A Message from the Under Secretary for Science

It is my great pleasure and privilege to introduce you to the U.S. Department of Energy's Office of Science.

To describe the far-reaching impact of DOE Office of Science-supported research on our economy, our technology, and our national life over the past five decades—and to predict the potential of Office of Science-supported research to transform Americans' lives for the better in the decades ahead—is an exciting task. Numbers only begin to tell the story. Forty-five Nobel laureates. Scores of fundamental discoveries in a wide array of fields from high energy physics, to biological research, to high-speed computing (the Office of Science website lists just a "top 100"). Countless new products, technologies, and even industries that owe their existence to scientific research first supported by Office of Science. But lists alone barely convey the true scope of the transformation we have generated, or the potential for new discoveries to transform our nation's future.

Our lives have been fundamentally reshaped by Office of Science-supported discoveries. The entire field of nuclear medicine arose largely as an outgrowth of "accelerator science" spearheaded by the Office of Science and its predecessor agencies to support research in high energy and nuclear physics. At the core of MRIs are superconducting magnets, a technology first successfully developed by Office of Science-supported scientists at Fermilab to build the atom-smashing Tevatron. PET Scans grew out of pioneering advances by the Office of Science and predecessor agencies in particle accelerators, biological radiotracer molecules, photodetectors, and high-speed computers. Today particle accelerators producing X-rays, protons, neutrons, or heavy ions—once built mainly as research tools for physicists—provide advanced cancer treatment for millions of patients and are found at every major medical center in the United States.

The Information Age itself would have been impossible without the fundamental breakthroughs produced research supported by the Office of Science—including key discoveries essential to the development of the Standard Model of high energy physics. Our world of "smart" cellular phones, cameras, music players, and appliances rely on the utilization of such phenomena and tools as the giant magnetoresistive effect and plasma chambers first investigated by Office of Science-sponsored researchers.

In short, Office of Science-sponsored discoveries are part of the very fabric of our contemporary high-tech world—a legacy of its historic role as the primary federal sponsor of basic research in the physical sciences.

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

Science with a Mission

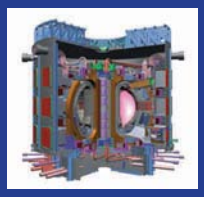
Advancing the Energy, Economic, and National Security of the United States

OUR PRIORITIES

The research priorities of the Department of Energy's Office of Science flow from our long-term strategic goals and reflect our Nation's commitment to energy security, a cleaner environment, improved health care, greater economic prosperity, and intellectual leadership.

Pursuing these research priorities over the next five to 10 years and beyond will be challenging, but they hold enormous promise for the future of our Nation and the overall well-being of our citizens.

ITER FOR FUSION ENERGY



ITER is an international collaboration to build the first fusion science experiment capable of producing a self-sustaining fusion reaction, called a "burning plasma." It is the next essential step on the path toward demonstrating the scientific and technological feasibility of fusion energy.

The President has made achieving commercial fusion power the highest long-term energy priority for our Nation.

SCIENTIFIC DISCOVERY THROUGH ADVANCED SCIENTIFIC COMPUTING

Scientific computing at DOE Office of Science national laboratories and user facilities enable scientists to use quantum calculations to understand the combustion process, model thermal reactions, analyze climate change data, reveal chemical mechanisms of catalysts, and study the collapse of a supernova.

Extraordinary advances in computer architecture and software design are making scientific computing a true third pillar of discovery, joining theory and experiment as a standard tool that researchers rely upon to make scientific progress.

NANOSCALE SCIENCE FOR NEW MATERIALS AND PROCESSES

The DOE Office of Science has built five new DOE Nanoscale Science Research Centers to provide the Nation's research community with world-class resources for the synthesis, processing, fabrication, and analysis of materials at the nanoscale.

Large and complicated structures can be designed, one atom at a time, for desired characteristics such as super-lightweight and ultra-strong materials. The Office of Science will help lead this revolution – with nanoscale research in materials sciences, physics, chemistry, biology, and engineering – and tools that can probe and manipulate matter at the atomic scale.

TRANSFORMATIONAL SCIENCE FOR BIOFUEL BREAKTHROUGHS

The DOE Office of Science has established three new DOE Bioenergy Research Centers, as part of its Genomics: GTL program, to accelerate basic research on plants and microbes toward the development of cost-effective means to produce cellulosic ethanol and other plant fiber-based biofuels.

Scientists at these multidisciplinary centers are marshalling the latest advances in biotechnology and genomics-based systems biology to achieve the transformational scientific breakthroughs needed to tap this abundant, renewable, and potentially carbon-neutral source of energy.

DOE Bioenergy Research Centers

DARK ENERGY AND THE SEARCH FOR GENESIS

How the universe originated – its genesis – is one of the great mysteries of science. So is "dark energy," which dominates today's universe.

The DOE Office of Science is conducting experiments at its accelerators to determine whether the complex patterns of particles and forces we observe today arose from a much simpler universe at the extremely high energies that prevailed in its first moments.

The Office of Science also is working to solve the mystery of dark energy, which makes up more than 70 percent of the universe and evidently causes its accelerating expansion.

Quantum Universe: The Revolution in 21st Century Particle Physics, a report jointly commissioned by the Office of Science and the National Science Foundation has identified the most compelling questions facing contemporary particle physics research and outlined a program to address them.

NUCLEAR MATTER AT THE EXTREMES

The DOE Office of Science is conducting experiments at Brookhaven National Laboratory's Relativistic Heavy Ion Collider to study brief, submicroscopic samples of hot plasma of free quarks and gluons that filled the universe at the age of one microsecond.

New studies are planned to explore the extremes of nuclear matter and the processes that form nearly all of our chemical elements in stars and supernovae.

Understanding how nuclear matter is formed is critical to understanding the processes within stars and how elements are created – including possible new elements at high-energy densities and the extreme limits of stability.

RESEARCH FACILITIES FOR THE FUTURE OF SCIENCE

Just as very large and complex machines and instruments have enabled U.S. researchers to make many of the most important scientific discoveries over the past six decades, the discoveries of the future will require powerful next-generation scientific tools.

In *Facilities for the Future of Science: A Twenty-Year Outlook*, the DOE Office of Science proposed a portfolio of 28 prioritized new scientific facilities and upgrades of current facilities spanning the scientific disciplines to ensure the U.S. retains its primacy in critical areas of science and technology well into the next century.

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NATIONAL LABORATORIES

The Department of Energy's Office of Science is the steward of 10 world-class laboratories with unmatched capabilities for solving complex interdisciplinary scientific problems.

These laboratories are often called the "crown jewels" of our national research infrastructure. The DOE national laboratory system is the most comprehensive research system of its kind in the world – and the backbone of American science.

The Office of Science national laboratories perform research and development that is not well suited to university or private sector research facilities because of its scope, infrastructure, or multidisciplinary nature – but for which there is a strong public and national purpose.

A high level of collaboration among all of the national laboratories in the use of unique scientific equipment and supercomputers, facilities, and multidisciplinary teams of scientists increases their collective contribution to the Department of Energy and the Nation, making the laboratory system more valuable as a whole than the sum of its parts.

THE 10 DOE OFFICE OF SCIENCE NATIONAL LABORATORIES

AMES LABORATORY

LAWRENCE BERKELEY NATIONAL LABORATORY

ARGONNE NATIONAL LABORATORY

OAK RIDGE NATIONAL LABORATORY

BROOKHAVEN NATIONAL LABORATORY

PACIFIC NORTHWEST NATIONAL LABORATORY

FERMI NATIONAL ACCELERATOR LABORATORY

PRINCETON PLASMA PHYSICS LABORATORY

THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY

STANFORD LINEAR ACCELERATOR CENTER

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USER FACILITIES

The Department of Energy's Office of Science builds and operates the world's finest suite of scientific facilities and instruments that researchers depend on to extend the frontiers of science.

In the 2007 fiscal year, these facilities were used by more than 21,000 researchers from universities, national laboratories, private industry, and other federal science agencies.

These very large and complex machines and instruments have enabled U.S. researchers to make many of the most important scientific discoveries over the past six decades, with spin-off technological advances creating entirely new devices and industries.

The Office of Science's state-of-the-art facilities are located at national laboratories and universities, open to researchers on a peer-reviewed basis, shared with the science community worldwide, and feature technologies and capabilities that are available nowhere else.

20-YEAR FACILITIES OUTLOOK

The health and vitality of U.S. science and technology depends upon the availability of the most advanced research facilities.

Facilities for the Future of Science: A Twenty-Year Outlook listed 28 new large scientific facilities and upgrades of current facilities that will define scientific opportunities across all fields of science supported by DOE over the next 20 years.

Investment in these facilities will yield extraordinary scientific breakthroughs – and vital societal and economic benefits.

The $1.4 billion Spallation Neutron Source (SNS) at Oak Ridge National Laboratory, the largest civilian science project in the U.S., was completed in 2006 on time and on budget. The SNS will provide the most intense pulsed neutron beams in the world for scientific research and technology development.

WHAT DISTINGUISHES THE DOE OFFICE OF SCIENCE?

The Office of Science fills a unique and central role in the Nation's scientific endeavor. Our work is complementary to that of other government research agencies.

We distinguish ourselves by our emphasis on research that:

> is driven by the Department of Energy missions,
> takes the long view,
> is open and interdisciplinary,
> requires the use of large-scale facilities, and
> takes risks commensurate with the high pay-offs we expect.

OUR FACILITIES

The DOE Office of Science facilities include:

> particle accelerators,
> synchrotron light sources,
> neutron scattering facilities,
> nanoscale science research centers,
> supercomputers,
> high-speed networks, and
> genome sequencing facilities.

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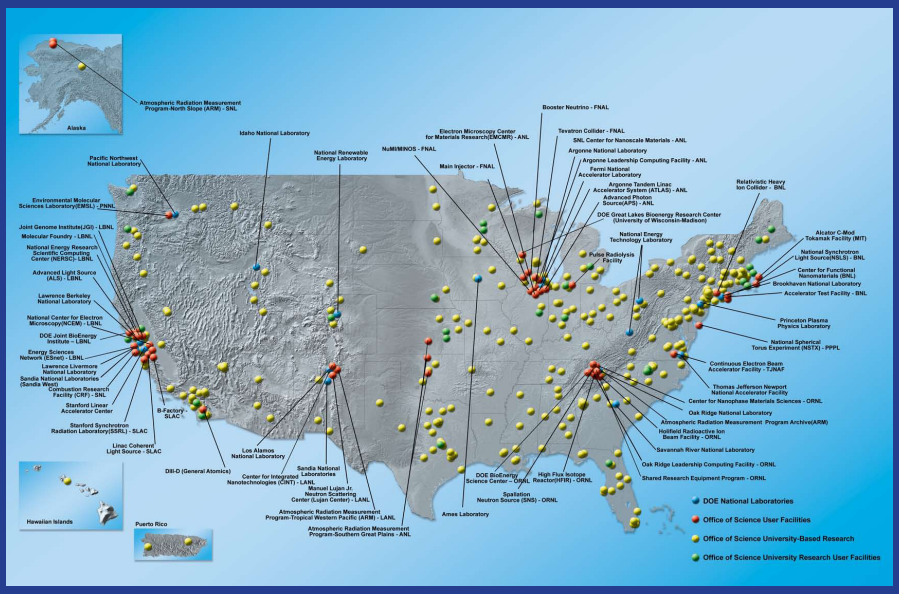
RESEARCH UNIVERSITIES

The Department of Energy's Office of Science supports a diverse portfolio of research at colleges and universities across the United States.

We balance our signature support for big science and interdisciplinary teams with investments in research projects conducted by leading university and laboratory investigators.

About half the users at Office of Science user facilities are from colleges and universities, providing important resources to their researchers.

In addition, about a third of Office of Science funding goes to support research at more than 300 colleges and universities nationwide, as the map below highlights.



WORKFORCE DEVELOPMENT

The Office of Science has played a fundamental role in training America's scientists and engineers for more than 50 years. Today we offer a range of workforce development programs for teachers and scientists to help ensure this Nation has the scientific workforce it will need in the twenty-first century.

The Office of Science sponsors undergraduate student internships at national laboratories and fellowships for distinguished science, technology, engineering, and mathematics educators.

Faculty sabbatical fellowships also are available for faculty from minority serving institutions to collaborate on research projects at national laboratories.

DOE NATIONAL SCIENCE BOWL®

The Department of Energy's national laboratories conduct some of the most sophisticated research and development in the world. We therefore have a keen interest in encouraging America's youth to study and pursue careers in science.

The Office of Science reaches out to America's youth in grades K-12 and their teachers to help improve students' knowledge of science and mathematics and their understanding of global energy and environmental challenges.

To attract and encourage students to choose an education in the sciences and engineering, the Office of Science also manages the DOE National Science Bowl. At these educational events, high school and middle school students solve technical problems and answer questions in all branches of science and mathematics.

Since the National Science Bowl program began in 1991, it has brought together more than 130,000 high school and middle school science and mathematics students– as well as their teachers – from across the country. DOE's Office of Science launched the National Science Bowl for middle school students in 2002.

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PROGRAM OFFICES

The Department of Energy's Office of Science is the single largest supporter of basic research in the physical sciences in the United States. It oversees – and is the principal Federal funding agency of – the Nation's research programs in high energy physics, nuclear physics, and fusion energy sciences.

The Office of Science sponsors fundamental research programs in basic energy sciences, biological and environmental sciences, and computational science. In addition, the Office of Science is the Federal Government's largest single funder of materials and chemical sciences, and it supports unique and vital parts of U.S. research in climate change, genomics, life sciences, and science education.

"Scientific and technological research are a high calling for any individual. And promoting research is an important role of our Federal government."

"Science and technology have never been more essential to the defense of the Nation and the health of our economy."

> President George W. Bush

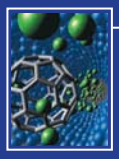
The Office of Science manages this research portfolio through the following interdisciplinary program offices, with these goals and areas of research:

OUR PROGRAMS AND GOALS

ADVANCED SCIENTIFIC COMPUTING RESEARCH

Deliver Computing for the Frontiers of Science

> Computer science and software research
> Extending science through computation and collaboration
> Supercomputing technologies for science
> Computational and network infrastructure and tools



BASIC ENERGY SCIENCES

Advance the Basic Sciences for Energy Independence

> Materials sciences and engineering research
> Chemical sciences, geosciences, and physical biosciences research
> Nanoscale science, engineering, and technology research
> Scientific user facilities to understand materials and perform nanoscale science

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

Harness the Power of Our Living World

> Bioenergy research
> Genomics and low dose radiation research
> Climate change research
> Environmental remediation sciences
> Medical sciences

FUSION ENERGY SCIENCES

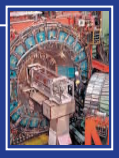
Bring the Power of the Stars to Earth

> Harnessing fusion energy through basic research in plasma and fusion sciences
> ITER, the international burning plasma experiment

HIGH ENERGY PHYSICS

Explore the Fundamental Interactions of Energy, Matter, Time, and Space

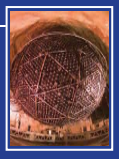
> Explore unification of the forces and particles of nature
> Understand the cosmos and the destiny of the universe
> Develop the tools for scientific revolutions to come



NUCLEAR PHYSICS

Explore Nuclear Matter – from Quarks to Stars

> Studies of hot, dense nuclear matter
> The quark structure of matter
> Nuclear structure/astrophysics, fundamental symmetries, and neutrinos



WORKFORCE DEVELOPMENT FOR TEACHERS AND SCIENTISTS

Train the Next Generation of Scientists and Engineers to Maintain U.S. Scientific and Technological Leadership

> Student internships at national laboratories
> Fellowships for distinguished science, technology, engineering, and mathematics educators
> The DOE National Science Bowl® for high school and middle school students

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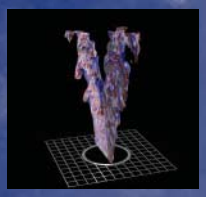
ADVANCED SCIENTIFIC COMPUTING RESEARCH

The Advanced Scientific Computing Research (ASCR) program mission is to discover, develop, and deploy the computational and networking tools that enable scientific researchers to analyze, model, simulate, and predict complex phenomena important to the U.S. Department of Energy.

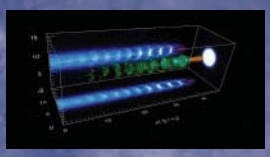
RECENT SCIENTIFIC ACHIEVEMENTS

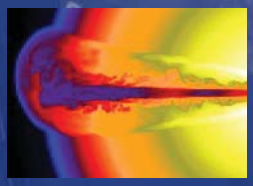


Creating laboratory-scale simulations of turbulent flames for greater insight into reducing pollutants, increasing combustion efficiency

Understanding microturbulence in plasmas advances the design of fusion reactors as potential energy sources of the future

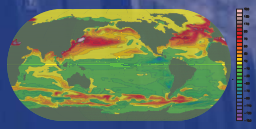
Plasma-driven particles offer promise of reducing the size of accelerators from kilometers to meters, for expanded use in medicine and research



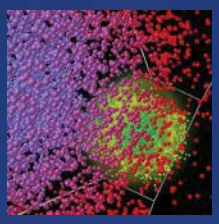


Using satellites, telescopes, and advanced computer simulations, astrophysicists have solved a 30-year-old question on the origins of gamma ray bursts

Improving the accuracy of complex models for understanding global climate change



FastBit enables researchers to quickly find significant scientific results in massive experimental datasets at speeds 10 times faster than commercial search techniques



MAJOR USER FACILITIES

Leadership Computing Facilities provide users with large amounts of computing time on some of the most advanced computing resources anywhere to tackle some of the most challenging scientific problems.

Oak Ridge National Laboratory
Argonne National Laboratory

The National Energy Research Scientific Computing Center provides leading-edge computing resources to support more than 2,500 researchers at national laboratories and universities across the nation.

Lawrence Berkeley National Laboratory

The Energy Sciences Network is a high-speed network providing high-bandwidth to enable thousands of researchers at national laboratories, universities, and other institutions to communicate with each other using the collaborative capabilities needed to address some of the world's most important scientific challenges.

Lawrence Berkeley National Laboratory

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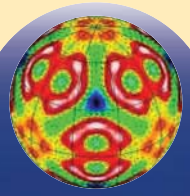
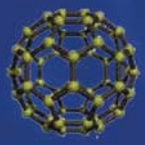
BASIC ENERGY SCIENCES



The Basic Energy Sciences (BES) program supports fundamental research in materials sciences, chemistry, geosciences, and aspects of biosciences to expand the scientific foundations for improved and potentially revolutionary advances in energy technologies and for understanding and mitigating the environmental impacts of energy use.

RECENT SCIENTIFIC ACHIEVEMENTS

The 1996 Nobel Prize in Chemistry recognized a new form of carbon, buckminsterfullerene, which initiated worldwide activity devoted to the study of carbon clusters and tubes, all with remarkable new electrical and optical properties.

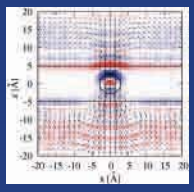


The 2003 Nobel Prize in Physics recognized contributions to the theory of superconductors and superfluids, once both mysterious and perplexing to the scientific community, which led to the development of new superconducting materials and energy transmission technologies.

The 1997 Nobel Prize in Chemistry honored the discovery of the mechanism of adenosine triphosphate (ATP) production in the living cell, a discovery that led to new biological and bioinspired paths to solar energy conversion; fuels and chemical feedstock production; and chemical catalysis.

The 1994 Nobel Prize in Physics recognized the development of neutron scattering as a powerful tool for determining the positions and motions of atoms in materials, with unique applications to magnetic materials and to polymers and biological materials.

The unexpected discovery of parasitic nanoparticles has given insight into the challenges associated with efficient deposition of the layered gallium nitride-based semiconductors critical to Solid-State Lighting – a technology with vast potential for far higher efficiency lighting.



Basic Research in Theory, Modeling, and Simulations
Complementing experimental efforts, "computer experiments" have been performed which are difficult or impossible to perform in the laboratory such as investigations into the behavior of electrons flowing in nanowires and nanotubes.

Ultrafast Science
A novel method has been demonstrated for clocking ultrafast x-ray pulses on the femtosecond time scale – a key contribution to the science base for the next-generation light sources anticipated to provide breakthrough discoveries in materials science, chemistry, and biology.

MAJOR USER FACILITIES

Five Synchrotron Radiation Light Sources, sources of intense beams of x-rays, are used to explore the properties of materials, analyze samples for trace elements, probe the structure of atoms and molecules, study biological specimens, investigate chemical reactions, and manufacture microscopic machines.

High-Flux Neutron Sources, sources of intense neutron beams, are used to study the position and motion of atoms in materials. Scientists learn details about materials ranging from liquid crystals to superconducting ceramics, from proteins to plastics, and from metals to micelles to metallic glass magnets.

Three Electron Beam Microcharacterization Centers, sources of intense electron beams, enable the study of high temperature superconducting materials, irradiation effects in metals and semiconductors, phase transformations, and processing related structure and chemistry of interfaces in thin films.

Five Nanoscale Science Research Centers provide the ability to fabricate complex structures using chemical, biological, and other synthesis techniques; characterize them; assemble them; and integrate them into devices – and do it all in one place.

The Combustion Research Facility is an internationally recognized facility for advanced characterization techniques and for the study of combustion science and technology. Research efforts combine theory, modeling, and experiment including diagnostic development, kinetics, and dynamics.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

The Biological and Environmental Research (BER) program includes these research areas: life and medical sciences, climate change research, and environmental remediation sciences. Achievements in genomics and biology will spur novel solutions for clean energy, reduce the rate of atmospheric carbon dioxide concentration increase, environmental clean-up, and medicine. Capabilities for predicting global climate change will enable science-based planning for future energy needs. Understanding the fate and transport of environmental contaminants will yield long-term solutions for clean-up and monitoring.

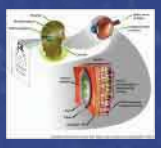
RECENT SCIENTIFIC ACHIEVEMENTS

Mapping and Sequencing the Human Genome

The Department of Energy was the first agency to fund research into genome mapping and sequencing, launching the historic quest to discover the genetic blueprint of human beings.

First DNA Sequence of a Woody Plant

Understanding the genetic regulation of woody biomass from poplar, the first tree to have its genome decoded, may lead to improved feedstock for producing biofuels such as cellulosic ethanol to replace gasoline as a transportation fuel.



Artificial Retina Helps the Blind to See

A microelectrode device implanted into the eye of blind patients has given them rudimentary vision, allowing patients to detect motion and to locate and differentiate simple objects.

Imaging Awake Animals

Medical imaging of animals, infants, or people with movement disorders requires anaesthesia that distorts diagnostic information. New imaging devices allow imaging of awake animals, an advance that may translate to improved human medical diagnosis.

Explaining Ocean Warming

Climate model research shows that the observed warming of the ocean during the past 40 years is related to increases in atmospheric greenhouse gas concentrations. The warming cannot be explained by natural climatic variability and volcanic eruptions.

Effects of Carbon Dioxide and Ozone on Trees

Elevated ozone concentration reduced tree growth whereas elevated carbon dioxide increased growth, but the effect of combining ozone with carbon dioxide could not be predicted from results with each gas alone. It required field experimentation with both gases in combination.

Understanding Plutonium Mobility

Plutonium transport at Rocky Flats occurs by dispersal of particulates and colloids, not by soluble species migration. This understanding facilitated a faster and less expensive closure.

MAJOR USER FACILITIES

Atmospheric Radiation Measurement (ARM)

The largest uncertainty in climate prediction is the role of clouds in controlling solar and thermal radiation of the earth system. The ARM program provides critical data for the models used for climate prediction.

The Environmental Molecular Sciences Laboratory provides integrated experimental and computational resources for discovery and technological innovation in the environmental molecular sciences. The facility houses leading-edge computational and experimental resources for addressing complex scientific problems of interest to DOE and the nation.

The Joint Genomics Institute's Production Genomics Facility (PGF) carries out high throughput DNA sequencing to address the DOE mission needs for sequencing microbes and plants that can provide new biofuels and help clean up the environment.

FUSION ENERGY SCIENCES

Excellent Science Attractive Energy

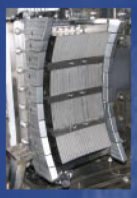
Office of Fusion Energy Sciences

The Fusion Energy Sciences (FES) program is the national research effort to advance plasma science, fusion science, and fusion technology—the knowledge base needed for an economically and environmentally attractive fusion energy source.

RECENT SCIENTIFIC ACHIEVEMENTS

Improved Energy Confinement Demonstrated on DIII-D

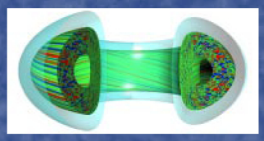
Advances in the capability to measure fluctuations in plasma density and temperature have shown agreement between an observed reduction in energy loss and predictive codes.



Microwaves Drive a Million Amperes of Plasma Current in Alcator C-Mod

Nearly all of the plasma current in Alcator C-Mod was driven using electromagnetic waves, replacing the initial current driven by its central transformer – a critical capability for steady-state operation of tokamaks.

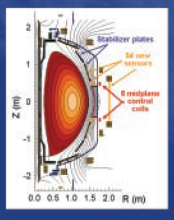
High-Resolution Tokamak Plasma Simulations



State-of-the-art magnetohydrodynamic codes being developed in the U.S. have substantially increased the realism of their simulations by increasing the resolution of their models, allowing the inclusion and study of physical processes previously neglected.

Improved Ion Temperature in the Madison Symmetric Torus (MST)

In MST, an innovative experiment at the University of Wisconsin-Madison, plasmas have recently been produced in which ions, as well as electrons, attain temperatures of about 10 million degrees using its programmable magnetic control system.



Stabilization of Resistive Wall Modes in the National Spherical Torus Experiment (NSTX)

Using the feedback capability of the plasma control coils on NSTX, researchers made significant progress on stabilization of the resistive wall mode instability at plasma rotation speeds relevant to ITER.

Computer Simulations of High Gain for Inertial Fusion Energy (IFE)

Computer simulations at the University of Rochester show that with less expensive lasers for compressing the IFE fuel and a petawatt laser-produced electron beam for heating it, a fusion gain of > 60 can be achieved.

MAJOR USER FACILITIES

ITER (Latin for "the way") will be the first magnetic fusion experiment to produce more energy than it uses. There are seven international collaborators, including the U.S. The site for this project is Cadarache, France.

The DIII-D tokamak at General Atomics in San Diego, CA, is the largest magnetic fusion facility in the U.S., with considerable experimental flexibility and extensive diagnostics to measure the properties of high temperature plasmas.

NSTX (National Spherical Torus Experiment) at the Princeton Plasma Physics Laboratory produces a plasma configuration which may have several advantages over conventional tokamaks, including the potential for smaller, more economical fusion reactors.

Alcator C-Mod at MIT is the only tokamak in the world operating at ITER design magnetic field and plasma densities, and produces the highest pressure tokamak plasma in the world, approaching pressures expected in ITER.

HIGH ENERGY PHYSICS

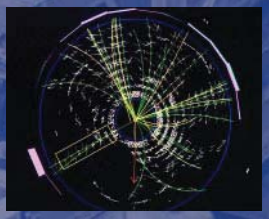
The High Energy Physics (HEP) program mission is to advance fundamental understanding of the physical universe by investigating physics at the smallest distance scales (elementary particle physics) as well as the largest (the geometry of the universe).

RECENT SCIENTIFIC ACHIEVEMENTS

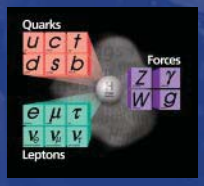
Dark Energy
Observations of supernovae have shown that the expansion of the universe is speeding up. The cause of this acceleration is still a mystery, but implies that most of the energy content of the universe is of a new form called "dark energy."

Neutrino Oscillations
Neutrino detectors have determined that the shadowy elementary particles known as neutrinos oscillate among three different "flavors" as they travel through space and have miniscule but non-zero masses.

Discovery and Characterization of the Top Quark
The discovery and subsequent determination of the mass of the top quark to high precision has allowed physicists to zero in on the mass of the undiscovered Higgs boson, a crucial component of the theoretical framework of particle physics.



Matter-Antimatter Oscillation of the B_s Meson
The B_s meson (a particle made up of a bottom quark bound to an anti-strange quark) oscillates rapidly into its antiparticle. The recent measurements of this oscillation have constrai ned the nature of new physics at the energy frontier, the "Terascale."



Pinning Down the Standard Model
Very precise measurements of the interactions of electron and positron beams have extended and refined our understanding of how the electromagnetic and weak interactions are unified in the Standard Model.

Plasma Wakefield Acceleration
Electrons surfing on a plasma wave (the wake left by a laser beam or an electron beam) have been accelerated within a meter to energies that require kilometer-long conventional accelerators.

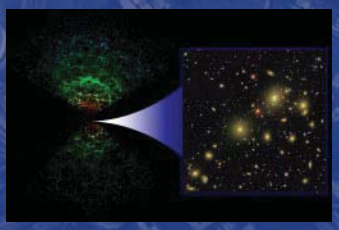
MAJOR USER FACILITIES

The Tevatron, operated by Fermi National Accelerator Laboratory, is a proton-antiproton collider that now offers the world's highest energy particle collisions.

PEP-II, operated by Stanford Linear Accelerator Center, is an electron-positron collider that allows for precise investigations of elementary particle physics.

The Large Hadron Collider, a new accelerator that will collide protons at energies high enough to explore physics at the Terascale, is now under construction at CERN (European Organization for Nuclear Research) in Switzerland.

The Sloan Digital Sky Survey will produce a three-dimensional map of 100 million celestial objects, covering a quarter of the entire sky. Its studies of galactic clusters will shed light on dark energy.



NUCLEAR PHYSICS

The mission of the Nuclear Physics (NP) program is to foster fundamental research in nuclear physics that will provide new insights and advance knowledge on the nature of matter and energy and develop the scientific knowledge, technologies, and trained workforce that are needed to underpin DOE's missions for nuclear-related national security, energy, and environmental quality.

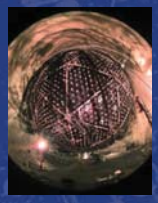
RECENT SCIENTIFIC ACHIEVEMENTS

A New Form of Matter Discovered

The universe may have begun as a "perfect" liquid, not a gas. Researchers have evidence for an extraordinary new state of hot, dense matter that behaves like a liquid with little viscosity rather than a fiery gas.

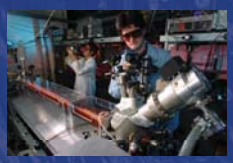
Neutrinos and the Core of the Sun

The solution to the 30-year-old mystery of missing solar neutrinos lies not with the Sun, but with the neutrinos, which change identity as they travel from the core of the Sun to the Earth.



Strange Quarks Influence Proton Structure

Although strange quarks are not permanent residents of the proton, researchers discovered these particles may contribute to a proton's charge distribution and its magnetization.



Unique Technique Aids Hunt for Atomic Nucleus Size

Researchers have developed revolutionary techniques to make the first model-independent measurement of the radius of the ^{6}He nucleus and find it to be two trillionths of a millimeter.

Nuclear Reaction Rates Determine the Observational Reach of Gamma-Ray Observatories

Measurements of the production and destruction of radioactive nuclei establish the maximum distance that from which satellite gamma-ray observatory can detect exploding stars.

Advances in Superconducting Radio-Frequency

Large crystal superconducting niobium has been used to develop cost-effective, high performance accelerating cavities for next-generation particle accelerators.

MAJOR USER FACILITIES

The Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory is the world's premier facility for studying new states of matter not in existence since microseconds after the Big Bang and for studying the spin structure of the proton using polarized protons.

The Continuous Electron Beam Facility (CEBAF) at Jefferson Lab is the world's leading facility for studies of the internal quark structure of the nucleon with electron beams and is a world-leader in the research and development of superconducting radio-frequency technologies.

The Argonne Tandem Linac Accelerator System (ATLAS) at Argonne National Laboratory and the Holifield Radioactive Ion Beam Facility at Oak Ridge National Laboratory are low-energy National User Facilities that allow important advances in understanding energy production in stars, heavy element formation, and supernovae explosions through nuclear structure and astrophysics studies.

WORKFORCE DEVELOPMENT FOR TEACHERS AND SCIENTISTS

The Office of Workforce Development for Teachers and Scientists (WDTS) has many national programs that support the next generation of scientists, engineers and science, technology, engineering and mathematics (STEM) educators. WDTS programs encourage students to pursue advanced science and mathematics courses and participate in a variety of special programs outside of their classrooms. WDTS national programs are run mainly through the U.S. Department of Energy's National Laboratories.

KINDERGARTEN THROUGH HIGH SCHOOL STUDENTS

National Science Bowl ®

The National Science Bowl® is a nationwide academic competition that tests students' knowledge in all areas of science. High school and middle school students are quizzed in a fast paced question-and-answer format similar to *Jeopardy*. The mission of the National Science Bowl is to encourage students to excel in science and math, and to pursue careers in those fields.

UNDERGRADUATE STUDENTS

Student Undergraduate Laboratory Internship Program (SULI)

Semester or summer internship program for college students to work with scientists or engineers on research projects at the National Labs

Community College Institute (CCI) of Science and Technology

Summer research internships for community college students

Pre-Service Teacher Program (PST)

Summer research experience for STEM education majors who work with a scientist and a master teacher to bring research into their future classrooms

TEACHERS AND FACULTY

Department of Energy Academies Creating Teacher Scientists (DOE ACTS)

Three-year summer research experience for STEM teachers at the DOE National Laboratories for professional development and to effect change at their home school

Albert Einstein Distinguished Educator Fellowship Program

One-year Washington, DC, fellowship program to bring teachers to Congress and appropriate federal agencies to influence national science education policy

Faculty and Student Teams Program (FaST)

Summer lab research experience for one faculty and two or three undergraduate students from a college or university that is a minority-serving institution or receives little to no Federal research money

Used Energy-Related Laboratory Equipment (ERLE) Grant Program

Excess laboratory equipment can be obtained free by universities and colleges

www.science.doe.gov

Office of Science
U.S. DEPARTMENT OF ENERGY

Science with a Mission

Advancing the Energy, Economic, and National Security of the United States

OUR LEGACY

The Department of Energy's Office of Science is heir to the revolutionary work of Albert Einstein, Enrico Fermi, and E.O. Lawrence.

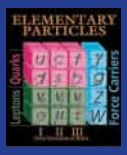
The Office of Science makes history every day because we sustain their tradition of innovative basic scientific research that improves people's lives.

As testimony to the high quality and impact of the research DOE underwrites, more than 80 Nobel Laureates have been supported by or affiliated with the Department of Energy and its predecessor agencies.

The Office of Science has a vital tradition of funding fundamental research that focuses on critical national challenges – and produces important scientific breakthroughs and contributes to our Nation's well-being.

FACILITIES FOR DISCOVERY

Supported the construction and operation of accelerators, from cyclotrons to light sources to colliders, for fundamental research; these are used for a wide range of applications, such as fabricating semiconductors and microchips, studying the structure of viruses, and designing new drugs

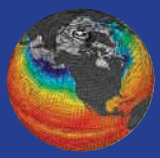


QUARKS AND LEPTONS

Sponsored research leading to the discovery of quarks and leptons, the most fundamental constituents of matter, resulting in 13 Nobel Prizes

MEDICAL DIAGNOSIS AND TREATMENT

Helped develop new tools for the non-invasive diagnosis and treatment of disease, including PET scans, MRIs, and nuclear medicine cancer therapies

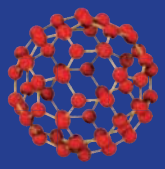


CLIMATE CHANGE SCIENCE

Launched the first research program in the U. S. to study climate change in 1978; using computer software and systems that model and simulate environmental conditions and project climate change under varying emissions scenarios

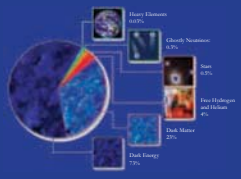
BASIC RESEARCH IN SUPPORT OF THE HYDROGEN ECONOMY

Conducted a workshop in 2003 to determine the basic research required to turn the promise of a hydrogen economy into a reality; now the Office of Science is funding an innovative long-range program of basic research, coupled and coordinated with applied programs, to achieve critical revolutionary breakthroughs in hydrogen production, storage, and use



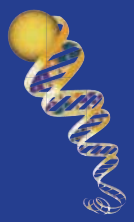
A REVOLUTION IN CARBON CHEMISTRY

Supported the 1996 Nobel Prize-winning discovery of a new form of carbon, the buckminsterfullerene or "buckyball," which has spurred a revolution in carbon chemistry and can be manipulated to produce superconducting salts, new three-dimensional polymers, new catalysts, and biologically active compounds



DARK ENERGY

Funded research leading to the discovery that about 70 percent of the universe is composed of "dark energy," an unidentified form of energy not included in the Standard Model, physicists' current theory of matter and the forces of nature – and that the expansion of the universe is accelerating, rather than slowing due to gravity as expected

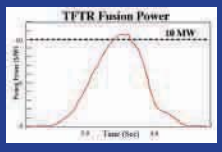


PIONEERING THE HUMAN GENOME PROJECT

Launched the human genome program in 1986 and developed the cost-effective DNA sequencing and computational technologies that made it possible to finish the "book of life" in 2003; also founded the DOE Joint Genome Institute, which completed the sequencing of three of the human genome's chromosomes – numbers 5, 16, and 19 – which together contain some 3,300 genes, including those implicated in forms of kidney disease, prostate and colorectal cancer, leukemia, hypertension, diabetes, and atherosclerosis

DETECTING NEUTRINOS

Sponsored research resulting in the Nobel Prize-winning detection of atmospheric and solar neutrinos, which in turn led to research determining that the mysterious elementary particles have mass and oscillate among three "flavors" as they travel through space



A FUSION SCIENCE MILESTONE

Produced a record 10.7 million watts of fusion power at the Princeton Plasma Physics Laboratory's Tokamak Fusion Test Reactor in 1994, an outcome promoting fusion as an attractive energy source; if converted to electricity, the amount of fusion power produced in the experiment would be enough to meet the needs of 3,000 average-sized homes

RESTORING SIGHT—AND MORE

Sponsoring research and development of an artificial retina, which can restore sight in blind patients with macular degeneration, retinitis pigmentosa, and other eye diseases; the technology that is being developed in the artificial retina project may be adapted to help persons with spinal cord injuries, Parkinson's disease, deafness, and almost any other neurological disorders

JJuly

Office of the Under Secretary for Science

http://www.science.doe.gov/

Dr. Raymond L. Orbach
Under Secretary for Science, S-4
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
Phone: 202-586-0505
Fax: 202-586-87660
ray.orbach@science.doe.gov

Office of Science

http://www.science.doe.gov/

Dr. Patricia Dehmer
Deputy Director for Science Programs, SC-2
Office of Science
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
Phone: 202-586-5434
Fax: 202-586-4120
patricia.dehmer@science.doe.gov

Mr. George Malosh
Deputy Director for Field Operations, SC-3
Office of Science
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
Phone: 202-586-5440
Fax: 202-586-4120
george.malosh@science.doe.gov

Dr. Jeffrey Salmon
Deputy Director for Resource Management
SC-4
Office of Science
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
Phone: 202-586-8305
Fax: 202-586-4120
jeffrey.salmon@science.doe.gov

Program Offices

Advanced Scientific Computing Research

Dr. Michael R. Strayer
Associate Director, SC-21
Office of Science
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1290
Phone: 301-903-7486
Fax: 301-903-4846
michael.strayer@science.doe.gov

Basic Energy Sciences

Dr. Harriet Kung
Associate Director, SC-22
Office of Science
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1290
Phone: 301-903-3081
Fax: 301-903-6594
harriet.kung@science.doe.gov

Biological and Environmental Research

Dr. Anna Palmisano
Associate Director, SC-23
Office of Science
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1290
Phone: 301-903-3251
Fax: 301-903-5051
anna.palmisano@science.doe.gov

Fusion Energy Sciences

Mr. Gene Nardella
Acting Associate Director, SC-24
Office of Science
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1290
Phone: 301-903-4941
Fax: 301-903-8584
gene.nardella@science.doe.gov

High Energy Physics

Dr. Dennis G. Kovar
Associate Director, SC-25
Office of Science
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1290
Phone: 301-903-3624
Fax: 301-903-2597
dennis.kovar@science.doe.gov

Nuclear Physics

Dr. Jehanne Simon-Gillo
Acting Associate Director, SC-26
Office of Science
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1290
Phone: 301-903-3613
Fax: 301-903-3833
jehanne.simon-gillo@science.doe.gov

Workforce Development for Teachers and Scientists

Mr. William Valdez
Associate Director, SC-27
Office of Science
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
Phone: 202-586-6549
Fax: 202-586-7719
bill.valdez@science.doe.gov