Lawrence Livermore National Laboratory

Science and Technology

The Science and Technology (S&T) Principal Directorate provides the leading-edge science and engineering capabilities that enable the Laboratory to anticipate, innovate, and deliver solutions to problems of national importance.

This nation's security and prosperity are directly linked to U.S. preeminence in science and technology. Science and technology brought an end to World War II, put men on the moon and revealed the building blocks of life. Science and technology gave rise to microchips, the Internet and a multitude of consumer products that drive the U.S. economy. Over the last half-century, 50 to 85 percent of the growth in the U.S. gross domestic product is attributable to advancements in science and engineering.*

Today, science and technology hold the key to solving many of the most serious challenges facing the country. To prevent nuclear terrorism, new technologies are needed that can rapidly detect small or shielded quantities of nuclear materials. Widespread outbreaks of *E. coli* in food products and the H1N1 influenza pandemic highlight the speed with which pathogens can spread and the need for improved disease detection capabilities. Perhaps most important, the world needs new sources of energy coupled with an understanding of global climate and the influence of human activities to ensure that new energy technologies do not harm the environment.

Lawrence Livermore National Laboratory (LLNL) applies its unique experimental facilities, world-class computing resources, and multi-disciplinary expertise to tackle these and other nationally important problems.

Computation

High-performance computing is one of the Laboratory's signature strengths. LLNL is home to 22 supercomputers, with a combined peak computing power of 1,689 teraflop/s (trillion floating point operations per second). A calculation that took an entire day in 1995 now takes only one second. Two of these machines—BlueGene/L and Dawn—are among the top 10 fastest computers in the world. Experience in using Dawn will lay the foundation for Sequoia, a 20-petaflop/s (quadrillion flop/s) system to be delivered in 2011.

Our computer scientists develop the tools, technologies and applications, including state-of-the-art capabilities in mathematical modeling and scientific visualization, needed to exploit the full potential of these powerful machines. Researchers at LLNL and the other national laboratories use the computers to study at a first-principles level such phenomena as the interactions between individual atoms and electrons (necessary to

Using the short-pulse, ultra-intense Titan laser, LLNL scientists are able to produce more positrons faster and in greater density than ever before, making possible new research into the nature of antimatter.

* Casey Coleman, Innovation in the Business of Government: A GSA Blog, 28 April 2009: http://blogs.gsa.gov/blogs/OCIO.nsf/archive?openview&title=Competitiveness&type=cat&cat=Competitivenessarchive?openview&title=Competitiveness&type=cat&cat=Competitiveness

The 500-teraflop/s Dawn supercomputer is one of 22 such machines at the Laboratory with a total combined computing power of 1.689 teraflop/s (trillion floating point operations per second).

understand the behavior of materials at their most basic level) or the turbulence that results when a shock wave passes through a fluid (important for understanding the physics of combustion, supersonic vehicle propulsion, and the evolution of supernovas).

Engineering

Engineering at the Laboratory encompasses all facets of the discipline. Our engineers design, construct, and operate a host of large, complex mechanical, electrical and optical systems, including the 192-beam National Ignition Facility, the High Explosives Applications Facility with its fully contained detonation tanks, and the tandem Van de Graff accelerators at the Center for Accelerator Mass Spectrometry. LLNL engineers are central to all aspects of the Stockpile Stewardship Program. They also design and fabricate nanoscale devices, such as laser fusion targets, miniaturized chemical and biological detectors and even an artificial retina.

Many of the technologies, devices and processes developed by LLNL have commercial applications, and we work with industry partners to move these advances into the marketplace. Notable technology transfer successes include the miniature thermal cycler that permits rapid DNA analysis within minutes instead of days and a laser peening technology that strengthens critical aviation components, such as jet engine fan blades.

Physical and Life Science

LLNL research yields critical insights that extend the frontiers of knowledge in the physical and life sciences. Our scientists are active in all aspects of modern physics, from the search for dark matter to studies of the fundamental properties of fusion plasmas. Laboratory-designed technology is at the heart of the adaptive optics systems that enabled the Keck and Gemini telescopes to capture the first-ever images of a multi-planet solar system. Livermore researchers work at the nano-scale to develop novel materials with properties tailored for very specific purposes, such as carbon nanotubes—special molecules made of carbon atoms in a unique tubular arrangement that allows liquids to rapidly flow through while blocking larger molecules, offering a cheaper, low-power way to desalinate or purify water.

Laboratory scientists make significant contributions to biosecurity, public health and bioenergy. They develop new technologies for detecting biothreat agents and other microbial organisms as well as new techniques for studying cells at the molecular and genetic levels, advances that hold promise for identifying the perpetrators of a bioattack, preventing infectious disease and treating cancer and deriving energy efficiently from biological sources.

LLNL is a recognized world leader in atmospheric science and climate modeling, elucidating the processes that drive climate change, including the effects of human activities. Our researchers also develop scientific and technical innovations to reduce the environmental impact of fossil fuels, expand the use of alternative energy resources, and create new energy sources for the future.

For more information, contact the LLNL Public Affairs Office, P.O. Box 808, Mail Stop L-3, Livermore, California 94551 (925-422-4599) or visit our website at www.llnl.gov.

LLNL is managed by Lawrence Livermore National Security, LLC, for the U.S. Department of Energy, National Nuclear Security Administration, under Contract DE-AC52-07NA27344.

LLNL-BR-423446

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