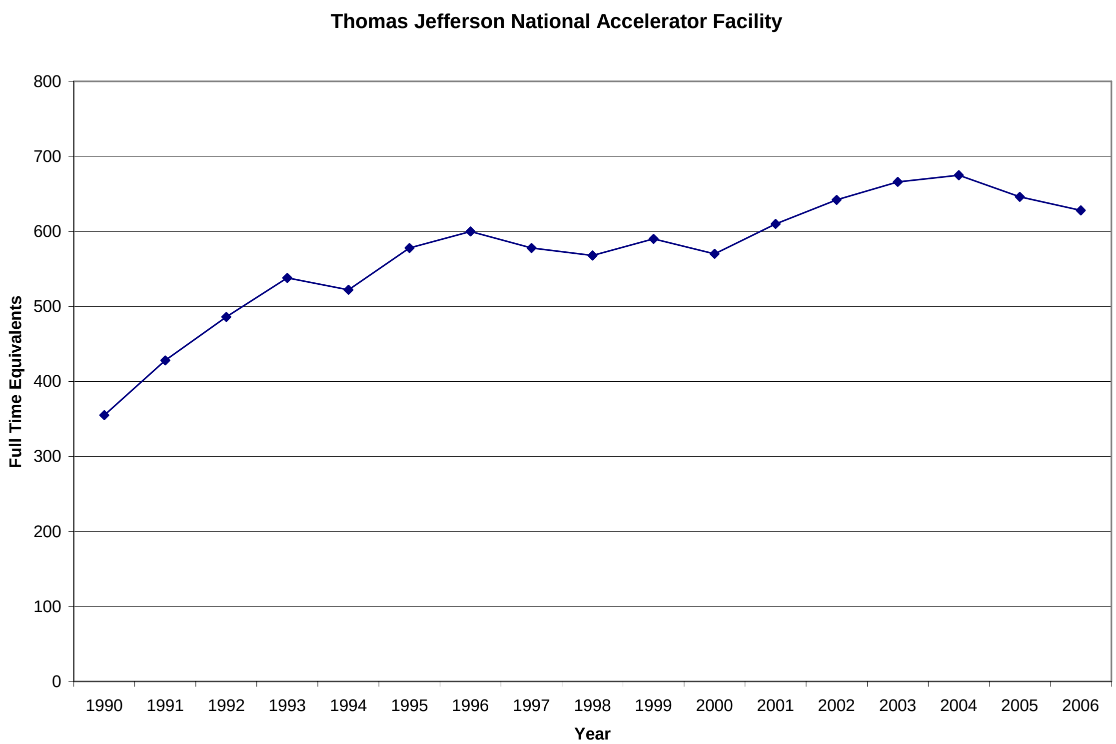
TJNAF's world-class FEL provides an accelerator physics/technology test bed which allows them to enhance CEBAF's performance and capabilities. This is a tremendous benefit to their in-house Nuclear Physics program and to DOE as a unique repository of technology expertise available to other science and technology facilities throughout the nation. Over the next five years and beyond, TJNAF anticipates continued funding from the DoD, allowing the laboratory to continue to build on their investment and ensuring continued world leadership on the frontiers of FEL, Energy Recovered Linac (ERL) and superconducting radiofrequency (SRF) technology.

Uncertainties and Risk Management

External Factors: TJNAF, as an integral part of the national lab system, provides unique and complementary capabilities to the other labs in the system contributing to the DOE missions and to the overall national S&T agenda. The Lab is poised to lead the world in experiment and theory of nuclear confinement physics and related accelerator and SRF technologies. The internationally based nuclear physics program complements the work being done at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory, while enabling a program of hadronic physics research that is unique in the world to answer key questions about the structure of matter at its most fundamental (quark and gluon) level. There are, however, major risks to this future- scientific, technical, management and financial. If the funding for the 12 GeV Upgrade project is delayed, there is a pipeline of first class 6 GeV experiments in place for the short-term. TJNAF will continue to pursue alternative approaches to make the 12 GeV Upgrade a reality. TJNAF has a history of effectively leveraging Work for Others (WFO) to benefit Nuclear Physics and the Office of Science. DOD investments toward a world-class Free Electron Laser (FEL) provide an accelerator physics/technology testbed with potential for basic energy sciences. In addition, joint activities, are poised to capitalize on FEL capabilities for laser bioscience. TJNAF will continue to build on the investment by DOD and others to remain on the frontier of FEL and ERL technology.

S&T Workforce: The success of TJNAF's scientific program is anchored by the leadership of its key managers and depends on its ability to attract and retain a diverse world-class workforce. TJNAF utilizes a comprehensive staffing plan that identifies, prioritizes and projects programmatic labor needs. Through careful monitoring of hiring and attrition TJNAF's workforce trending in the out years demonstrates constant effort in the indirect functions. Programmatic needs point to a small increase in labor force.

Workforce Trends



Employee Diversity: TJNAF, as with all national DOE laboratories, must make significant progress in the recruitment and retention of underrepresented populations, particularly African American and Hispanic scientific staff. In particular, TJNAF is committed to pacing the rapidly increasing representation of women and underrepresented minority science and engineering Ph.D.'s graduating from tier 1 universities. TJNAF's existing education activities range from K-12 (most notably the BEAMS program, which serves as a national model) to graduate education and laboratory affiliations (joint faculty positions, post docs and graduate students) that emphasize Minority Serving Institutions (MSI's).

TJNAF, in alliance with JSA, its M&O contractor and specifically JSA's majority owner, Southeastern Universities Research Association's network of more than 60 member universities, (5 of which are MSI's), will collaborate on recruiting, improving and retaining workforce diversity and strength. Efforts will include utilizing an inventory of potential diverse candidates in all scientific areas and in particular for senior role model scientific and management fields; identifying and cultivating potential employees early via summer schools and focused workshops; insisting on qualified diverse candidates for postings; encouraging employee affinity groups; and addressing exit issues critical to retaining a diverse workforce. TJNAF is committed to hiring reflecting the diversity of tier 1 university science and engineering Ph.D.'s now, and a population reflective of National scientific and engineering diversity by 2015.

Based on national availability projections for the scientific and engineering Ph.D.'s, TJNAF's goal is an S&T workforce consisting of 35% female, 12% African American, 3% Hispanic, and 1% Native American. Critical to the success of this commitment is the realization of constrained-ideal funding projections as well as maintenance of the diverse workforce development pipeline, a core educational activity of TJNAF.

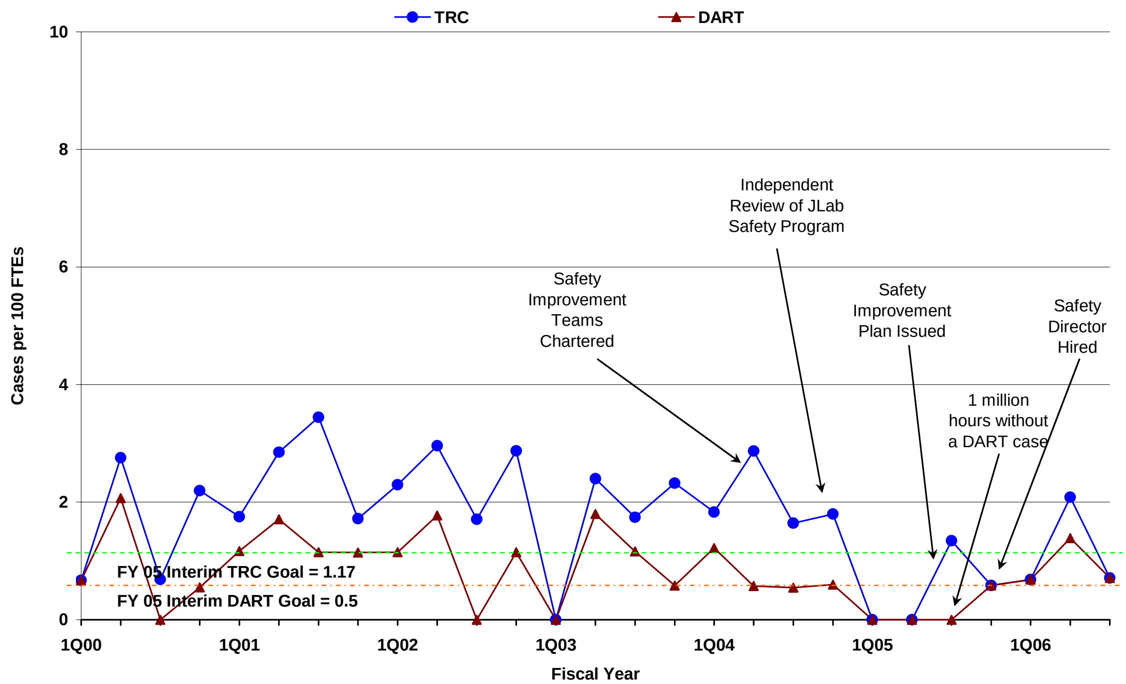
Safety: TJNAF continues to move aggressively to improve its safety performance through a multi-activity initiative. The Lab has increased effort in work planning and control, feedback and improvement along with focusing on safe behavior awareness at the Lab to continue marshaling improved safety performance across the board. Initiatives included:

- Increased focus on self assessments to identify opportunities for improvement. Conducted assessments in areas of Lock Out/ Tag Out, work planning, feedback and improvement, and environmental management system.
- Continued to articulate the safety challenge at all levels of the organization through performance expectations and other communications
- Integrated safety committees under the Director's Safety Council
- Continued emphasis of timely reporting of minor injuries/incidents
- Expanded the behavior based safety effort (DuPont Safety Training Observation Process) in high risk groups
- Initiated injury awareness and prevention campaign led by our Occupational Medicine Director
- TJNAF joined EFCOG to further enhance lessons learned sharing

A review of current lagging indicators (Total Recordable Case rate, or TRC; and Days Away/Restricted/Transferred rate, DART) shows that TJNAF compares well with results at other Office of Science labs. TJNAF recently logged 156 days without a lost time injury, and ended FY 2006 with the second best DART rate amongst SC laboratories. TJNAF will continue additional safety improvement initiatives and is actively engaged with lessons learned and sharing amongst SC Labs, EFCOG, and NLIC.

DART and TRC Rates and Major Safety Initiatives

Thomas Jefferson National Accelerator Facility



Physical Infrastructure: TJNAF is located on a 163 acre Federal reservation in Newport News, Va. The reservation, including three facilities (97,000 square feet [sf]), was transferred from NASA to DOE in 1987. Subsequently, DOE constructed 311,000 sf of new facilities, including the Continuous Electron Beam Accelerator Facility and support facilities. In total, TJNAF has 476,670 sf of DOE-owned buildings with 76% of facilities less than 20 years old. TJNAF's Asset Utilization Index (AUI) is 1.0 for offices, laboratories and warehouses (excellent). The replacement plant value of TJNAF's general purpose facilities is $139M.

TJNAF will attain a maintenance investment index of 2% of replacement plant value in FY 2007, which will be continued in FY 2008 and the out years. TJNAF's deferred maintenance (DM) backlog is $8.8M. The Asset Condition Index (ACI) is 0.95 for mission critical facilities (the DOE goal is 0.964 or above) and 0.82 (the DOE goal is 0.948 or above) for mission dependent facilities. ACI is computed as 1 minus the result of deferred maintenance divided by replacement plant value. To reduce the DM backlog, thereby improving ACI, TJNAF has initiated a deferred maintenance reduction effort with $.9M of funding in FY 2008.

The FY 2008 GPP funding request is $2.0M. A 61,000 sf addition to CEBAF Center was completed in January 2006. It provides an expanded computer center, cafeteria, and offices and made it possible to eliminate 32,000 sf of existing trailer space.

TJNAF's future recapitalization and modernization challenges include a shortage of office, technical, experimental, and storage space. The laboratory is working to achieve the goals for energy reduction and use of renewable energy established in the Energy Policy Act of 2005.