Preventing Nuclear War

New instruments detect nuclear detonations

Quick Read
Researchers develop advanced nuclear threat detection technologies.

Today, nuclear threats around the world are very real risks to global security. Reducing threats of weapons of mass destruction and terrorism are critical to our national security. Los Alamos National Laboratory, a leader in nuclear science and national security, is at the forefront of nonproliferation via multilateral research across the Lab: satellite explosion monitoring, intelligent sensors, worldwide materials detection and protection, bioscience radiation research, and ensuring the safety and reliability of the U.S. nuclear deterrent. One prominent Lab method that protects the world detects nuclear explosions in atmosphere and space.

The world is full of nuclear-weapons knowledge and materials, providing many terrorists with the ability to make weapons. While many nuclear sensors exist worldwide, they are frequently incapable of distinguishing millions of natural events and background data—lightning flashes, cosmic collisions-from a true nuclear signal. Lightning strikes the earth approximately 100 times per second, confusing traditional detectors.

Ground-based supercomputers and human analysts might be capable of the critical but confusing task, but Los Alamos scientists and engineers have built intelligent instruments that can rapidly assess data in space-making nuclear detonation detection faster, easier and more accurate. The Lab's Satellite Nuclear Detonation Detection (SNDD) program team members also used advanced technology to make instruments smaller, lighter, inexpensive, and highly adaptable to different host satellites.

Detecting nuclear explosions is a difficult task. The surface area of the Earth is more than half a billion square kilometers; with atmosphere tacked on, there are about 50 billion cubic kilometers to monitor. New technologies, including the current system of 24 Global Positioning System (GPS) satellites, provide complete coverage that also increases troublesome background data.

The SNDD program's exceptional talent combines extensive knowledge of nuclear physics, engineering, space weather, computation, atmospheric and planetary sciences. The group developed strong ties with NASA, universities, and dozens of other institutions to lead the way in reducing threats. For example, Los Alamos Fellow Ed Fenimore designed the gamma-ray trigger for nuclear-event detection and designed the sensor that alerts NASA's SWIFT satellite of a gamma-ray burst.

Marc Kippen, SNDD x-ray instrumentation Project Leader, and histeam developed the combined x-ray spectrometer and particle dosimeter (CXD) by using advanced technology to integrate the two instruments into a single, more-capable x-ray sensor system. The particle detectors monitor the space environment and the system provides intelligent nuclear detection data. Another team, led by Dave Smith of the Lab's Space and Remote Sensing group, engineered a next-generation electromagnetic pulse sensor-the burst detector-verification (BDV) sensor-that will carry a huge amount of computation and data storage compared with its predecessors.

The SNDD's newest instrument, built by Eric Dors' team, is the space and atmospheric burst reporting system (SABRS), a highly modular package for detecting neutrons and gamma rays. It combines the 10 instruments on a satellite into one compact package that consumes less power, and weighs half as much as the old suite of instruments. Employing

advanced on-board signal processing, SABRS autonomously evaluates a signal. Consequences of a nuclear bomb explosion are high. Los Alamos National Laboratory's experts play a key role in preventing a nuclear war.

Pushing Frontiers

In the second half of 2008, Los Alamos National Laboratory made significant advances in its primary mission: safeguarding the U.S. nuclear deterrent and pushing the frontiers of science on multiple fronts.

The national stockpile stewardship program achieved a major milestone in September with the production of the first life-extended W76-1 ballistic missile warhead for Trident submarines. The achievement culminated more than a decade of work by scientists and engineers at Los Alamos and across the nuclear weapons complex-including two crucial experiments conducted by the Laboratory's Hydrodynamic Experiments Division.

Another highlight: Roadrunner reached a new performance record of 1.105 petaflops, keeping it atop the list of the world's fastest supercomputers. Built by IBM for the Lab, Roadrunner was the first computer the crack the petaflop barrier: one thousand TRILLION operations per second. Initial applications will range widely: studying in great detail the evolution of HIV... exploring deeply the formation—as well as deformation—of metallic nanowires...and-toward producing biofuels more efficiently-unraveling the processes by which bacteria break down cellulose.

Safety and environmental stewardship were again a major theme for our work in the latter half of 2008. In November, the last group of unvented high-activity drums left Los Alamos for the Waste Isolation Pilot Plant near Carlsbad. That shipment fulfilled a commitment to the Defense Nuclear Facilities Safety Board to prioritize disposal of the highest-activity transuranic wastes stored at the Lab.

Los Alamos also strengthened security, ensuring that nearly six dozen classified and unclassified computing systems are managed and operated securely. The Lab has now complied with all 14 security actions mandated two years ago by the Department of Energy. And, through our program to recruit cognizant systems engineers, we met the crucial need for sufficient numbers of engineers to keep vital mechanical and electrical safety systems functioning properly in our nuclear facilities.

The latter half of 2008 proved once again why Los Alamos is the nation's premier institution for scientific research. Capping the list of accomplishments was a new technology called MagViz that could eventually provide increased security at major airports. Based on medical MRI technology, MagViz can identify contents of bottles and other containers, distinguishing potentially hazardous liquids from the harmless shampoos and perfumes a traveler might carry onboard a jet. MagViz was demonstrated successfully in December at Albuquerque's airport.

We continued a long tradition of supporting U.S. space exploration. A NASA mission, launched in October to probe the far edge of the solar system from a high Earth orbit, carried a Los Alamos device called the High Energy Neutral Atom Imager. Its goal: to detect atoms emitted from a region where the outermost reaches of our solar system meet the vast interstellar space-giving us a panoramic view of this gateway to the galaxy.

Closer to home, Los Alamos continues to explore solutions to the energy needs of tomorrow. For example, scientists at the Lab hope to use tiny semiconductors called quantum dots to convert sunlight to electricity more efficiently than is possible with current solar panels-and to create new, efficient solid-state lighting.

Equally electrifying, Los Alamos materials scientists are helping unravel the mysteries of superconductivity. During the latter half of the year, LANL researchers identified entirely new mechanisms for superconductivity that could form the basis for new superconducting materials.

Underscoring the wealth of scientific talent at the Lab, Bob Albers, Paul Johnson, and Kurt Sickafus were named Laboratory Fellows in December. These three Fellows represent diverse disciplines, including theoretical physics, energy science, and geophysics.

Los Alamos may be one of the world's great technology incubators, yet we also strive to help others develop new ideas and products. In January, the Lab selected four young local companies as the newest recipients of awards from the LANS Venture Acceleration Fund. LANS, which manages and operates the Lab, supports the fund through donations from its earnings.

The Lab and LANS also teamed last September with a venture capital firm and a local venture capital fund to spin off technology developed by Lab scientists, with an emphasis on

creating companies in Northern New Mexico. The Lab could contribute up to one million dollars to the initiative over the first three years.
We also are pushing to build top-flight research facilities for the future. In July 2008, workers hoisted the final steel beam atop the skeleton of what will be the Radiological Laboratory Utility Office Building, part of the Lab's Chemistry and Metallurgy Research Replacement Project. Once completed, the CMRR nuclear facility will house several of the Lab's mission-critical projects, including analytical chemistry, materials characterization, and actinide research and development capabilities. They'll be relocated from their current location in the historic—yet antiquated—Chemical and Metallurgy Research building at Technical Area 3.
In December, Los Alamos welcomed hundreds of employees who transferred from KSL, the subcontractor whose work the Lab brought in-house. The move was geared to improve efficiency and reduce costs associated with site-support services, including maintenance, waste removal, and custodial work.
Throughout the Lab's history, Los Alamos has helped play a vital role in the surrounding communities, and in 2008, that tradition continued. Lab employees pledged a million dollars, and LANS matched one hundred percent: a record Los Alamos contribution to United Way of TWO MILLION dollars. Contributions from the Lab and LANS also helped fund dozens of nonprofit organizations and scholarship programs, including a LANS donation of $500,000 to a LANL Foundation scholarship named for former long-time New Mexico Senator Pete Domenici.
These accomplishments and many more added up to a strong year. Our customer, the National Nuclear Security Administration, reached the same conclusion in its very favorable assessment of the Lab's performance for fiscal year 2008. It's unmistakable: the extraordinary talent, commitment, and creativity that Los Alamos employees dedicate every day to national security science and the betterment of their communities.

About Our Capabilities, Facilities, and Staff

"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." Michael Anastasio, Dir.

Solving Complex R&D Problems with Special Blend of Staff, Capabilities and Facilities
Now in its seventh decade, LANL is one of the 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.
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. Our new discoveries continue to responde to emerging missions.
Being able to integrate and apply our capabilities rapidly to new challenges will be a key advantage in an increasingly competitive landscape.

Our 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