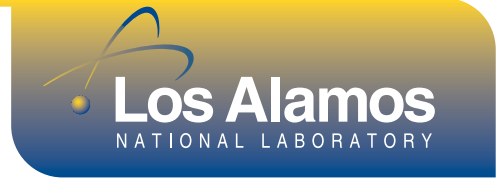


# Strategic Research for National Missions



Since its establishment as one of the secret laboratories of the Manhattan Project that helped end World War II, Los Alamos has attracted world-class scientists and applied their energy and creativity to solving the nation's greatest challenges. As one of the U.S. Department of Energy's multiprogram, multidisciplinary research laboratories, Los Alamos relies on having the best people doing the best science to solve problems of national and global importance. Los Alamos researchers combine security awareness, intellectual freedom and innovative scientific excellence with national service to develop scientific and technology based solutions.

The laboratory's core mission of monitoring the Los Alamos-designed weapons in the nuclear stockpile relies on this strong tradition of strategic scientific research. Strategic research provides a basis for the work of the Stockpile Stewardship Program through innovations in simulation and modeling, nuclear chemistry, materials science, nuclear physics and metallurgy. Basic science and engineering are also crucial to the laboratory's work on other global

security concerns, such as the detection of the proliferation of weapons of mass destruction and homeland security.

Strategic research contributes directly to national security by providing technical programmatic support to weapons, threat reduction and intelligence programs.

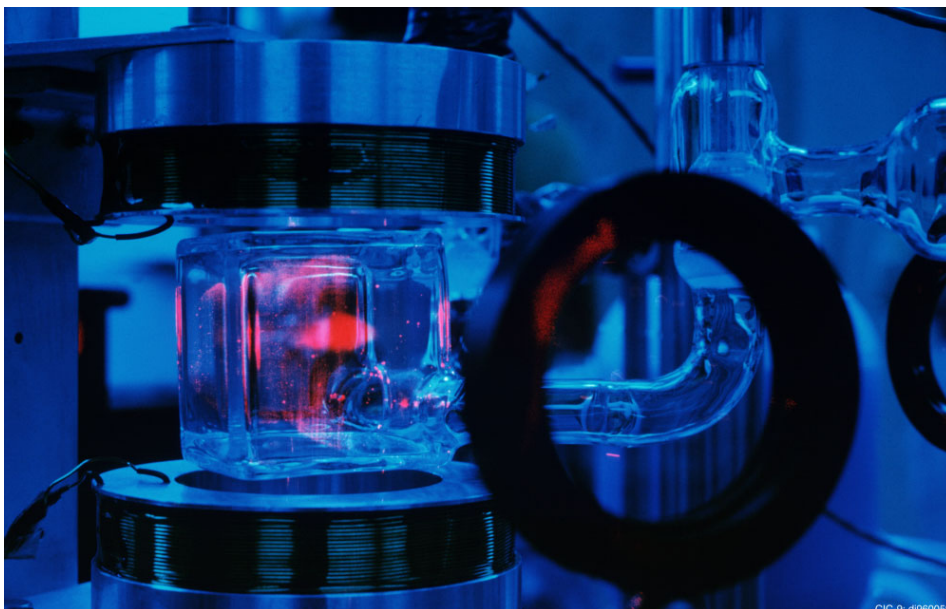
Additionally, strategic research contributes to national security by developing fundamental understanding in multiple disciplines, including materials science, chemistry, physics, computer science and bioscience to name a few. Research in these areas allows Los Alamos scientists to contribute to the foundation of U.S. technological advantage resulting in new capabilities, economic competitiveness, energy independence and avoidance of technological surprise. This technological advantage can have a significant impact on national security.

To accomplish the laboratory's primary national security mission, Los Alamos must maintain its world-class scientific and engineering capabilities. Strategic research supports this requirement by attracting the future generation of contributors who continue the Los

Alamos tradition of outstanding technical innovation. Most members of the technical staff pursue basic research while contributing to projects that directly support the laboratory's primary mission.

The areas of materials science, especially research into nanotechnologies, superconductivity and fuel cell development, are major contributors to continuing U.S. technological advantage. These cutting-edge laboratory programs might hold the key to more efficient energy use and energy independence. Similarly, fundamental research by theorists and computational and environmental scientists into carbon sequestration provides environmental and energy solutions. More than a decade of modeling the world's ocean and studies of climate, hydrology, and drought in the arid Southwest can help the nation address regional water shortages with technology options. In the biosciences, Los Alamos pioneered bioinformatics, the marriage of computer science and genetics, with applications in the battle against bacterial and viral epidemics such as the human immunodeficiency virus. Evidence of the practical value of such investigations came in 2003 when the laboratory captured eight of the prestigious *R&D100* awards, the most of any DOE laboratory. Yet those eight innovative projects represent only a fraction of the potential wealth of Los Alamos research.

Strategic research at Los Alamos may begin with breakthroughs in understanding the origins of the universe or the behavior of subatomic particles, but the multidisciplinary, focused approach taken by laboratory scientists and engineers seeks and frequently discovers applications to the national security mission. For example, efforts to build revolutionary computing engines based on the peculiarities of quantum information science has led to quantum cryptography, a secure communication tool for intelligence services. Studies of the genetic connections among strains of anthrax and other bioterror agents



**Time-orbiting potential magnetic trap, a tool used for various environmental and nonproliferation applications**

resulted in archival databases on which forensic detective work relies. And the quest by Los Alamos biophysicists and collaborators, including University of California professors, to bring eyesight to the blind with an artificial retina may enhance future remote sensing capabilities used to process images gathered by environmental and defense satellites.

Some of the key strategic science capabilities at Los Alamos include:

### **High-Performance Computing**

Extraordinarily powerful supercomputers and detailed numerical models allow scientists to visualize and predict real phenomena, from the inner workings of nuclear weapons to the course of wildfires, global weather patterns and epidemics. High-performance computing ensures the effectiveness of America's nuclear arsenal and plays an ever-increasing role on the forefront of scientific discovery, allowing researchers to build models of unprecedented complexity that substitute for global-scale experiments.

### **New and Exotic Advanced Materials**

The behavior of materials is crucial to predicting nuclear weapons performance and developing new, high-tech products. Breakthroughs in materials science include smaller, longer-lasting batteries; efficient fuel cells; stronger composite materials; and all-carbon prosthetics and joint replacements. Advanced materials promise such scientific breakthroughs as quantum computing and room-temperature superconductivity.

### **Cutting-Edge User Facilities**

Every year, hundreds of scientists and researchers from around the world use the laboratory's more than 50 cross-disciplinary user facilities. Examples of two such facilities are: LANSCE, the nation's most powerful source of pulsed particles, which allows scientists to study materials science, bioscience, physics and imaging; and the National High Magnetic Field Laboratory, a National Science Foundation-funded collaboration that provides insight into materials science and condensed matter physics.

### **Earth and Environmental Science**

Los Alamos applies advanced technologies such as climate modeling and wildfire prediction to better understand the complex geophysical systems that drive our earth, oceans, and atmosphere. The laboratory uses probabilistic risk assessment to analyze how natural and manmade hazards might harm human health and the environment.

### **Chemistry**

The laboratory's broad chemical research capabilities are applied to national security and civilian programs and through collaborations with industry, universities and other national laboratories. Core research areas include actinide and fission product chemistry, inorganic and organometallic chemistry, catalysis, radioisotope production and distribution, chemical engineering, sensor and detection technologies, nanoscience and nanotechnology, analytical chemistry, environmental chemistry, nuclear and radiochemistry, physical chemistry, chemical and nuclear physics, and optical and vibrational spectroscopy.

### **Bioscience and Biotechnology**

Evolved from the early need to understand the effects of radiation on humans, the laboratory's health sciences teams seek to understand and protect people from the dangers associated with nuclear, biological, and chemical weapons, and to expand the scope of knowledge in bioscience and biotechnology. A world leader in development of the human genome map, Los Alamos continues to develop new and better ways of unlocking the mysteries of life.

### **Physics and Theory**

Los Alamos contributes to scientific understanding of the physical world and generates new technologies through physical experimentation and accurate analysis of experimental data. From high-energy nuclear physics to the structure of the human genome to the theoretical quantum computer, the physical sciences are central to the laboratory mission.

### **Opportunities in Education**

Research and educational experiences at Los Alamos enhance the skills of more than 2,000 students each year. In addition to its postdoctoral program, largest in the DOE complex, the laboratory provides on-the-job educational opportunities to graduate and undergraduate students in a broad range of disciplines.

### **Partnerships with Industry**

Los Alamos has more than 300 industrial partnerships with a combined value in excess of \$650 million over the past decade, with an aggressive continuing program. Laboratory industrial partnerships help bolster the local and regional economy and increase America's competitiveness in the global marketplace.



Los Alamos National Laboratory is operated by the University of California for the U.S. Department of Energy's National Nuclear Security Administration