



Building the Future of Los Alamos

**The Premier National
Security Science
Laboratory**

The LANL ASC multiscale, multiphysics codes are continually incorporating fuller physics models that are closer to nature, thereby reducing reliance on calibration of parameters and building a more flexible predictive capability. This increased flexibility allows us to address physical regimes that have not or cannot be tested, or to address anomalous situations.





Being the premier national security science laboratory requires unparalleled science and engineering innovation, strong leadership, and excellence in operations.

Los Alamos National Laboratory plays an indispensable role in building America as a science and technology powerhouse, and our staff are an incredible resource to the nation and the world. *Building the Future* lays out our approach for maintaining a vital Laboratory, our vision of how Los Alamos should evolve in the next decade and beyond, and concrete steps for how we will get there. This document is not a strategic plan, rather it describes the guiding principles by which Los Alamos senior managers define priorities and make decisions related to programs, capabilities, and operations.

The Laboratory's role is to *anticipate, innovate, and deliver* to meet a broad range of national security challenges. These challenges include maintaining the effectiveness of the nation's nuclear deterrent, supporting the nation's nonproliferation and threat reduction priorities, and addressing emerging national security issues with urgency and agility. A strong basic research program that interweaves the multidisciplinary talents of Lab scientists and our unique facilities is essential to this mission.

Our reputation in science is extremely strong; I am committed to creating a future where our impact and role will be equally strong. As part of this effort, we are demonstrating an institution-wide commitment to excellence in operations, safety, and security that will bolster our reputation. We must be a leader in integrating science and operational excellence as a model for the DOE complex. In our first fiscal year of operations under Los Alamos National Security (LANS, LLC) we achieved important operational and technical successes. These were highlighted in the 2007 annual report for the LANS Board of Governors and in the 2007 year-end newsletter at www.lanl.gov/news.

The Los Alamos staff has contributed to a number of strategic activities recently, demonstrating continued passion concerning the future vitality of our science and technology. Eight Grand Challenges were developed, with broad staff participation, in a series of workshops in 2006–2007. The Grand Challenges are dynamic, far-reaching, and ambitious, so that our scientific and technical capabilities address national needs as they evolve. Three strategic thrusts that crosscut the Grand Challenges have been established:

- 1) Information science and technology enabling predictive science;
- 2) Experimental science focused on materials for the future; and
- 3) Fundamental forensic science for nuclear, biological, and chemical threats.

Supporting these thrusts, the Laboratory is pursuing a new experimental signature facility, (MaRIE, to study matter–radiation interactions in extreme environments) and building a petaflop supercomputing facility, Roadrunner. These science priorities and facilities support our core mission, and enable our targeted program growth areas: Global Threat Reduction and Energy Security.

Over the last 65 years, we have encountered and overcome many challenges. We must continue to adapt, invest in, and develop our future as one Laboratory. I ask for your continued commitment to create this future together.

A handwritten signature in black ink, reading "Michael Anastasio". The signature is written in a cursive, flowing style.

Michael Anastasio, *Director*



MISSION

As the premier national security science laboratory, our mission is to develop and apply science, technology, and engineering solutions to:

- Ensure the safety, security, and reliability of the U.S. nuclear deterrent;
- Reduce global threats;
- Solve emerging national security challenges.

The Laboratory serves as a security science resource to the U.S. government, as a collaborator with national laboratories and universities, and a partner with industry. We address problems that require multiple disciplines and an ability to deliver breakthrough ideas and solutions.

To strengthen and develop the unique capabilities needed to meet our mission, Los Alamos tackles the most challenging problems in basic and applied science, with programs in advanced and actinide materials, energy, earth and environment, defense and intelligence, biosciences, and advanced scientific computing.

VISION

Los Alamos is the National Security Science Laboratory of choice. When the country has a complex scientific or technical national security issue, the experience and capabilities at Los Alamos are called upon. We have the ability to reach out across many institutions to rapidly assemble the best team that can conceive of and deliver a solution. We are a training and proving ground for scientists looking for the toughest challenges facing our nation and the world.

CORE VALUES

The way in which we go about accomplishing our work reflects our Laboratory and personal values, and we share a common set of core values:

- Service to our nation
- Ethical conduct and personal accountability
- Excellence in our work
- Mutual respect and teamwork

New missions

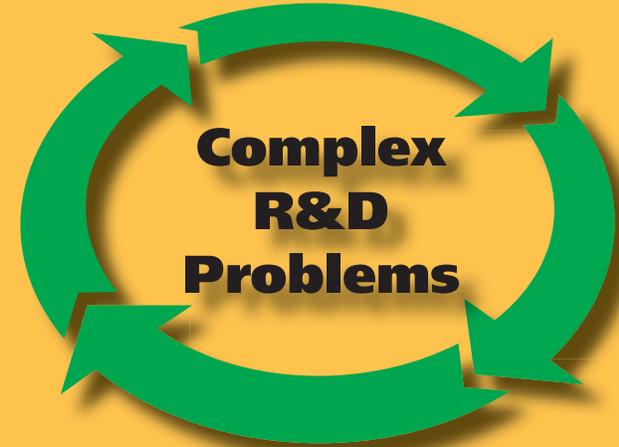
- *Energy security*
- *Global threat reduction*

Unique mission

- *Stockpile stewardship*
- *Nuclear nonproliferation*

Spin-off innovations

- *Global climate modeling*
- *Nanostructured materials*
- *Fuel cell catalysts*
- *Genetic imagery exploitation*



Outstanding application to programs

- *Science-based prediction*
- *Machine learning*
- *Understanding materials properties*
- *Nuclear forensics*



We must maintain strong science, technology, and engineering capabilities that support a broad range of national security programs.

Special blend of capabilities and facilities

- *Computational fluid dynamics*
- *Proton radiography*
- *Nuclear materials & chemistry*
- *Space sciences*



Strong partnerships

- *Unique external capabilities*

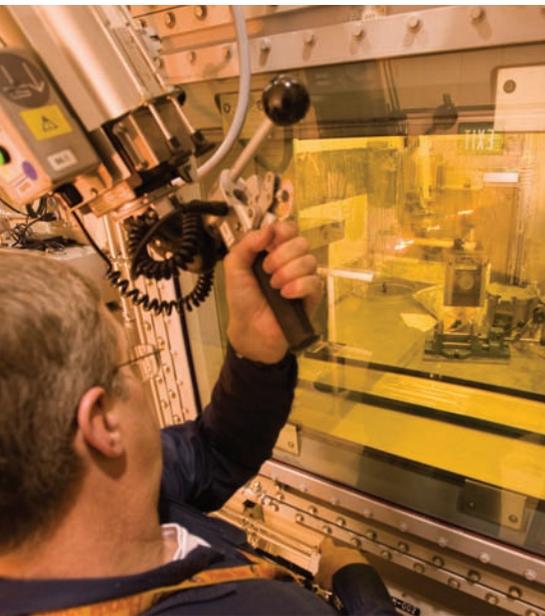
Now in its seventh decade, Los Alamos National Laboratory (LANL) is an indispensable national security resource. We provide science leadership for a nuclear weapons stewardship mission that remains technically challenging and vital to the nation. We remain among a very few laboratories that can bring great breadth of fundamental and discovery science, technology, and engineering rapidly together to create tangible solutions for national security needs.

Yet the Laboratory is also on the cusp of change. Global security challenges—increasingly varied and asymmetric threats (such as the proliferation of weapons of mass destruction and terrorism), growing energy demand, even the impact of natural events on regions and societies—increasingly call for innovative scientific and technological responses. Concurrently, the nuclear weapons program will become smaller, though still the core component of our work, as part of weapons complex transformation. Our staff, working with partners throughout science and industry, must be able to deliver today's solutions while maintaining the depth of capabilities to deliver the next generation of discoveries.

Los Alamos has demonstrated a cycle of innovation where we have developed world-leading capabilities and facilities in response to urgent, unique missions. While delivering outstanding results for our core programs, we also spin out new discoveries that lead to emerging missions. This cycle has been a hallmark of our history. The growing complexity of threats to our national security will require us to apply this cycle for multiple sponsors and with greater agility. This is the essence of a capabilities-based Laboratory: we must maintain strong science, technology, and engineering capabilities that support a broad range of national security programs. Being able to integrate and apply these capabilities rapidly to new challenges, across organizational boundaries, will be a key advantage in an increasingly competitive landscape.

Where we must succeed

Our strategic investments in science must continue to emphasize underlying science issues that are critical to solving current or future national security concerns.



Los Alamos integrates science across individually strong disciplines to solve complex scientific problems

- Outstanding science and technology developed from unique and challenging missions
- More than 1100 peer-reviewed publications per year
- More R&D 100 Awards than any other institution over the last 20 years

To achieve the vision we seek as a capabilities-based Laboratory, we must succeed in three broad areas.

- ① **We must invest** in and leverage *science that matters* to tackle worthy problems, relevant to many aspects of our national security.
- ② **We must be more agile** in *the way we do our work*, more easily drawing on strengths across the Laboratory and increasingly creating strong teams with partners. We also need to continually improve our operational effectiveness in all dimensions: safety, security, business, and environmental, to support our ability to meet mission goals.
- ③ **We must transform** our *scientific campus and facilities* to a more compact, modern, integrated campus. A new, modern signature facility, MaRIE (Matter–Radiation Interactions in Extremes), will leverage and extend the unique capabilities around the Los Alamos Neutron Science Center (LANSCE). Together, these success factors are the path to our ability to recruit and retain the most talented staff from around the world.

Succeeding in these three areas of transformation will also ensure that Los Alamos sustains key differentiators as a national security science laboratory:

- Critical integrated technical solutions delivered on a short schedule,
- Long-term commitment to technical excellence, integrity, and innovation across a wide range of science, technology, and engineering,
- Responsiveness to urgent national priorities,
- Ability to conduct complex experiments,
- Broad and deep intellectual capability for the future, and
- Inherently high-security environments involving classified work.

Science that Matters

The Department of Energy (DOE) national security science laboratories have distinct technical areas of emphasis. Los Alamos, at this highest level, emphasizes fundamental understanding of materials, actinide science and radiation-materials interactions, and an approach to predictive science that integrates theory, simulation, modeling, and complex experimentation. However, the complexity of our programs demands a span of excellence that crosses nearly every discipline in science. Our strategic investments in science must continue to emphasize “Science that Matters”—underlying science issues that are critical to solving current or future national security concerns. We must also tackle the most difficult challenges—ones with no previous known solution where new discoveries can lead to dramatic breakthroughs for programs and the frontiers of science, technology, and engineering.

We have identified three strategic thrusts for priority attention within “Science that Matters:”

- Information science and technology enabling predictive science,
- Experimental science focused on materials for the future, and
- Fundamental forensic science for nuclear, biological, and chemical threats.

These interdependent thrusts are consistent with our emphasis as a materials-centric national security science laboratory and with identified programmatic focus areas within the Laboratory—for example, predictive capability and penetrating imaging within the weapons program, and persistent surveillance within threat reduction programs. These thrusts will help guide priority investments of resources, including institutional support, new business development, and strategic recruitment.

How We Work: Value from Internal and External Teaming

Partnerships and collaborations with academic institutions, industry, and other laboratories are often the most cost-effective way to accomplish our programmatic goals; where sponsors seek to choose the solution from among a variety of potential R&D providers, partnerships may be the only way that superior specialty capabilities or ideas at Los Alamos can successfully be brought to bear. They also provide opportunities to engage academic and other researchers, students, and industrial communities, helping to meet the partner’s goals as well as add new science, technology, and skills to our Laboratory’s workforce.

The Laboratory is actively working to improve the business and intellectual property practices necessary for partnerships to

Los Alamos grand challenges for science

Challenges addressing science

- Beyond the standard model
- Superconductivity and actinide science
- Complex systems
- Fundamental understanding of materials

Challenges addressing mission

- Carbon neutral fuel cycle
- Ubiquitous sensing
- Boost physics

Overarching capability

- Information science and technology
-

be developed and productive. These improvements will allow our research facilities and staff to more readily engage appropriate external communities. For example, we have streamlined the approval process for Cooperative R&D Agreements (CRADAs) and non-federal Work-for-Others agreements (www.lanl.gov/partnerships). The Laboratory instituted new policies in 2006 to facilitate direct funding from non-profit foundations. The Laboratory Center for National Security Education and the new university Institutes provide a framework for linking educational opportunities to new collaborations with New Mexico research universities and the University of California campuses. The robust and growing programs funded by DOE outside of NNSA, as well as other Federal agencies such as the Department of Defense, National Institutes of Health, NASA, and the National Science Foundation, have recognized the value of Los Alamos as a contributor of unique capabilities and a collaborative R&D approach in partnership with other institutions.

In the dynamic national security and technical environments we face today, we need to create partnerships even more expeditiously, both internally and with external partners. Partnering will be a guiding principle for internal organization and interactions, program management, and operational barrier removal.

Operations Enabling Mission Accomplishment

Achieving our missions also requires outstanding operations and infrastructure. Because of our unique role in national security science, the Laboratory is held to the highest standards of conduct. Our reputation and our survival demand that Laboratory activities be carried out in a secure, safe, healthy, and environmentally responsible manner. The four parent organizations of LANS, LLC are focused on establishing and sustaining safe, reliable, and consistent processes, and we are realizing significant results. For example, in safety we reduced by 30.9% the Laboratory's DART rate (days away, restricted, or transferred) between June 2006 and December 2007, and we increased the mean time between significant safety events by more than 220% compared to FY2006 data. However, the challenge of leading change at Los Alamos is a multi-year journey, and although our pace is accelerating, the Laboratory must continue to improve its rate of progress. The LANS Board of Governors is committed to bringing the best practices, systems, and tools to Los Alamos while also operating in a cost-competitive manner.

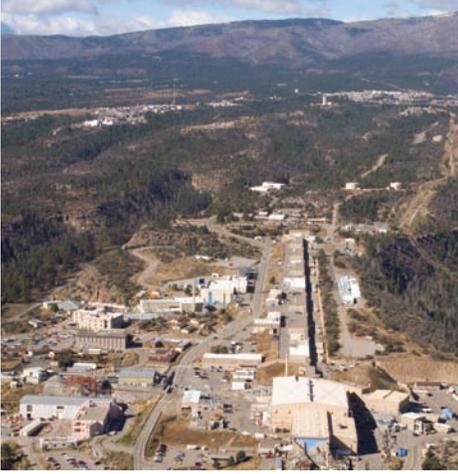
PowerFactoRE: Flexible tool for predicting manufacturing reliability saves Procter & Gamble over \$2 Billion

- P&G cut capital expenses (as percentage of net sales) from 8% to 4%.
- Received R&D100 and Federal Laboratory Consortium Awards.
- Provided real-world data to validate simulation codes developed for stockpile stewardship.

"This solution is the single most powerful driver for reducing costs of manufacturing that I have found in over 25 years of experience at P&G."

Mary Anne Gale,
VP Global Supply Chain
Operations





MaRIE: a unique experimental facility for creation and exploitation of Matter-Radiation Interactions in Extremes

- The Fission and Fusion Materials Facility and enhancements to the Weapons Neutron Research Facility will create extreme radiation fluxes.
- The Multi-Probe Diagnostic Hall and enhancements to the Lujan Center will provide unprecedented probes of matter.
- The M4 Facility dedicated to making, measuring, and modeling materials will translate discovery to solution.

Transforming the Scientific Campus and Facilities: Agile, Sustainable, Integrated, Forward-Looking

To support our vision as the premier national security science laboratory, we must modernize aging facilities and consolidate our footprint to a sustainable size and configuration.

Our vision of the future (circa 2020) campus responds to several long-term drivers: the future national security mission environment; weapons complex transformation; the evolution of science and technology that will be applicable to national security; and the necessary interactions among our capabilities. That vision focuses more of our science, technology, and engineering facilities in or near TA-3 and in the Pajarito Corridor. Several capabilities in remote areas will be consolidated toward the Laboratory core, and some of today's physically distinct sites must be eliminated. The Laboratory will be focused around six capability-oriented scientific facility campuses (right).

While eliminating obsolete space, we are also planning new facilities. MaRIE (Matter-Radiation Interactions in Extremes), a new signature science facility, will be a magnet for groundbreaking research in key areas of materials and energy. Other new facilities projects include the Chemistry and Metallurgy Research Replacement, the Science Complex, and LANSCE refurbishment.

The total LANL site will be focused around six capability-oriented scientific facility campuses

1. Bio and physical sciences (including Science Complex)
2. Complex materials functional prediction and design
3. Information sciences
4. Radiological and actinide chemistry, materials, and analysis
5. Explosives science and field evaluation
6. LANSCE: Structure and dynamics of matter at extreme scales and conditions



Building the future

LANL will maintain its role as the center of excellence for nuclear weapon design and engineering, plutonium research, development, and manufacturing.



Stockpile Stewardship: Los Alamos is vital to maintaining the U.S. nuclear deterrent

- Los Alamos developed the science and technology to assess the stockpile without testing
- Los Alamos systems are present in all three legs of the nuclear triad
- We designed 80% of the enduring stockpile
- The weapons program integrates high performance computing and complex experiments

Ensuring the Safety, Security, and Reliability of the U.S. Nuclear Deterrent

Near-term thrusts within the nuclear weapons program support national priorities for ensuring the safety, security, and reliability of the stockpile. Long term, our mission requires sustenance of the unique science capabilities developed for stockpile stewardship. As one example, the increasing maturity of advanced simulation codes and platforms and physics-based models now spurs focused, experimentally based efforts for validation, which in turn fosters new weapons predictive capability.

The weapons mission relies fundamentally on science-based prediction: the ability to compute *a priori* the results of an experiment or test, using verified and validated simulation tools.

Roadrunner, the new LANL petascale computing platform, will enable new capabilities for both weapons and nonweapons predictive science. A thrust in penetrating imaging links successful operation of both axes of the Dual-Axis Radiographic Hydrotest facility (DARHT), proton radiography (pRad) at LANSCE, and intensive development of image analysis. This ability to watch, model, and predict dynamic changes in matter at very high resolution will lead to insights in many other fields. Our neutron science facilities, together with a refurbished Chemistry and Metallurgy Research facility, continued use of TA-55 for plutonium R&D and pit manufacturing, and other infrastructure consolidation and transformations that support national NNSA strategies create the backbone for our future campus. Yet these capabilities also support important national deliverables for assessing, maintaining, and manufacturing the nuclear deterrent without nuclear testing.

Under NNSA's proposed preferred alternative, LANL will maintain its role as the center of excellence for nuclear weapons design and engineering and plutonium research, development, and manufacturing. This selection



Persistent Surveillance: (e.g. AngelFire) Advanced digital image processing and decision support save lives in Iraq

- **Unique capability: Real-time, high-resolution surveillance over a wide area, zoom and replay**
- **Tested and fielded in 18 months with the Air Force Research Lab and the US Marine Corps**

“Distributes real-time imagery straight to the war fighter, providing the ability to zoom in and observe an area more closely... allows for playback of significant events with a ‘TiVo-like’ capability to monitor areas.”

John Young, *Director of Defense Research and Engineering, Pentagon, USA Today*

affirms the Laboratory’s long-term mission to maintain the science and manufacturing capabilities needed by the nation to ensure the viability of our deterrent. In the last year, we have demonstrated our unique role by restoring the nation’s manufacturing capability for nuclear triggers (including the first pit in 20 years certified with the NNSA “Diamond stamp” for the W88 submarine warhead). Following this milestone, the Laboratory produced 11 W88 pits and delivered six to the Pantex plant, exceeding NNSA requirements by 10% while demonstrating improved quality assurance.

Reduce Global Threats

Los Alamos threat reduction and national security programs (www.lanl.gov/natlsecurity/threat/) reduce the threat from weapons of mass destruction (including unconventional weapons and Emergency Response); bolster the nation’s space surveillance capabilities and understanding of proliferators’ resources and intentions; strengthen the national infrastructure against attack via cyber, surveillance, and security countermeasures; and support war fighter needs. These programs help secure nuclear materials around the world, protect infrastructure, support nuclear, chemical and biological forensics, and develop technology for rapid response and analysis. Our threat reduction programs leverage existing programs and concentrate capabilities across the Laboratory to fill critical needs in these areas. Los Alamos will magnify

key national technical capabilities in sensing, surveillance, and space superiority by developing advanced materials for sensors, power production, and communication, remote sensing science, and predictive modeling. Finally, Los Alamos will also apply remote sensing science, materials and energetic-materials science, and information science to develop countermeasures for explosives, as well as chemical and biological threats. These activities will advance national capabilities to understand, detect, track, mitigate, and attribute threats even in data intensive and noisy environments.

Solve Other Emerging National Security Challenges

Los Alamos science, energy, climate, and environmental programs address missions relevant to national security. The science programs serve the nation, conducting long-term, national-security-inspired, fundamental science, enabling transformational discoveries. These programs further help LANL nurture and develop its internal capabilities by enhancing interactions with the best researchers and facilities in the world.

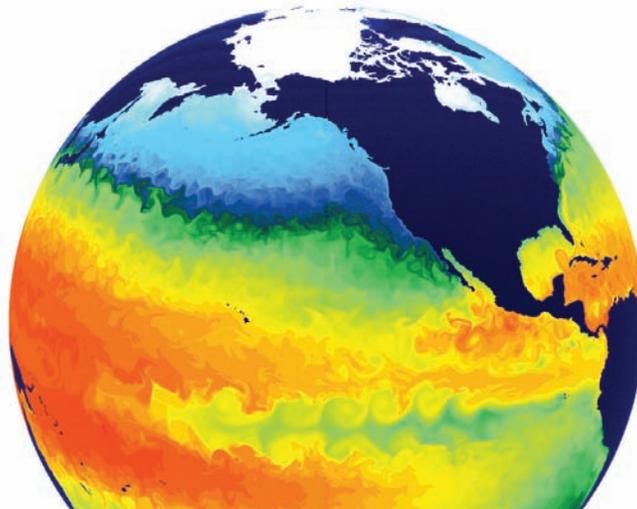
Energy security is also explicitly a national security mission. In the next three decades the global demand for energy will more than double. Meeting this demand without adverse consequences to the climate and world economy is the greatest challenge facing the nation and the world.

We have identified three themes that underpin the priorities for a vital Los Alamos mission in energy security:

- 1) **Sustainable Nuclear Energy.** Los Alamos has a combination of unique programs and capabilities that can contribute to energy independence. Mission priorities include enabling advanced nuclear fuel cycles, understanding materials in intense radiation environments, and predictive models ranging from materials fabrication and performance to facilities engineering and operations.
- 2) **Mitigating Impacts of Energy Demand Growth.** The energy infrastructure will be subjected to increasing unpredictability as demand grows. There will be systemic consequences of growth, insertion, and regulation of renewable sources, and of economic fluctuations, climate change, and human migration, on scales ranging from regional to global. The challenge is to predict and mitigate these impacts to develop policy and investment choices and ensure a reliable future energy supply.

- 3) **Materials and Concepts for Clean Energy.** Because no one technology can meet future demand, Los Alamos will maintain programs spanning energy generation, storage, and transmission. Key challenges include revolutionary alternatives to conventional oil, such as unconventional fossil fuels, clean carbon (capture and sequestration), and hydrogen fuel cells. Energy storage efforts will target materials advances for supercapacitors and chemical hydrogen storage.

Ocean surface temperature and circulation modeled with the Parallel Ocean Program (POP). Los Alamos' POP and Sea Ice (CICE) models were critical to the Intergovernmental Panel on Climate Change Assessment that won the 2007 Nobel Prize.



Superconducting materials deposited onto a flat-formed tape. The tape, one-tenth the thickness of a human hair, can carry more than 100 amperes per centimeter width — which is 100 times the amount of current that can be carried through an equivalent area of copper wire.



Science, Technology and Engineering Priorities

Science that Matters

- Information science and technology enabling integrative and predictive science
- Experimental science focused on materials for the future
- Fundamental forensic science for nuclear, biological, and chemical threats

How We Work

- Collaborate, partner and team to make decisive contributions to our sponsors
- Outstanding operational excellence for safety, security, and efficient pursuit of ST&E for our missions

Transform Our Scientific Campus

- Campus for 2020 (consistent with complex transformation)
- Modern science facilities: LANSCE refurbishment, CMR Replacement, Science Complex
- Signature facilities for experimental science (MaRIE) and computational science (Roadrunner)

