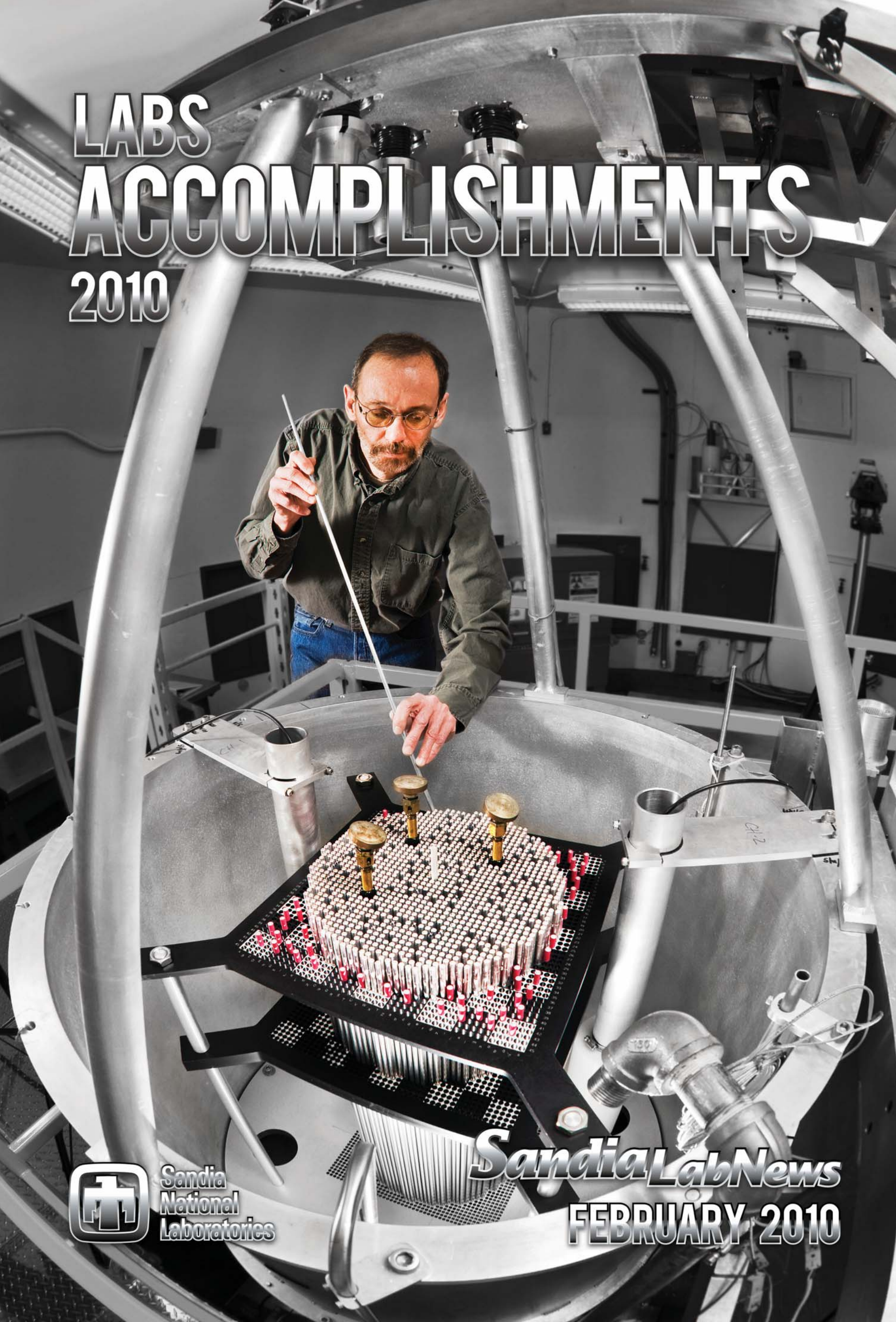
LABS ACCOMPLISHMENTS 2010



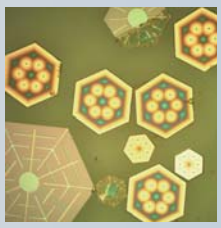
Sandia National Laboratories

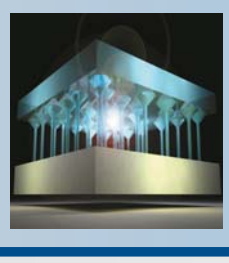
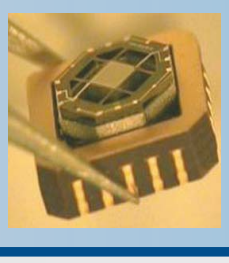
Sandia LabNews

FEBRUARY 2010

2009 marked 60 years of achievements by Sandia National Laboratories. Since 1949, Sandia has developed science-based technologies that support US national security. Americans depend on Sandia's technology solutions to solve national and global threats to peace and freedom. In this photo from the 1950s, two Sandians examine equipment undergoing component testing for environmental stresses, including, in this case, subzero temperatures in a cold chamber.

Inside . . .

John Ford (1381), places fuel rods in the Seven Percent Critical Experiment (7uPCX) test reactor — a reactor stripped down to its simplest form. The fuel rod John is holding is actually a dummy rod used for practice.

Cover photograph by Randy Montoya

This year's *Labs Accomplishments* publication recognizes some of Sandia's best work during 2009, as submitted by center offices and selected by division offices. Each citation is followed by the numbers of centers that contributed most directly to the effort described.

An acronym after each accomplishment indicates which of Sandia's strategic management units (SMUs) or strategic management groups (SMGs) the work most directly supported. The SMG/SMU acronyms are:

NW: Nuclear Weapons SMG & SMU
DS&A: Defense Systems & Assessments SMU
ER&N: Energy, Resources, & Nonproliferation SMU
HS&D: Homeland Security & Defense SMU
ST&E: Science, Technology, & Engineering SMU
IES: Integrated Enabling Services SMU
WFO: Work for Others

Sandia LabNews

Bill Murphy • *Lab News* Editor
Rod Geer and Darrick Hurst • *Labs Accomplishments* Team
Michael Lanigan • *Labs Accomplishments* Production

http://www.sandia.gov/LabNews

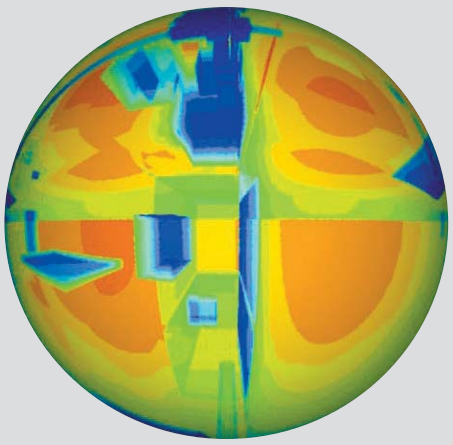
Albuquerque, N.M. 87185 • Livermore, Calif. 94550
Tonopah, Nevada • Nevada Test Site • Amarillo, Texas
Carlsbad, New Mexico • Washington, D.C.

Sandia National Laboratories

Sandia National Laboratories is a multiprogram laboratory operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation and a prime contractor to the US Department of Energy's National Nuclear Security Administration.

Nuclear weapons engineering

We have made significant **progress toward uncertainty quantification for predicting X-ray dose rate in weapon systems.** A methodology was developed for quantifying the uncertainties in predicting the dose-rate environment for weapon systems in hostile X-ray environments. These methods will aid weapon designers in the qualification of future systems to nuclear survivability requirements. (1300, 1400) NW



Leakage paths in a system identified by radiation transport analysis.

The first-ever simulations were performed of three-dimensional plasma transport in a classified neutron tube geometry using new capabilities developed in the ASC Program Assured Performance Focus Area. A number of simulations were performed using more than 100 million plasma particles with meshes containing more than 10 million elements requiring thousands of processors. These simulations demonstrated the dependence of tube performance on geometric variations. This achievement is **critical to completing an NNSA 2015 milepost quantifying neutron tube performance uncertainty to manufacturing and design variations.** (1500, 2700) NW

Two major alterations (ALT 357/358) to the B61-7/11 family of weapons were completed, marking **the end of an eight-year, multisite effort that spanned the design to production spectrum.** Major accomplishments included the installation of a new spin rocket motor and a new Los Alamos National Laboratory-designed canned subassembly. Additionally, B61-7/11 recode operations were completed for the first time at Pantex using the newly implemented Code Management System. (2100, 2500, 2900, 1500, 400) NW

B61-7 ALT 357/358 Last Production Unit.

Joint Test Assembly (JTA) product realization teams delivered the first W76-1 JTA1 and W88 JTA2-Refresh production units. **These JTAs later performed flawlessly when launched from an Ohio-class submarine on a Trident-II missile during a stockpile evaluation flight test —** culmination of multiyear/multiagency programs that included NNSA, US Navy, Sandia, Savannah River Site, Kansas City Plant, Pantex, Y-12, and Los Alamos National Laboratory. Both JTAs are highly instrumented and contain advanced telemetry systems that collect warhead data to be used for surveillance of the W88/Mk5 and W76-1/Mk4A. (0400, 1700, 2500, 2600, 2700, 2900, 5300, 8200) NW

DoD's Trusted IC Supplier Program accredited Sandia's Microsystems Center as a Category 1A supplier of both trusted design and foundry services. Our ISO 9001-certified processes for custom integrated-circuit design, fabrication, packaging, test, failure analysis, and reliability allow Sandia to **offer a total integrated trusted solution to both our internal and external national security customers.** (1700) NW

Department 2614 led development of a micro-optical switch targeted for multiple uses. **This design integrates fiberoptics and MEMS, creating new performance capabilities for optical applications.** MEMS provide the precision alignment of optical fibers — fibers that can carry large power and data bandwidth. The compact and robust device has been tested in multiple environments and has successfully switched more than 5 million cycles. (1500, 1700, 2100, 2400, 2600, and Kansas City Plant) NW

Sandia's System of Systems Analysis Toolset (SoSAT) is providing an unprecedented system of **systems modeling and analysis capability for the Army's planned new ground combat vehicles (GCV) as part of its modernization program.** This summer, Sandia provided modeling and analysis for inputs to the new GCV requirements and performance objectives during the 120-day study. The use of SoSAT was critical in providing a methodology to model the new Office of the Secretary of Defense Materiel Availability Key Performance Parameter (KPP) requirement. (6300) DS&A

Sandia's Integrated Surety Solutions (ISS) project team completed a crucial Level II milestone by **demonstrating advanced technologies for enhanced weapon surety during transportation.** ISS made significant progress toward realization of key elements within the National Surety Plan (under development by NNSA and weapon laboratories). Demonstrations were conducted for NNSA Assistant Deputy Administrator (ADA) for Secure Transportation and ADA for Science, Engineering, and Production. (8200, 2100, 6400) NW

The US is currently spending hundreds of millions of dollars on upgrades to the physical security of nuclear weapons facilities and exploring technologies for increasing the use denial capabilities of its nuclear assets. DANTE is a force-on-force battle simulation tool built on the Umbra framework. Umbra is a flexible tactical hybrid simulation engine and framework that can integrate physical, cyber, and behavioral elements at variable fidelity in a 3-D environment. **DANTE successfully modeled a US nuclear weapons facility, providing insight into the effectiveness of physical security tactics and technologies.** By better understanding how physical security and weapon use denial approaches work together, more effective system solutions can be pursued, potentially saving millions of dollars. (400, 6300, 6400) NW

Integrated Planning has been designed and deployed across the full suite of NW core products and essential capabilities. This planning approach identifies the requirements basis and key linkages across the program, has a time horizon consistent with the national budget process, and is intended to strike an appropriate balance between product pull and technology push. It provides **an internal framework for ensuring maximum consistency and alignment across Sandia's nuclear weapons program.** It also provides a common integrating construct for communication with our NNSA customers. (200, 2100, 2400, 2500, 2600, 2700, 2800, 2900, 8200, 8400, 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1800, 5300) NW

The environment in which Sandia will execute its NW mission over the 2010-2014 timeframe will provide challenges unlike anything the Labs has ever faced. Sandia's Nuclear Weapons Leadership Council (NWLC), in consultation with NW program and line directors, has developed a vision to guide Sandia in these times. The central theme of *Nuclear Weapons Vision – 2014* is that **nothing will be more important in meeting these extraordinary challenges than the people of Sandia Labs.** (220) NW

The W76-1 Intent Stronglink (ISL) requires three electrical feedthrough connectors (aka headers) that had posed serious manufacturing cost and yield problems. The ISL Header Manufacturing Team developed an alternative design employing a novel glass-ceramic material system not previously used for weapon components. The new system **demonstrated superior performance and provided a substantial cost reduction with greatly improved yields.** The team qualified the new process and components, then manufactured and shipped sufficient quantities of the three diamond-stamped headers to support W76-1 build schedules, all within four months. (2400, 2600, 2700, 1500, 1800, 420) NW

W76-1 Intent Stronglink headers with a novel glass-ceramic materials system that improves performance and manufacturability while also significantly reducing cost.

The 2009 Nuclear Posture Review, when released, will articulate the nuclear policy affecting the future of the stockpile, the weapon production complex, NNSA, and the national laboratories. **Sandia's Systems Analysis Group has contributed to this effort as an officially designated analysis cell responding to Office of the Secretary of Defense** requests on a range of issues. Of particular note were efforts to visualize how the nuclear triad would be balanced at lower stockpile levels, the development of many stockpile composition alternatives and courses of action for NNSA, and a white paper on weapons needed in a future stockpile to hedge against technical failures and/or geopolitical requirements. (500) NW

The Integrated Budget Tool (IBT) was developed to assist federal program managers during the annual budget process. The IBT, using detailed budget information that includes a prioritized list of activities, performs an optimized resource competition to develop a new budget plan that honors budget allocation constraints and illustrates the resulting impact on the future NA-10 program. The tool has been **deployed to NNSA headquarters and applied to analyze several future budget scenarios in support of FY2011 and future year budget negotiations.** (500, 6300) NW

Development of a power-harvesting Integrated Gas Transfer System (IGTS) achieved a major goal by initiating performance testing of a tritium-filled prototype at the Savannah River Tritium Facility. **Performance has compared well with high-fidelity thermoelectrical models over a period of 10 months**, showing no losses beyond that owing to tritium radiological decay. The IGTS technology is being leveraged in a concurrent cross-center effort developing a standalone tritium thermoelectric generator (TTG). Both Kansas City Plant and Savannah River National Laboratory are partnering with Sandia on the TTG development project. (8200, 8300, 2500, 1800, 1500) NW

TTG developmental hardware.

Restart authorization for Tonopah Test Range operations, including all work relating to the planning, testing, recovery, clearing, safing, handling, and storage of our Joint Test Assembly (JTA) mission, was approved by the Div. 2000 VP on June 1, 2009. This quick effort also resulted in the **successful testing of 52 Man-Portable Air Defense System (Man-PADS) missiles** and resulted in software algorithm updates for the defensive systems of DoD aircraft deployed in the Iraq/Afghanistan theater to improve survivability rates of aircraft engaged in those conflicts. (2900, 4100, 400) NW, DS&A

Tonopah Test Range

Weapon security

The OPUS Project, which is **developing hardware to improve safety, security, and logistics of over-the-road transportation of nuclear weapons, completed its baseline design phase in 2009** and now moves into the qualification phase. The primary products of the project are overpacks that accommodate the six containerized weapon systems to provide roll-on/roll-off loading efficiency with improved crash and fire performance and improved security. Prototype equipment has been tested at Pantex and Military First destinations. The first production unit is expected in May 2011. (400, 6400, 2900, 6700, 1500, 8100) NW

Remote sensing

New technology has resulted in a lithium-ion battery that can operate outside its package, even in the presence of oxygen or water. The anode, cathode, and electrolyte are coated or spray-painted onto an arbitrary surface. By doing away with inert components, **the resulting battery allows more energy to be stored in four times less space. The approach took top honors out of 800 projects at a recent tri-lab LDRD symposium.** A spin-off of the technique demonstrated high-temperature operation suitable for down-hole drilling applications. (2500, 1800) DS&A, ER&N

A hands-on demonstration of a 20 mA Li-ion battery bent around a 1.8 V red LED.

Sandia's space mechanism designs range from cryogenic filter wheels to highly preloaded launch locks to sub-micron step-focusing mechanisms. **Support equipment that protects personnel and high-value national security assets during assembly operations also is part of the design suite.** This innovative equipment is used to lift, support, and transport specialized payloads while meeting all system requirements. Specialized tooling — a gantry system, for example — allows for precise alignment of optical assemblies into the system in a few hours compared to multiple days for the previous program. Using unique optomechanical design techniques, the gantry system employed a composite beam and flexures to minimize deflections and meet critical alignment tolerances, thereby assuring the required system performance. (2600, 5700, 5500, 2400) DS&A

Gantry system, conceived and designed by Dept. 2617 staff, used to align a lens cell assembly for optical testing. The system allowed alignment tolerances in the ten-thousandths range to be maintained to meet system performance requirements.

Sandia satellite payloads and ground systems are important components of the US Nuclear Detonation Detection System (USNDS). Sandia sensors fly aboard Global Positioning System (GPS) and Defense Support Program (DSP) satellites. **Two notable spaceflight milestones were achieved this year.** On June 14, 2009, DSP Flight 14 reached its 20th anniversary on-orbit; and on Aug. 17 the last GPS Block IIR spacecraft was successfully launched. Several teams are actively engaged in utilizing the data from more than two dozen on-orbit systems. Additional teams are preparing the next-generation (Block IIF) payloads for launch in 2010 and are developing ground systems to interpret data from advanced sensors. (5700, 5500, 5300, 1700, 2600) DS&A

The last Block IIR Global Burst Detector payload being launched from Cape Canaveral on Aug. 19, 2009.

Sandia recently participated in the design, development, manufacture, and characterization of next-generation, large-format, high-frame-rate visible and infrared focal plane arrays (FPAs). These new state-of-the-art sensors are **the first of their kind and will enable critical new national security missions.** The FPAs have been fully characterized in the laboratory for satellite flight performance and baseline operation; integration into a telescope payload begins in 2010. (5700, 1700, 5500, 5300) DS&A

Significant improvement in the US capability to accurately locate possible nuclear tests and other seismic events is being achieved by Sandia's Next Generation Monitoring Systems organization. A fully global 3-D model of the Earth's mantle was produced using an iterative tomographic inversion technique with a data set of more than 9 million source-receiver ray paths. Through combination of state-of-the-art ray-bending techniques, variable resolution tessellated gridding, and large-scale multicore computing, **this model is expected to achieve levels of event location accuracy not previously seen.** (5500, 5700) DS&A

On Nov. 23, 2009, space shuttle astronauts manually deployed Sandia's latest research payload on the exterior of the International Space Station. The Single Event Upset Xilinx-Sandia Experiment team is the first in the nation to launch an experiment on the Xilinx Virtex 5 advanced Field Programmable Gate Array. Valuable ionizing high-energy particle upset data will be gathered and paired with data collected from the Space Station's charged particle radiation spectrometer **to advance understanding of the effect of space weather on high performance, space-based computing.** In July 2010, the astronauts will retrieve the experiments and return them to Earth for further analysis by the Sandia team. (5700, 2600, 1700, 1800) DS&A

MISSE-7 suitcase-like containers hold Sandia experiments on the exterior of the International Space Station. White rectangular box is SEUXSE; orange boxes contain passive Sandia-developed advanced materials and components.

Sandia was part of a multiagency, multicorporation effort to develop a small, low-cost, high performance space-based imaging radar to find ice/water for manned space flight to the moon. NASA's Lunar Reconnaissance Orbiter launched June 18, 2009, from Cape Canaveral and reached lunar orbit on June 25. Sandia delivered software and flight-qualified hardware of the Digital Receiver and Quadrature Waveform Synthesizer. **Sandia is analyzing radar imagery for signs of ice, uncovering the moon's coldest, darkest regions, looking into craters, and other mysterious areas that never receive sunlight.** (5300, 5900, 5700, 1500) DS&A

Launch of lunar reconnaissance orbiter.

In October and November 2009, Sandia and the New York Air National Guard (NYANG) partnered to conduct crevasse detection tests in Antarctica. The NYANG provided the LC-130 aircraft to test the Crevasse Detection Radar (CDR), Sandia designed X-band Synthetic Aperture Radar (mini SAR derivative); the radar operated successfully and demonstrated its ability to detect buried crevasses.

Test results proved that the CDR is capable of operating on an LC-130 and **will serve as a valuable tool to map out deep-field landing areas to avoid accidents involving buried crevasses.** As a result, four current production radars are in design and will be delivered at the end of CY2010. (5300) DS&A

Following an eight-hour flight the radar is deployed beneath the aft paratrooper door.

Marty Thomson (5348), lays out radar reflectors at the Pegasus site.

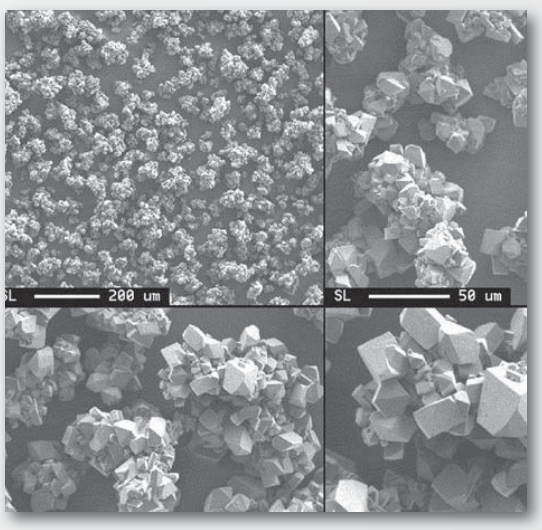
South Pole station and ceremonial South Pole marker.

Product realization

Engineering staff in Sandia's Electronic Fabrication Department followed Lean Six Sigma methodology to implement a high-rigor/high-quality cable manufacturing work cell to meet spaceflight hardware requirements. Following AS9100 spaceflight documentation, Sandia engineering design requirements and customer feedback, **an automated cable manufacturing process from design to manufacturing to final acceptance is now available to Sandia engineering.** The final step in this seamless process will format the hardware in an inclusive software application for paperless manufacturing from a SolidWorks design. (2400) NW, WFO

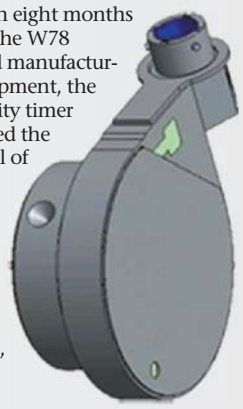
Cable manufacturing equipment and products.

Design engineers in Dept. 2550 have qualified CL-20 for use in the MC4872 detonator. CL-20 is a secondary explosive that captured widespread interest due to its high output and enhanced safety characteristics. Sandia has been conducting experiments with CL-20 in exploding bridgewire devices (EBD) to support development qualification activities for various programs. The MC4872 option represents an improvement in performance, shelf-life, and safety relative to legacy components. **This constitutes the first new energetic material introduced into the stockpile by Sandia in the past 10 years.** (2500) NW



Characterization of CL-20 suitable for implementation in mark-quality energetic components includes scanning electron microscopy (SEM) imaging of the powder, as shown above.

The Timer Product Realization Team (PRT) established and qualified manufacturing processes and delivered 170 mark-quality units in less than eight months as a stop-gap measure to support the W78 program. Starting with no defined manufacturing space, tooling, or process equipment, the team achieved the first mark-quality timer assemblies at Sandia. This surpassed the 18-month product realization goal of Div. 2000, culminating with a defect-free product acceptance by the Sandia Site Office. This activity **allowed neutron generator shipments to our Air Force customer seven months ahead of our external production supplier.** (2700, 2500, 2400, 1500, 400) NW, Stockpile & Weapon Product Realization Strategic Area



Timer assembly.

The first production unit (FPU) of a Joint Test Assembly (JTA8) for the Air Force nuclear air-launched cruise missile (W80-1) was completed in July 2009, ahead of schedule and under budget. The JTA8 FPU flight test occurred in November 2009. The JTA8 replaces the older JTA1R, which was designed and fielded in the early 1980s. **The JTA8 significantly increased the ability of Sandia and LLNL to evaluate the W80-1 warhead components in realistic flight environments.** Additionally, the JTA8 costs $150K less per unit than the JTA1R. (8200, 8100, 2700, 12300) NW

Sandia's External Production organization ended FY09 with the build out of the B61 spin rocket motor (SRM). The final source acceptance and diamond stamping of Lots 16 and 17 on Aug. 27, 2009, brought to closure the successful development and manufacturing of the newly designed SRM. The development efforts began in April 2003. **The SRM provides enhanced spin stabilization at extreme dynamic pressures.** Over the past several years, nine lots were produced and delivered to be fielded in the B61 stockpile. Over the life of the SRM, the program achieved a $991,000 savings. (2500, 2100) NW

The newly designed spin rocket motor is being retrofitted into B61 weapons.

Following a four-year Sandia-led development program, the spin rocket motors, which have significantly higher torque output, are being retrofitted into B61 weapons.

Sandia qualified the Joint Test Assembly Neutron Generator Monitor in time to meet the W80 JTA8 schedule. This monitor is **a solid-state, dual-channel, X-ray shielded device capable of measuring the individual outputs of the two simultaneously operating neutron generators** in the W80 JTA8 system. With this new monitor, W80 JTA testing will, for the first time, be supported with waveform data on neutron output and with X-ray-induced error reduced by at least an order of magnitude. (2700, 400, 2900, 8100, 8200) NW, Stockpile & Weapon Product Realization Strategic Area

Neutron generator monitor.

We successfully completed the Micro-Modular Telemetry (MMT) project, delivering and testing eight MMT for survival in Stockpile-to-Target Sequence environments for both re-entry vehicle and gravity bomb delivery. **Surviving these environments demonstrates that the design has reached the project goals** of achieving a Technology Readiness Level (TRL) of six and a Manufacturing Readiness Level of one. The MMT project enables the "pre-qualifying" of standardized modules that can be quickly and efficiently assembled to create telemetry systems with a desired set of performance attributes. (8100) NW

The Product Realization Integrated Digital Enterprise (PRIDE) program delivered Pantex test data and nuclear explosive operating procedures through the PRIDE portal to meet system engineer requirements. It deployed the Master Nuclear Schedule application and was assigned stewardship for three Kansas City Plant computing systems. **These PRIDE classified systems enabled NNSA and the Nuclear Security Enterprise (NSE) to manage the stockpile.** They supported the Sandia-led annual assessment, provided data to NSE manufacturing processes, and exchanged data with DoD to track interagency shipments. (9500, 2900, 9300) NW

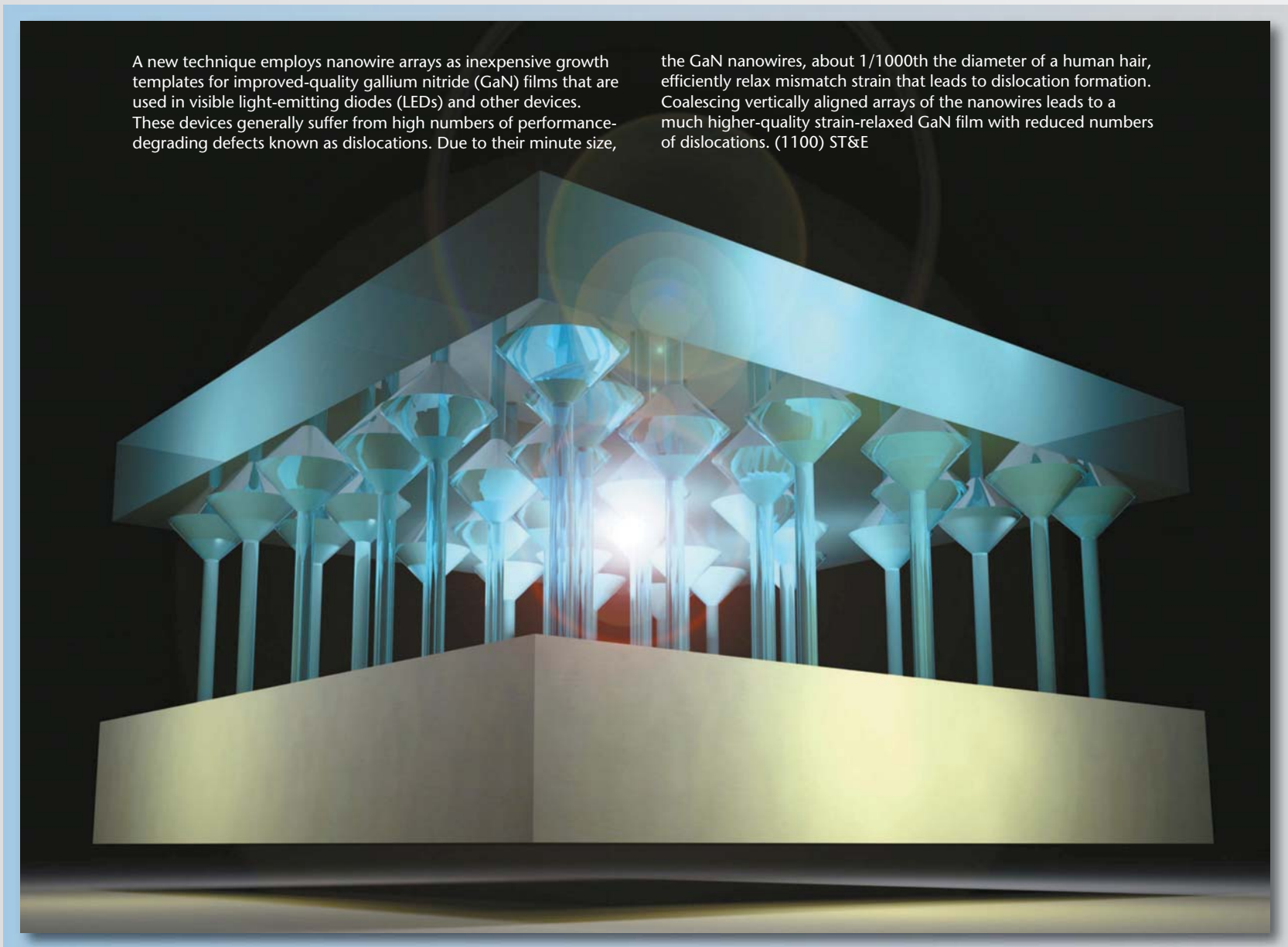
Supply chain

Logistics Operations received a certificate of registration to the International Organization for Standardization (ISO) 9001:2008 Quality Management Systems - Requirements. Their ISO journey started more than three years ago as a tool to improve customer satisfaction and create a culture of continual improvement. The main benefit of registration has been the creation of a more process- and data-managed organization. Logistics Operations (shipping/packaging, material movement, property management, fleet services and corporate storage) was **acknowledged by the British Standards (BSI) registrar as a very professional organization where top management has initiated a continual improvement philosophy**, eagerly accepted by and acted upon by all personnel. (10200) IES

ISO-certified Logistics Operations Logo.

Fleet Services received national recognition as one of the top 100 fleets in North America. Achievements include continuous improvements using process-based quality management system; implementing commercial off-the-shelf fleet management software for efficiencies of operations; continual leadership in alternative fuels and petroleum reduction, exceeding Presidential Executive Orders. **Alternative fuel vehicles encompass 46 percent of the fleet, with petroleum consumption reduced more than 27 percent since 1999.** There also is an impressive safety culture — more than 500 injury-free days using Behavior-Based Safety, Human Performance Improvement, and other initiatives. (10200) IES

Materials



A new technique employs nanowire arrays as inexpensive growth templates for improved-quality gallium nitride (GaN) films that are used in visible light-emitting diodes (LEDs) and other devices. These devices generally suffer from high numbers of performance-degrading defects known as dislocations. Due to their minute size, the GaN nanowires, about 1/1000th the diameter of a human hair, efficiently relax mismatch strain that leads to dislocation formation. Coalescing vertically aligned arrays of the nanowires leads to a much higher-quality strain-relaxed GaN film with reduced numbers of dislocations. (1100) ST&E

Artist's rendering of the dramatic strain relaxation in a GaN film grown on GaN nanowires, appearing on the inside cover of the June 19, 2009, issue of *Advanced Materials*.

Partnerships & alliances

In July 2009, Sandia and Northrop Grumman Electronic Systems signed the first-ever, five-year umbrella cooperative research and development agreement between the two entities. This accord **acknowledges Sandia as a strategic partner to one of the world's largest defense contractors.** Northrop Grumman employs 120,000 individuals and has sales of $34 billion. Among the agreed areas of mutual interest, quantum information systems and focal plane arrays have been given the highest priority for near-term attention. Discovery, discussion, and development of numerous project/task statements (PTSs) are under way on terahertz lasers, silicon photonics, and other systems technologies. (5200, 10012, 11500, 5300, 1700) DS&A

Jim Pitts, Northrop Grumman Electronic Systems, and Dori Ellis (5200), DSA Chief Operating Officer, at signing of umbrella CRADA.

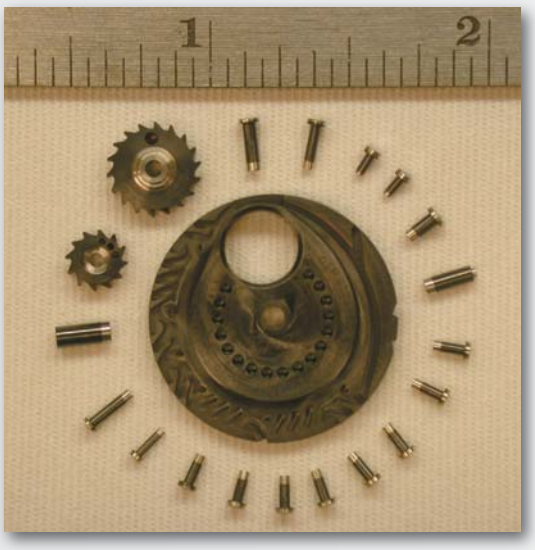
Since 9/11, federal agencies have looked for cost-effective ways to improve security. NNSA's Office of Field Security tasked the Security Systems and Technology Center to develop a plan to address Congress' 2008 NNSA Act. The plan **describes the principles and processes NNSA needs to effectively manage the entire life cycle of physical security technologies to securely perform its mission.** The plan includes a survey of existing physical security technologies and a funding strategy to determine how NNSA will use funds in future budget requests. (6400) HS&D

Three Industry Partnerships programs received international and regional recognition. The Sandia Science & Technology Park won "Outstanding Research Park of the Year" from the Association of University Research Parks. The New Mexico Small Business Assistance Program won the Federal Laboratory Consortium "Outstanding Regional Partnership Award." Both programs were recognized for leveraging Labs technology to create jobs in New Mexico. Sandia and the Semiconductor Research Corp. won the "Deal of Distinction" award from the Licensing Executives Society for agreements associated with the National Institute for Nano-Engineering. (1030, 1800) ST&E

We proposed an answer to a decades-old conundrum: Why does grain growth stop? Controlling grain size is crucial to developing novel materials, especially for extreme environments. Yet grain size is not infinitely variable; annealing increases grain size by a factor of 10 at most. Our simulations show that even at high temperatures microstructures contain some smooth, very slow boundaries that pin the grains after modest amounts of growth. This observation provides **the first explanation for grain growth stagnation in high-purity materials.** (1800) ER&N, ST&E

The Manufacturing Science and Technology Center and the Engineering Sciences Center jointly **developed experimental and computational methods to accurately predict degradation of adhesive bond strengths in humid environments.** This included development of a rapid new test that predicts degradation on a very short time-scale and refinement of finite element codes to accurately predict the initiation of cohesive and adhesive failure in polymers. Temperature dependencies of various cohesive and adhesive tests were measured and the results were in excellent agreement with this nonlinear viscoelastic model. (2400, 1500) NW, DS&A

We have developed diamond-like nanocomposite (DLN) **advanced wear-resistant coatings with properties tailored to mitigate friction in electromechanical components.** Life cycle tests of DLN coatings in prototype Dual Stronglink Mechanism units showed dramatically improved mechanical life with little or no sign of wear even after thousands of cycles of testing in ambient air. This work was recognized by NNSA through an Employee of the Quarter award. These coatings are also being successfully evaluated for use in harsh and more demanding applications for the DoD. (1800, 2600) NW, DS&A, ST&E



Diamond-like nanocomposite (DLN)-coated dual stronglink mechanism parts.

IT, networks, & facilities

The next-generation PRoduct Information Management Environment (ePRIME) now supports WFO and NW projects. This environment **provides configuration and change management of product definition information — models, drawings, documents, and build records — across the product's lifecycle.** This solution — an important element of Sandia's Product Lifecycle Management (PLM) supporting Mission Execution — is led by Dept. 2990 following a business model for corporate and NSE integration, comprehensive cost management, and enterprise computing to assure scalability and sustainability for lab-wide use on projects large and small. (2900, 2100, 5200, 5500) NW

The Facilities Operations and Management Center 4800 continues to lead the DOE complex in energy use reduction, as it has for the last 20 years. In fiscal year 2009, **Sandia reduced energy intensity in regular office buildings by 6.4 percent, and reduced water intensity by 14.2 percent.** (4800) IES

The three-year Heating System Modernization (HSM) project has successfully converted 47 Sandia buildings from a central steam plant (Bldg. 605) to independent boilers. In May, the steam plant was shut down permanently. The project **realized monthly savings of $70,000 on gas, $7,000 in water-treatment chemicals, $7,000 in labor, and 500,000 gallons of water.** It also reduced operations and maintenance costs in repairing steam leaks in Sandia's deteriorated underground piping system. Two huge fuel-oil storage tanks were also demolished, reducing Sandia's regulatory compliance risk. (4800) IES

Sandia removed 125,000 square feet of space from its inventory in FY2009, including removed or demolished owned space and leased space. About 75,000 square feet of High-Security Buildings (HSB) were added. **The Decontamination & Demolition Program won a DOE Environmental Sustainability Star (EStar) award for emphasizing NNSA pollution-prevention (P2) techniques when razing substandard buildings.** This awards competition recognizes exemplary environmental-sustainability practices across the department. (4800) IES

Blackberry handheld computing devices can now be brought into the limited area under a new pilot program. This culminates a four-year effort to enhance communications productivity and address related security concerns. Blackberry functionality has been integrated with the laboratory's desktop computing environment in both New Mexico and California. Testing, evaluation, and deployment in several early phases has been completed and will be expanded to laboratory scale in the coming year. (9300, 9600, 8900)

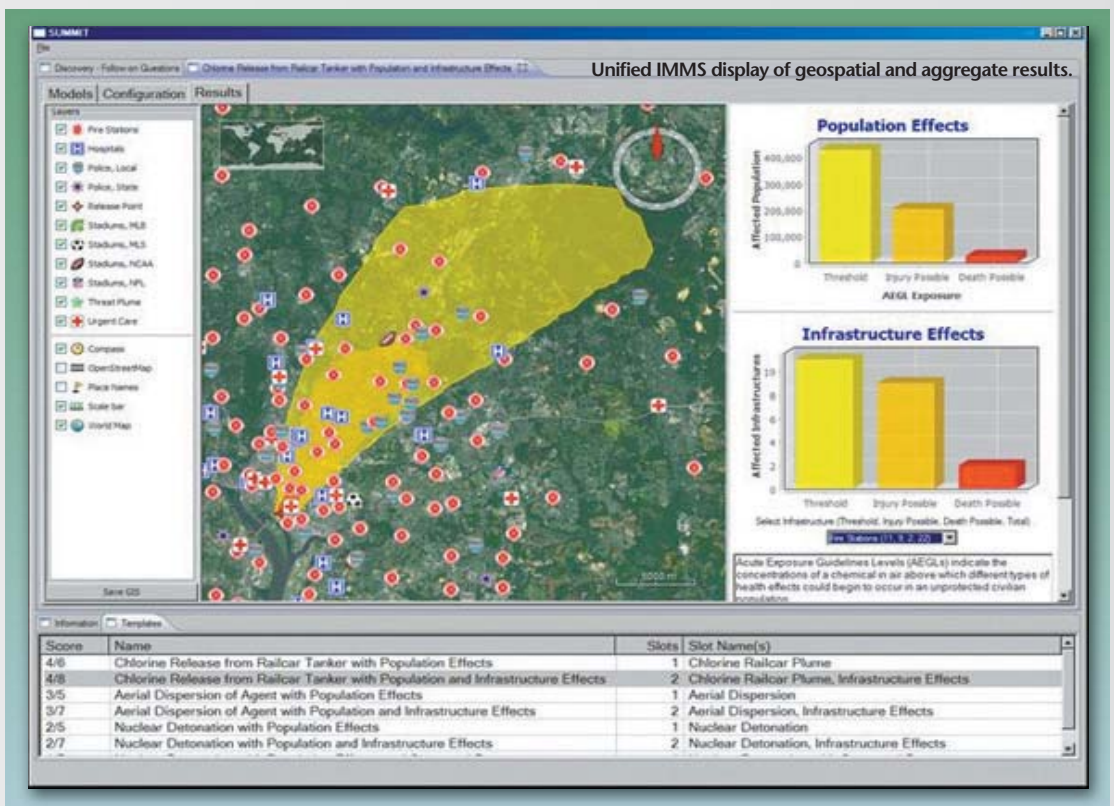
TracerFIRE incident responders collaborate to address the threat.

Sandia hosted a unique training and cyber war games exercise (TracerFIRE) designed to help NNSA formalize and build a community of analysts that will cooperatively respond to cyber incidents. To create a realistic environment, **the exercise included all of the NNSA labs and external partners such as the FBI and DOE Cyber Incident Response Center.** This effort and the relationships established among the defenders have led to collaboration on several real-world attacks that have taken place throughout NNSA. (8900, 9300, 12002) NW

Homeland security

The Chemical Facility Restoration Operational Technology Demonstration project recently executed a Final Demonstration at Ontario (California) International Airport. A primary **objective was to decrease the time required to restore critical infrastructure to operational status following a chemical warfare agent release.** This multiyear project developed plans, procedures, and technologies for rapid and effective restoration of major transportation hubs, such as airports, following a chemical contamination incident. Project deliverables and their impact on the restoration process timeline were exhibited at the three-day Final Demonstration. (6300, 8100, LLNL, ORNL, PNNL) HS&D

Mark Tucker (6327) demonstrates the Sandia-developed decontamination foam for a crowd at Family Day 2009. (Photo by Randy Montoya)



Sandia completed the first year of work on the Integrated Modeling, Mapping, and Simulation (IMMS) project for the Department of Homeland Security Science & Technology organization. The focus of the project is a **software architecture that enables model, simulation, and data federation for incident planning and response efforts.** Advanced collaboration technologies enabling distributed planning and exercise are also being explored. An IMMS concept demonstration was featured at the opening ceremony of the National Exercise and Simulation Center within FEMA HQ. (8100, 8900, 6300) HS&D

Sandia's Explosive Destruct System (EDS) has been certified for use in treatment of German Traktor Rockets. **Sandia's EDS has been widely used to safely destroy chemical munitions.** However, these captured German munitions include propellants, so certification that EDS could be used to safely treat them required extensive modeling, explosives testing, and preparation of full test documentation used in front of the DoD Explosives Safety Board to gain their approval. Treatment is now underway. (5400, 8100. 8200) HS&D

Sandia's Explosive Destruct System (EDS).

Military programs

Sandia has developed a novel micro gas analyzer based on tiny (0.1 cm³) gas chromatograph columns that separate complex chemical mixtures for accurate analysis. The breakthrough design achieves "two-dimensional" separation on two different columns, with the capacity to separate more than 300 compounds in four seconds. **This enables a fieldable detection capability for military and homeland security applications that avoids the high false alarm rates suffered by previously available high-speed chemical sensors.** (1700, 1800, 1500) DS&A, HS&D, ST&E

Gas chromatography column for fast chemical separations.

The Best Paper award was presented to Dale Coleman (5443), at the Twelfth Annual Directed Energy Symposium on Nov. 3, 2009. "Diagnostic Array for Characterizing Narrow Band HPM Sources," co-authored by C. Woods and G. Nelson from the Air Force Research Laboratory (AFRL), **presented an innovative diagnostic technique that allows accurate power distribution mapping from extended sources within the near-field limit.** This technique was developed under a program sponsored by AFRL, and has wide application to High Power Microwave systems development. (5400) DS&A

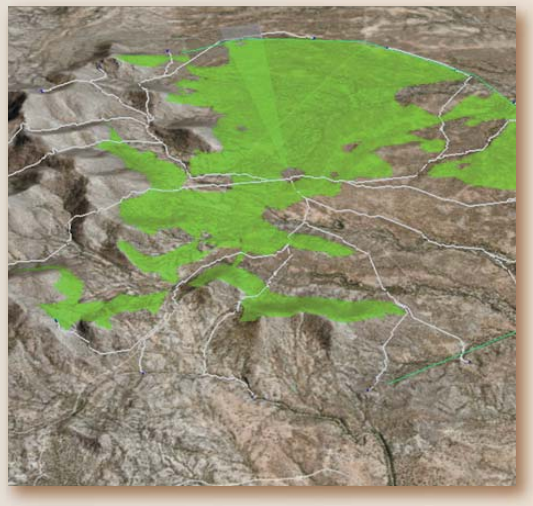
Nine Sandians made the nation's fight against improvised explosive devices (IEDs) personal in 2009 through on-site service with the Joint IED Defeat Organization (JIEDDO) in Washington, DC. **They provided much-valued and critical technical expertise in explosives, high-powered microwaves and directed energy, cell phone technology, operations research, and systems engineering.** They also provided reachback to broader Sandia capabilities in these and other technical areas to aid the Joint IED Defeat Organization in its mission to defeat IEDs as weapons of strategic influence for our adversaries. (1600, 2500, 5400, 6300, 6700, 8600, 8900) DS&A

Missile systems ARAV-C launch at Kauai Test Facility.

The Kauai Test Facility completed one of the most aggressive launch campaigns in its history to support the AEGIS Ballistic Missile Defense program. It consisted of six successful launches, including one intercept mission with the Japanese Navy. The final mission was for ARAV-C, in which Sandia designed, built, and fielded the Attitude Control Module. This added capability enables testing of extended features and upgrades of the AEGIS system. (5400, 5300, 2600, 2400) DS&A

Saving soldiers' lives in Iraq and Afghanistan was the objective of several Sandia departments through onsite and reachback support to the Joint Improvised Explosive Device Defeat Organization (JIEDDO). Innovative operations, research, and systems analysis methods improved IED events prediction accuracy, counter-IED initiatives' logistic support requirements assessments, and trends analysis for senior military leaders, including the Deputy Secretary of Defense. Rapid turn-around simulation tools addressed warfighter requests from the field. Dante (force-on-force simulation) and OpShed (Operations viewShed analysis tool) examined complex tactical problems of ground-based conflict. (6300) HS&D

Improvised explosive devices (IEDs) have proven to be a significant threat to soldiers in the Middle East.



Sandia's Operations Viewshed (OpShed) tool identifies paths over real terrain in ways that define adversary locations and safest paths for convoys and patrols.

The DoD/DOE Joint Munitions Program (JMP) Team received this year's NNSA-Defense Programs Award of Excellence. The JMP is an ongoing, jointly-funded effort by Los Alamos, Lawrence Livermore, and Sandia national laboratories. It was created by a memorandum of understanding in 1985, and develops advanced munitions technologies and tools that benefit both departments. **The JMP's contributions include model and code development, improved energetic materials, demilitarization technologies, fuzing and firing systems, terminal ballistics research, sensors, and materials reliability technologies.** (1500, 1700, 1800, 2500, 2600, 5300, 5400, 6400, 8100, 8200) NW, DS&A, ER&N, ST&E

General Atomics-Systems Group (GA-RSG) has delivered the 100th Lynx I, Block 20, Radar to the US Air Force for use in a Predator UAV. The Lynx I synthetic aperture radar (SAR) was developed by Sandia for GA-RSG. The official delivery of the 100th radar was commemorated at the GA-ESI facility during a May 1 ceremony hosted by Neal Blue, chairman and CEO of General Atomics. **This milestone continues our partnership with GA, directly benefiting the warfighter, and allowing a faster transition of new technology to the field.** (5300) DS&A

The Mine Resistant Ambush Protected (MRAP) Vehicle Joint Program Office (JPO) has engaged Sandia to support critical decisions concerning how to enhance and manage the MRAP fleet for current and future deployments. The JPO wants to assess and optimize the fleet against evolving operational requirements, performance upgrade needs, and the number of MRAP variants. Sandia is using its **unique simulation and optimization tools and expertise to provide quantitative analyses that will be the foundation of the JPO strategic plan** for future MRAP acquisitions and divestitures. (6300) DS&A

Mine Resistant Ambush Protected Vehicle undergoing testing.

The Terminal Ballistics Technology Department at Sandia demonstrated penetrator case design improvements in a sled test at Holloman High Speed Test Track on July 17, 2009. The work was done in partnership with the AFRL-Munitions Directorate. **Design improvements focus on new component packaging in a jointed case design while surviving a wider range of hard-target impact conditions.** This joint DOE-DoD successful sled test follows a previous success demonstrated with the Sandia Mobile Davis Gun. A second sled test at Holloman is scheduled for spring of 2010. (5400, 2600) DS&A

DOE-DoD penetrator sled testing team.

Computer & information sciences

Ron Minnich and Don Rudish (both 8961) working on the Thunderbird machine. (Photo by Randy Wong)

Computer scientists at Sandia/California have for the first time successfully demonstrated the ability to run more than a million Linux kernels as virtual machines. **The achievement will allow cyber security researchers to more effectively observe behavior found in malicious botnets**, or networks of infected machines that can operate on the scale of a million nodes. Botnets are often difficult to analyze since they are geographically spread over the globe. Sandia scientists used virtual machine (VM) technology and the Thunderbird supercomputing cluster for the demonstration. Running a high volume of VMs on one supercomputer — at a similar scale as a botnet — would allow cyber researchers to watch how botnets work and explore ways to stop them in their tracks. (8900, 9300) NW

R&D Magazine chose the Catamount Lightweight Kernel multicore operating system as one of the top 100 most technologically significant new products of 2009. Catamount allows existing parallel computing applications to use systems containing multicore processors more effectively without any modifications to the application. **Catamount is able to deliver significant performance increases for several critical data-sharing operations for supercomputers such as Sandia's Red Storm machine.** Sandia pioneered lightweight operating systems technology for supercomputing, an approach that vendors such as Cray and IBM have followed. (1400) ST&E

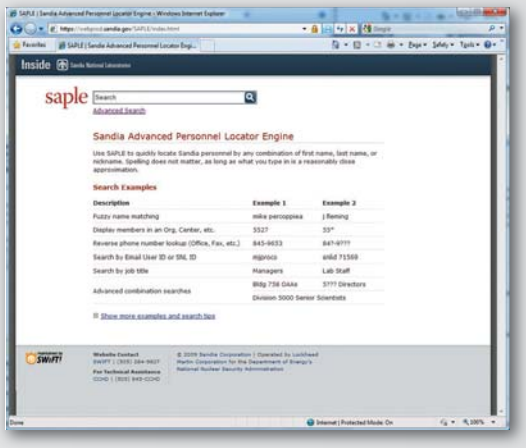
The SIERRA mechanics code has enhanced and consolidated its thermal/fluids and solid mechanics capabilities. The thermal/fluids module combines four codes and can solve general thermal and turbulent, chemically reacting, low-speed, non-Newtonian to hypersonic flows. The solid mechanics module is a combined explicit/implicit quasi-statics/dynamics capability with Lagrangian shock enhancements. SIERRA is **being used for NW simulations, e.g., coupled physics abnormal thermal and mechanical, hostile, and normal environments.** Sierra is also being applied to non-NW problems in homeland security, missile defense, Z-machine response, and aircraft vulnerability. (1500) NW

We applied a novel approach to modeling and simulation-based surety component analysis by extracting the vehicle model from a previously employed simulation and embedding it into an extensible, virtual 3-D simulation environment. The immersive simulation environment **provides a platform in which multiple instances of the vehicle model can be run simultaneously.** This, in addition to comparison against a closed-form analytical solution, facilitates estimation of model accuracy and calibration. Furthermore, we have provided a simulation telemetry extraction interface to allow for user-defined simulation instrumentation and communication to external surety simulation environments. (8900, 8100)

Vehicle extracted from earlier simulation and placed in new 3-D environment.

The Yucca Mountain project's colorful logo.

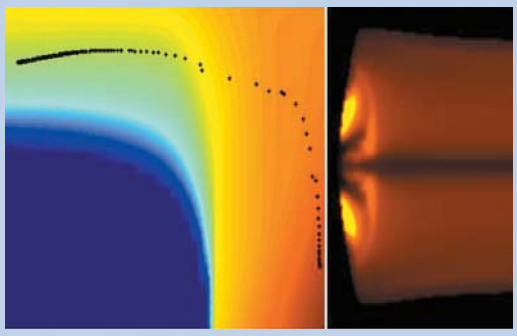
Yucca Mountain Project Information Technology (YMP IT) provided fast, effective SharePoint, Report Services, and SQL Server-based tools for mission critical activities such as: requests for additional information (RAIs), contentions, software configuration management, records & information discovery needs. Some of these tools were adopted by DOE. **YMP IT provided an IT infrastructure single point of contact for Sandia's Lead Lab role on the Yucca Mountain Project.** (9300, 9500) ER&N



Sandia Advanced Personnel Locator Engine (SAPLE).

SAPLE (Sandia Advanced Personnel Locator Engine) is the next-generation personnel directory search recently deployed into production lab-wide at Sandia. **Used more than 10,000 times daily, SAPLE helps staff find who they're looking for more efficiently.** SAPLE uses a set of "fuzzy" matching and phonetic algorithms, similar to the spell check feature in a word processor, so that close matches or misspellings will still return the correct results. SAPLE also allows natural language searches, wildcards, and combination searches including location, job title, and organization. (5500, 8900, 9500) IES

ALEGRA



Exploding wire validation progression of conductivities in temperature-density phase space and a snapshot of simulated temperatures in the wire. (Image courtesy ARL)

Recent enhancements to Sandia's ALEGRA magneto-hydrodynamics code have enabled physicists at the Army Research Laboratory (ARL) to explore dynamic events in detail extremely difficult to achieve experimentally. ALEGRA simulations of electromagnetic environments, with the help of advanced diagnostic visualization tools, have led to enhanced interpretation and understanding of previously confounding experimental results. ARL physicist Robert Doney says, **"Simulations are enabling and have been used for massive, multivariate parametric studies that simply cannot be performed experimentally."** Validation studies have led to improved confidence in accurate simulations. (1400, 1600)

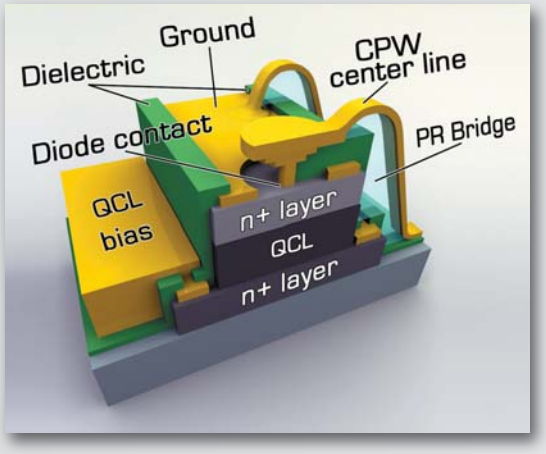
The NNSA has directed Sandia to dedicate the 38,400-processor machine called Red Storm to support national security modeling and simulation work in addition to the nuclear weapons mission. Customers are primarily in Defense Systems & Assessments (DSA). This new computing environment **will enable engineers and scientists across DOE to apply advanced computing solutions to impact national security.** (9300) IES, DS&A

Red Sky, Sandia's newest supercomputer, has made the Top 500 list as the 10th fastest computer in the world. The system was architected and built in partnership with Sun Microsystems and Intel to support institutional computing at Sandia and research at the National Renewable Energy Laboratory.

Red Sky, which has a peak performance of more than 500 teraflops (500 trillion mathematical operations per second), uses 1/6th the power per cycle of its predecessor and **saves more than five million gallons of water per year.** (9300, 1400, 6200) IES supported by all SMUs

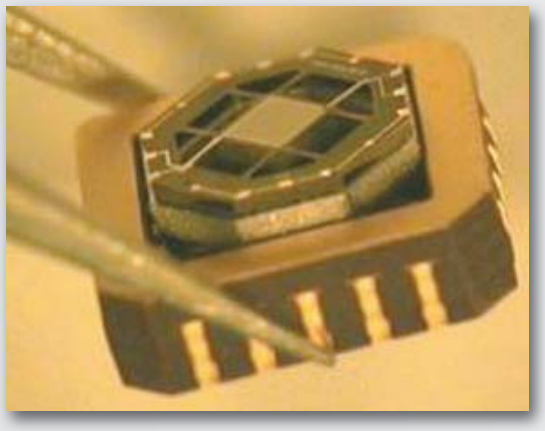
David Martinez (9324) walks through Red Sky, Sandia's newest high-performance computer. (Photo by Randy Montoya)

Microelectronics & microsystems



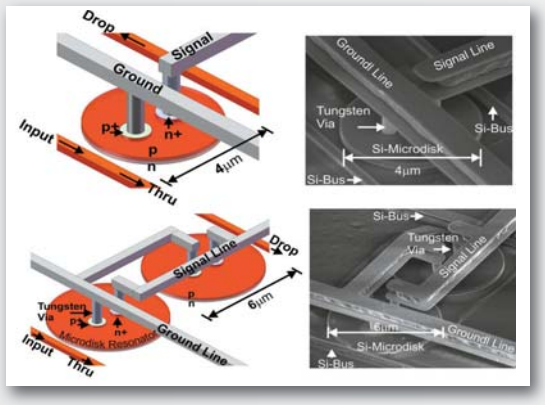
Monolithically integrated solid-state THz transceiver.

The "unconventional" terahertz (THz) frequency spectrum offers disruptive technology options for security, defense, and scientific missions. However, THz solid-state technology remains immature compared to lower-frequency electronics and visible-to-infrared photonics. We **demonstrated the world's first THz integrated circuit by monolithically integrating a semiconductor THz coherent source, a quantum cascade laser, and a diode receiver.** This circuit performs all functions of existing THz transceivers at a small fraction of the size and in a robust platform scalable to microfabrication production. (1100, 1700) ST&E



Chip-Scale Atomic Clock physics package containing Sandia optoelectronics.

Sandia successfully completed its DARPA Phase 4 contract under the Chip-Scale Atomic Clock Program to transfer its unique vertical cavity surface-emitting laser technology to a major commercial supplier to support future precision timing product deliveries. This Symmetricom, Draper Laboratory, and Sandia team achieved a 100-fold reduction of size and power needed to achieve atomic clock timing precision in a portable device. **Interest in high-precision timing in portable devices for the warfighter has increased with the emergence of broadband and secure communications, and precise location and navigation systems.** (1700) DS&A



Silicon modulators (above) and high-speed bandpass switches (below). Scanning electron micrographs courtesy of Alex Pimentel (1726).

A silicon microphotonic communications platform, developed and fabricated in MESA, has enabled the world's smallest and lowest-power high-speed silicon modulators and the first high-speed silicon bandpass switches. The modulators, 3.5 micrometers in diameter, can be driven to 10 Gigabytes per second and allow 100-fold reduction in power consumption compared to electrical communications and terabit per second communications across a single optical fiber. **These devices, recognized with a 2009 R&D 100 award, enable a communications platform for next-generation exascale supercomputers, terascale embedded processors, and focal plane arrays.** (1700, 5700) DS&A, ST&E

Engineering sciences

The first large-scale liquefied natural gas (LNG) fire test in the Phoenix series was successfully conducted. The resulting fire was 23 meters in diameter, the largest LNG fire test ever conducted on water. Data collected include surface emissive power, mass evaporation rate, and fire size. The tests were funded by DOE and the US Coast Guard, and **data will be used to provide the technical basis for regulatory agencies to set policy regarding hazard distances to LNG terminals.** (1500, 6300, 6200, 4100, KAFB – 58th, 277th) ER&N

LNG fire on water, 23-meter diameter. (Photo by Randy Montoya)

HR, finance & legal

The Human Resources organization successfully concluded labor negotiations with the OPEIU and MTC represented workforces. A strategic workforce planning process was established to include a "Strategic Sourcing" planning and decision-making process. The Executive Diversity Council was established and **a significant number of new diversity initiatives were implemented, resulting in a significant improvement in the Diversity Maturity Model Peer Review scores.** HR also integrated Full Spectrum Leadership into the performance management process. (3500) IES

Accounts Payable made significant strides in reducing costs and increasing efficiencies through automation. More than 8,200 cost transfer requests were processed with the new tool, saving staff ~500 processing hours, reducing approval time, and providing Labs-wide costs savings of ~$286,000. Electronic invoicing was expanded for all eligible suppliers. Since inception, Sandia has tripled the number of e-invoices received to more than 300 per month. The **system provides faster payments to suppliers while significantly reducing paper consumption, earning an Environmental Excellence Award in 2009.** (10500) IES

The budget group and the Work for Others (WFO) financial management team completed several deliverables with minimal impact and **improved the Labs' ability to accept WFO funding.** The team reduced Sandia's accounts receivable balance and improved the timeliness of collections. The balance decreased 85 percent from $143 million in September 2008 to $22 million as of October 2009. DOE's WFO Safeguards & Security refund directive was completed by crediting the 5,536 projects that incurred $9 million in burden costs. The team moved $5.3 million of existing WFO balances between different fund types so the line wouldn't have to establish dozens of new projects. (10500) IES

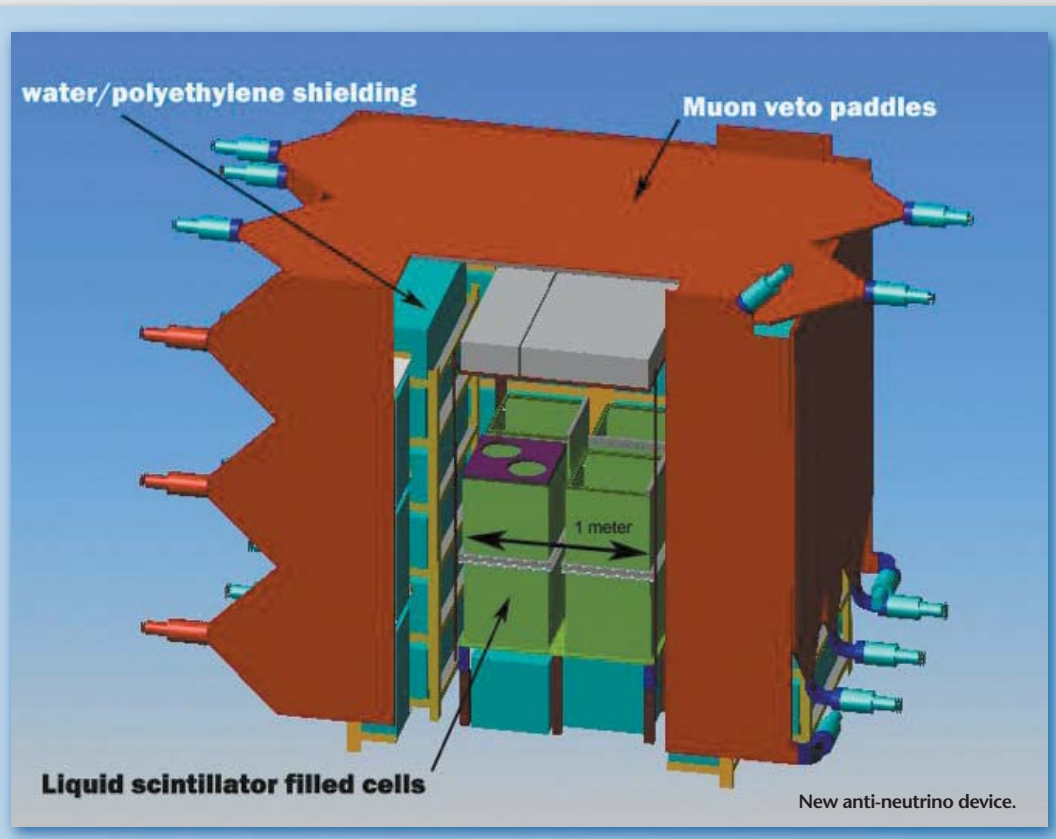
HBE encourages a healthy workplace culture where individual responsibility, informed consumerism, prevention and disease management result in better health outcomes and savings. HBE programs focus on health care cost containment strategies supported by the thoughtful application of evidence-based medicine — applying the scientific method to clinical practice. This year, HBE created a consumer-directed health plan, which rewards healthy behaviors, **hosted an on-site mobile mammogram unit to increase preventive screening rates, and implemented analytical reporting to identify opportunities specific to the risks of the Sandia population.** (3300) IES

HBE

A key to success of the Labs' Austerity Program is that each division worked this year to contribute, through savings, $25 million worth of efficiencies to help offset the contributions Sandia made to the pension plan. This effort required every Sandian to consider how they could contribute to these savings. Through our collective efforts to reduce space occupied and supplies used in the office; to stretch the life of equipment, reduce trips and travel expenses; and to absorb work of people who were not replaced, we enabled the Labs to proactively make early contributions to our pension plan. This not **only benefitted employees who will draw pensions, it reflected Sandia's commitment to work these issues within our operations and not have to increase costs to all of the Labs customers.** (All Organizations) All SMUs

In FY09 Sandia aligned business operations into one center. The objectives of this functional alignment were to implement cross-lab business efficiencies, to bring the business community together, and to address skills development. The result was labor efficiencies of 37 FTEs and $4.8 million. Through ongoing efforts **we continue to look at how to provide needed program support, support to a Labs clearing house for requirements, and other cross-lab process efficiencies.** Our joint efforts this year include testing of the money tool, ILMS consistency, austerity measures, division support and Maintenance of Center Capacity (MOCC) standards. (All Organizations) All SMUs

Global security



New anti-neutrino device.

Anti-neutrinos are fundamental particles whose detection is used to elucidate our fundamental understanding of physics. **A group at Sandia has used anti-neutrinos for a practical purpose: monitoring nuclear reactors.** This novel approach, which has faced much skepticism over the years, uses these fundamental particles to directly monitor the fission in a reactor core from outside containment. Sandia's demonstrations of this unobtrusive and incorruptible method's sensitivity to reactor operational power and plutonium production have been critical in gaining international acceptance. After nearly eight years of development, testing, and demonstrations, Sandia has succeeded in getting anti-neutrino monitoring of nuclear reactors into the International Atomic Energy Agency (IAEA)'s plans for the safeguarding of future facilities. (8100) DS&A

The Russian Nuclear Warhead Protection Team successfully designed and installed security upgrades at the Russian Federation 12th Main Directorate National Nuclear Warhead Stockpile sites, reducing the risk of nuclear warhead proliferation. These upgrades, part of the 2005 Bratislava Nuclear Security Initiative between former Presidents Bush and Putin, committed both countries to cooperatively secure Russian nuclear warhead sites. These **upgrades became integral to NNSA's mission to ensure that none of Russia's nuclear weapons or materials — poorly secured after the Soviet Union collapsed — fell out of government control.** (6700, 10600, 5900, 3300, 10200, 4000) ER&N

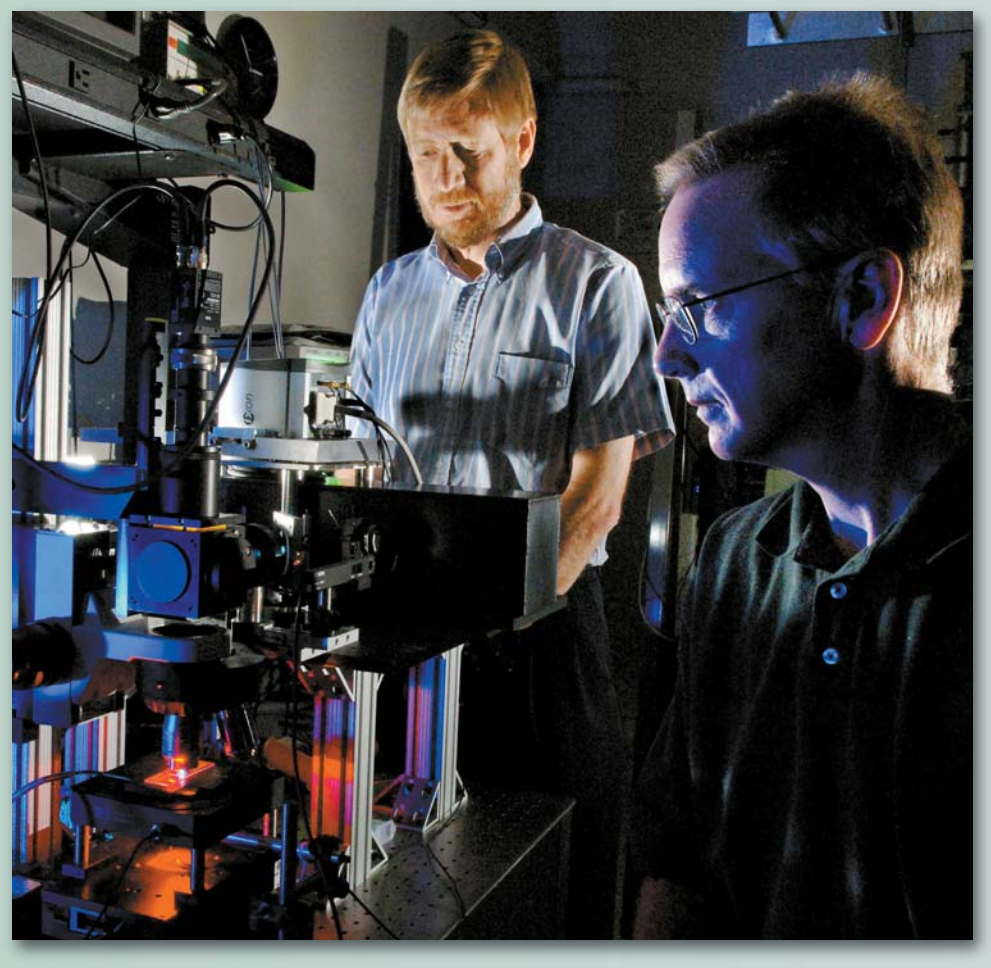
Sandia's Megaports Initiative team provided significant advancements to NNSA's Second Line of Defense program by developing a state-of-the-art wireless communications system network in Taiwan and providing key technical contributions to the Mobile Radiation Detection and Identification System prototyped in Oman. These technologies provide unique flexibility for deploying effective radiation detection systems for shipping containers in port environments while minimizing the impact on global commerce, where they play a **vital role in our nation's defense against nuclear terrorism and state-sponsored nuclear proliferation.** (6700) ER&N


The Megaports Initiatives Mobile Radiation Detection and Inspection System offers a versatile and flexible solution for radiation detection of shipping containers in a port environment.

Bioscience

Jerilyn Timlin (8622) received a **New Innovator Award from the National Institutes of Health for "Multiplexed measurements of protein dynamics and interactions at extreme resolutions."** The NIH New Innovator Award program supports new investigators with highly innovative research ideas at early stages of their careers. As one of only 55 award recipients nationwide, Jerilyn Timlin will receive $1.5 million over five years to develop state-of-the-art imaging technology that can measure protein complex formation and protein networks in a multiplexed fashion at high spatial resolution. (8600, 1800, 5500) HS&D, ER&N


Sandia chemist Jeri Timlin (8622), will use her National Institutes of Health (NIH) award to develop state-of-the-art imaging technology that can measure protein complex formation and protein networks. (Photo by Randy Wong)


Sandia researchers Michael Sinclair (1816), right, and David Haaland (8622) prepare the hyperspectral confocal microscope for measurement of a biological specimen. (Photo by Randy Wong)

A team of Sandia researchers won a 2009 R&D 100 award for development of a hyperspectral confocal fluorescence microscope that rapidly finds all emitting fluorescence species in an image and determines their relative concentrations without any a priori information. **The speed with which this information is acquired exceeds the acquisition time of other available hyperspectral imaging microscopes.** The microscope is especially useful for multiplexed 3-D imaging of live cells at diffraction-limited spatial resolutions. (8600, 1800, 5500) HS&D, ER&N, ST&E

Energy

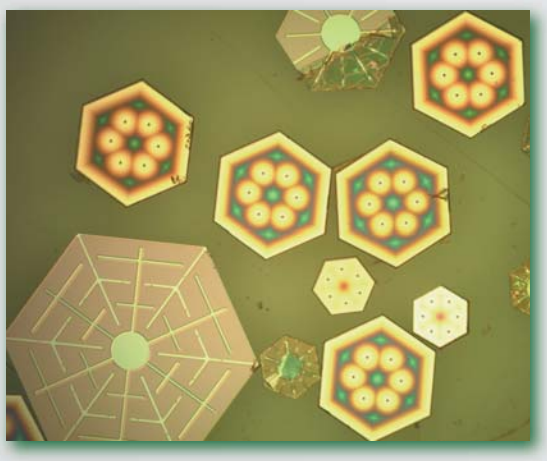
In May 2009, Sandia reopened the Sandia Pulsed Reactor Facility/Critical Experiments (SPRF/CX), a unique capability for experimenting with small nuclear reactors that allows the DOE Nuclear Criticality Safety Program to address key issues for nuclear materials management and nuclear power plant operations. Experiments currently underway at the SPRF/CX could lead to **more efficient operation of the nation's nuclear power reactors, potentially saving the industry — and ratepayers — billions of dollars.** Other experiments designed to improve the efficiency of DOE Environmental Management operations are under consideration. (1300, 4100) ST&E

Rick Gomez and Autumn Higgins (both 1381) examine practice fuel rods at the SPRF/CX reactor.
(Photo by Randy Montoya)

The photovoltaic (PV) installation on the roof of DOE's headquarters building in Washington, D.C., is now serving double duty: **providing energy to the building complex and collecting valuable data about solar radiation, weather, and system performance.** The 205-kilowatt installation at the Forrestal Building, comprising five systems representing four different PV technologies, now includes a solar radiation and weather monitoring system. This system was installed by Sandia to gather solar radiation, weather, and system performance data. Sandia will use the data to validate its PV performance model. (6300) ER&N

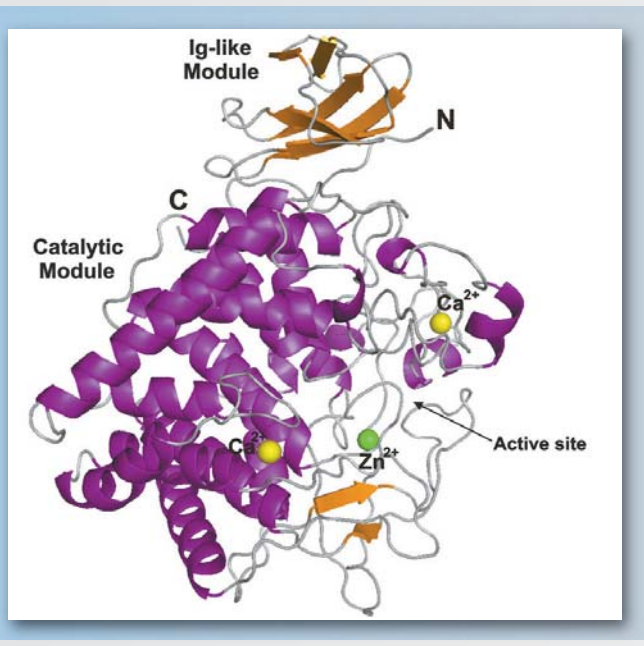
The new solar radiation and weather monitoring station on DOE's Forrestal Building will provide valuable feedback for solar program researchers.
(Photo by Randy Montoya)

Imagine electricity from the sun that is cheaper than fossil fuel power and packaged in panels as small as a pencil eraser or as big as a football field. The Microsystem-enabled photovoltaics project (MEPV) uses technology from Microsystems to produce thin film-like cells in



Inexpensive and highly efficient microsystem enabled photovoltaics.

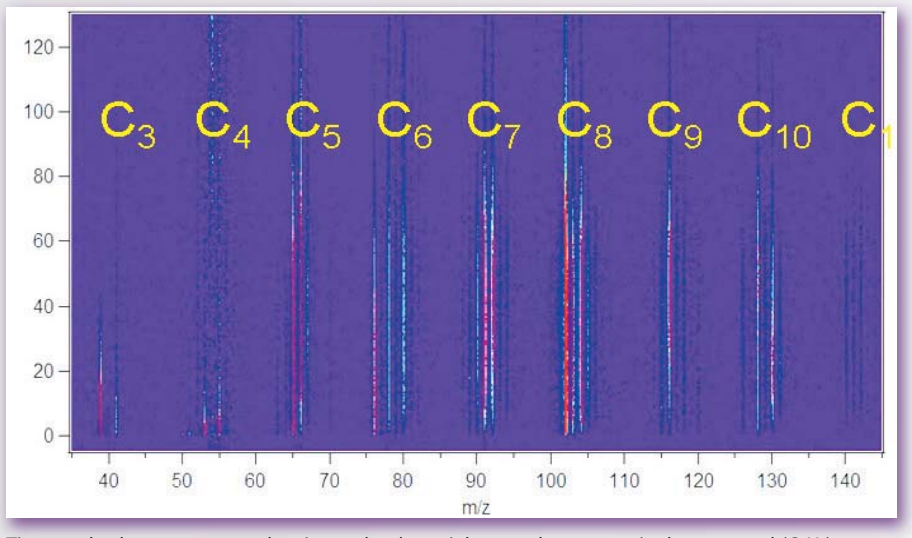
reliable and durable materials. Our group has demonstrated 15 percent silicon-efficient cells that are only 14µm thick and the first all-back-contacted GaAs solar cells. With sub-millimeter lateral dimensions, these cells could be used as an inexpensive "ink" that generates electricity. (6300) ER&N



Roughly 40 percent of the total cost of processing biomass into biofuel is due to converting the biomass into simple sugars that can then be fermented. Sandians working at the Joint BioEnergy Institute (Emeryville, CA) have isolated and developed novel cellulase enzymes that can tolerate high temperatures (> 70 C) and the presence of ionic liquids. These enzymes can more efficiently hydrolyze the polysaccharides found within lignocellulosic biomass into simple sugars than commercially available enzymes at these processing conditions, and **may enable more efficient and cost-effective production of advanced biofuels.** (8600, 1700) ER&N

High-resolution crystal structure of a thermostable cellulase isolated from *Alicyclobacillus acidocaldarius*.

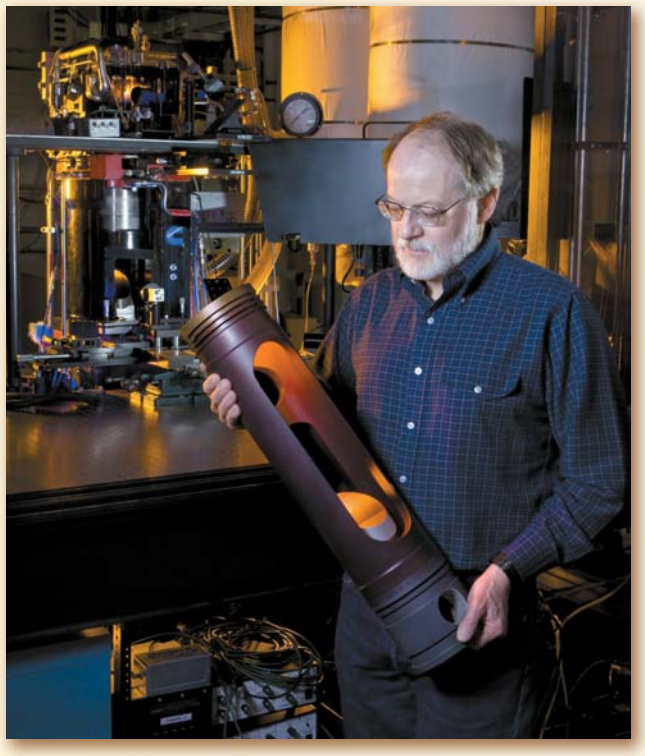
The Sandia multiplexed photoionization mass spectrometry reactor, operating at the Advanced Light Source at Lawrence Berkeley National Laboratory, exploits the powerful technique of tunable synchrotron photoionization to probe isomer-specific kinetics of combustion-relevant reactions. Researchers David Osborn and Craig Taatjes (8353) led groundbreaking studies probing the fundamental kinetics of sequential acetylene (C_2H_2) addition to propargyl (C_3H_3), one of the most important precursors to aromatic formation and soot production. They determined the isomeric composition of the C_5H_5, C_7H_7, and C_9H_8 products as a function of temperature up to 1000 K, proving that the resonance-stabilized isomers cyclopentadienyl, benzyl, and indene are the major products. Formation of the C_9H_8 isomer indene, a bicyclic species with five-carbon and six-carbon rings, is **an important step toward nonplanar polycyclic aromatic species and fullerene-like structures.** (8300) ER&N



Time-resolved mass spectrum showing molecular weight growth processes in the propargyl (C_3H_3) + acetylene (C_2H_2) system.

The DOE Office of Basic Energy Science awarded a joint team from Sandia and the University of Texas, Austin (UT) one of 46 Energy Frontier Research Centers and a $15.5 million grant for a five-year research project. The objective of the Sandia-UT Center for Frontiers of Subsurface Energy Security (CFSES) is to **understand the behavior of multiphase subsurface systems that are highly heterogeneous,** chemically and physically, from the subpore to the basin scale, which will improve predicting the behavior of these systems over long-term scales. (6700, 1500) ER&N

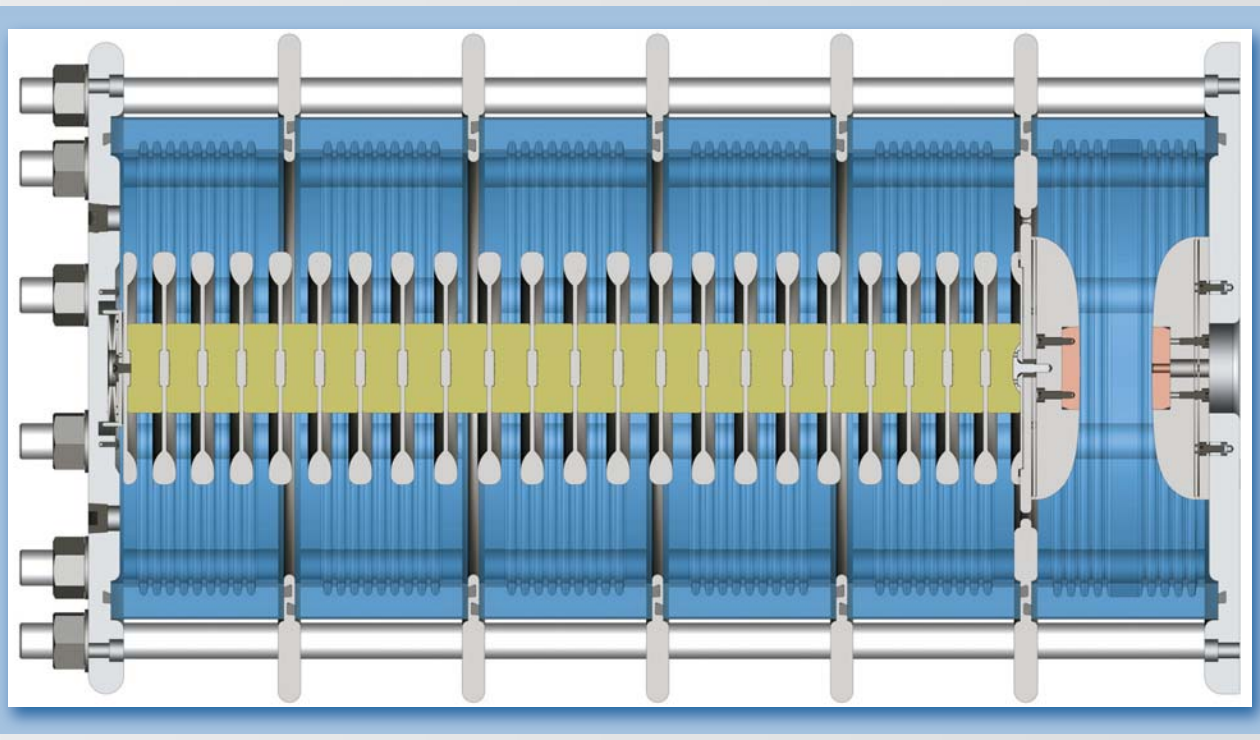
Using intake-pressure boosting, Sandia researchers achieved engine loads a factor of two higher than previously achieved for a homogeneous-charge compression-ignition (HCCI) engine fueled with conventional gasoline. This established a new high-load milestone. Intake boosting is well known as a method for increasing the power output of internal combustion engines. However, its application to HCCI with conventional liquid fuels (gasoline or diesel) has been limited because boost enhances autoignition of the fuel causing the combustion timing to become overly advanced. To overcome this problem, **the Sandia team used exhaust gas recirculation (EGR) to slow autoignition, combined with substantial combustion timing delay to allow high loads without knock.** This work shows that well-controlled, boosted HCCI has a strong potential for achieving power output levels and efficiencies comparable with those of turbocharged diesel engines, but with near-zero pollutant emissions. (8300) ER&N



Sandia engine research team member John Dec (8362) holds a specialized optical piston used in engine research.
(Photo by Randy Wong)

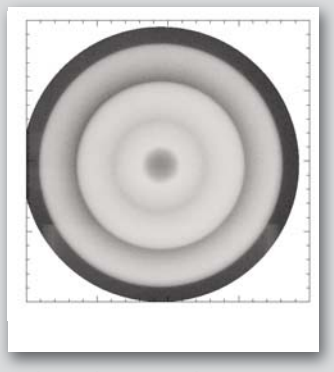
Pulsed power

We have developed **the first six-megavolt switch for advanced superpower accelerators, thereby solving a 25-year-old problem in the international pulsed-power community.** Each switch transports two terawatts, 600 kilojoules, and 0.2 coulombs, can be triggered with 20-nanosecond precision, and has a lifetime of more than 100 shots. (The total installed electrical-power generating capacity worldwide is 4 terawatts.) Thirty-six such switches deliver all of the power and energy produced by the 80-terawatt Z machine, which is the world's most powerful pulsed-power accelerator. (1600) NW, ST&E



First six-megavolt switch for advanced superpower accelerators.

The self-magnetic-pinch electron beam diode is being developed as a high brightness flash X-ray source, **suitable for core-punch radiography in support of the nuclear weapons science-based stockpile stewardship program.** When fielded on the Radiographic Integrated Test Stand (RITS-6) accelerator, the diode can produce short-pulse (45 ns), high-resolution radiographs of dense objects with areal mass in excess of 180 g/cm². A test object made of concentric spherical shells of tungsten and copper was radiographed and analysis performed to determine the density of the materials. The density of the tungsten was verified to within 0.3 percent. (1600) NW

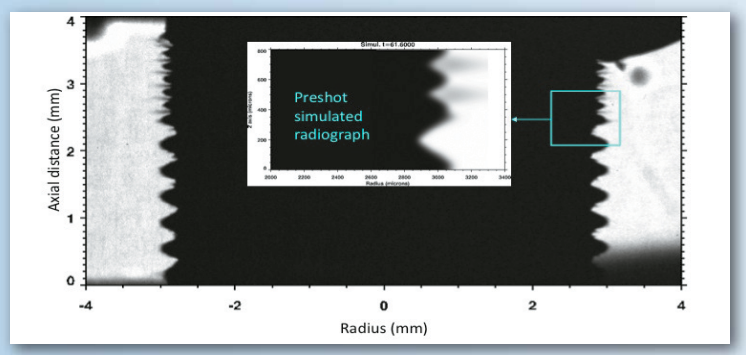


Radiograph of a test object consisting of concentric spherical shells of air, tungsten, and copper (going from inside out).

A new load geometry on Z has successfully launched centimeter-sized flat plates to record velocities of ~46 km/s (over 100,000 mph), thereby **allowing highly accurate dynamic material property data in a pressure range previously unobtainable with such precision.** The experiments conducted to demonstrate

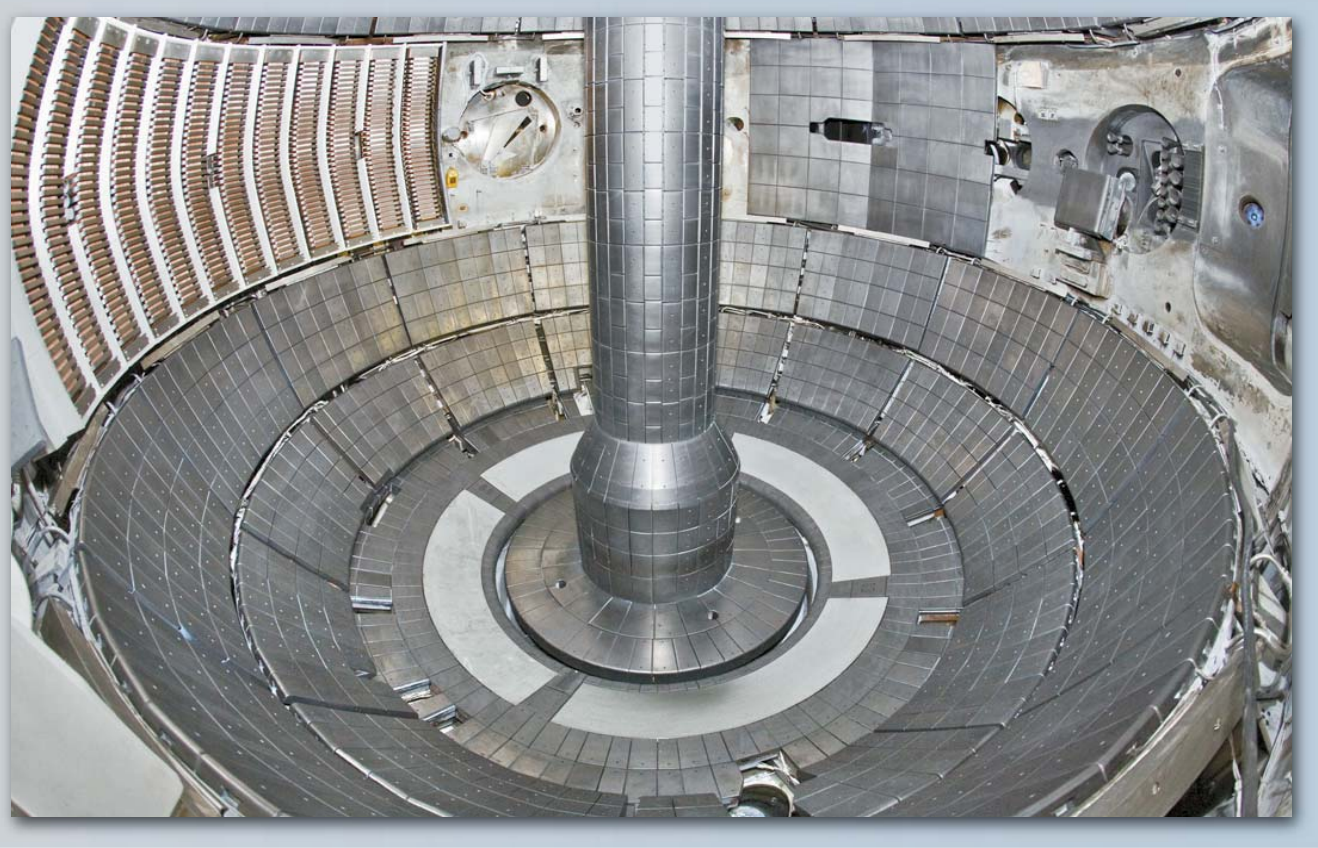
the launch capability provided equation-of-state data for quartz and sapphire to impact pressures of 15.7 and 20.7 million atmospheres, respectively. The results also enable improvements in our magnetohydrodynamic modeling, which will allow further optimization and potentially higher impact pressures. (1600) NW, ST&E

The Magneto-Rayleigh-Taylor instability of imploding cylindrical liner z-pinches has been measured for the first time on the Z facility. Growth of perturbations with five percent initial amplitude was measured with multi-frame X-ray backlighting using the Z-Beamlet laser. Simulations of the perturbation growth agree very well with the measurements. These experiments are **the first step in the systematic evaluation of a new concept for achieving thermonuclear fusion in cylindrical implosions.** Code validation allows predictive models of liner integrity, a critical requirement for the concept. (1600) NW, ST&E



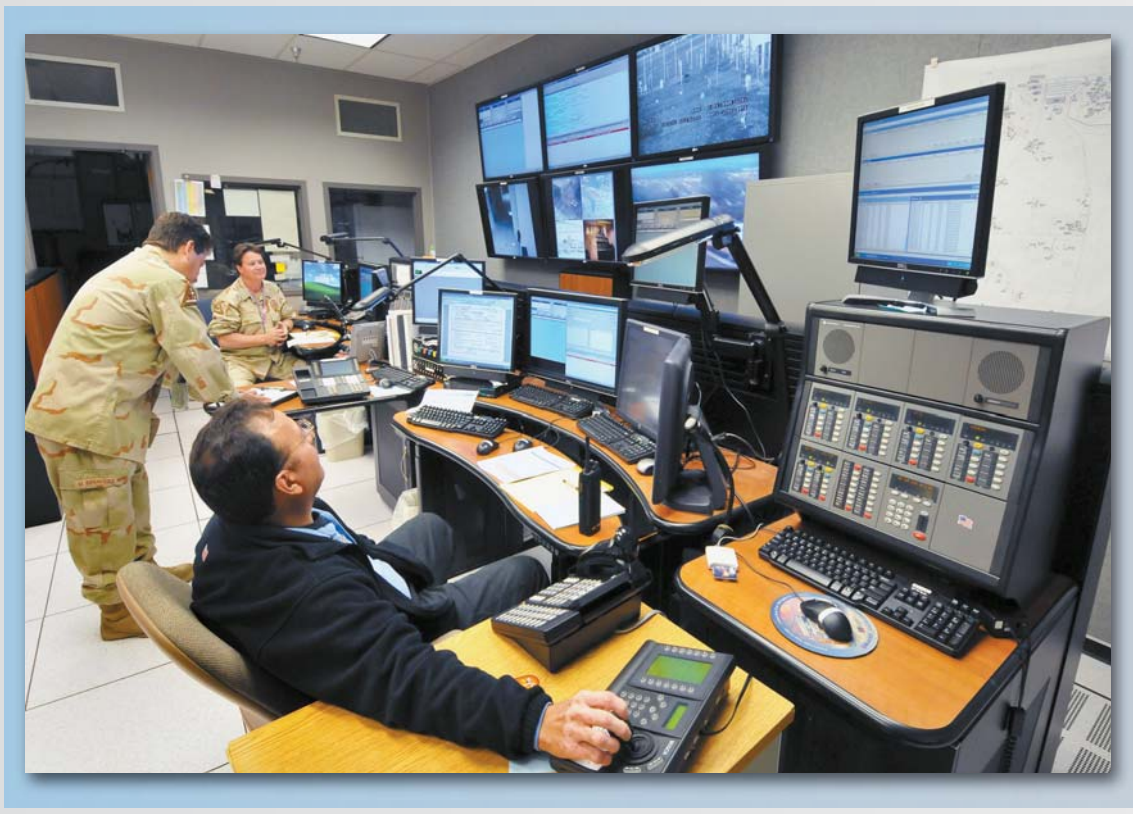
One of eight X-ray radiographs of the evolution of the outer edge of an imploding cylindrical z-pinch. The inner edge is not visible. Perturbations have grown by a factor of ~15 from 0.002 cm in initial amplitude to ~0.03 cm.

The Sandia/California Machine Shop (8236-2) successfully fabricated a Liquid Lithium Diverter (LLD) for the National Spherical Tokamak Experiment "Reactor." The LLD has four toroidal panels, each consisting of a copper plate clad with stainless steel and a surface layer of flame-sprayed porous molybdenum that will host lithium deposited from an evaporator. **Several other shops were asked to fabricate the same hardware, however due to the complexity they declined to proceed.** Open communication and collaboration with the customer, Princeton Plasma Physics Laboratory, was key to success of the project. (8200) ST&E



Interior of the National Spherical Tokamak Experimental Reactor.

ES&H & security



The Security System Replacement Program (SSRP) — **a project to modernize Sandia's electronic security system infrastructure, auxiliary power system, hardware, software, and Security Command Center** — is in full swing. There were several major accomplishments in FY09. The Diamond I security system was successfully upgraded to the new Diamond II system, thus eliminating Diamond I. The Security Command Center was fully renovated, and the auxiliary power systems have been installed. The program is now four months ahead of schedule and approximately $2 million under projected project cost. (4200) NW

The newly renovated Security Command Center. (Photo by Randy Montoya)

Sandia/New Mexico successfully completed the Emergency Management Inspection, conducted in January and February 2009 by the Office of Emergency Management Oversight (HS-63). The inspection report stated that "This 2009 inspection found that, overall, SSO and SNL are progressing in their efforts to implement a comprehensive emergency management program…" The **report identified strengths in the Sandia training, drill, and exercise program; SSO and Sandia emergency management program plans and procedures; and comprehensive mechanisms for improving the site's emergency management program.** (4100, 4200, 3300, 3600, SSO) IES

In June 2009, Sandia/New Mexico's Environmental Management System (EMS) received International Organization for Standards (ISO) 14001 certification. EMS is the way Sandia identifies, manages, and mitigates its impact to the environment. It is rare that a site as complex as Sandia achieves ISO 14001 certification. The auditors noted that Sandia/New Mexico was the most diverse and complex organization they have certified. ISO 14001 **certification benefits Sandia because it streamlines and clarifies the approach to compliance, promotes environmental stewardship, and strengthens the assurance system.** (4100) IES

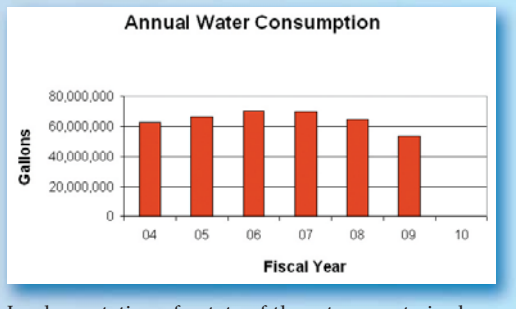
The Environmental Restoration Project successfully completed the construction of an alternative evapotranspirative cover at the Mixed Waste Landfill. **Extensive technical investigations proved that the landfill will not represent an unacceptable risk to the environment.** The protective cover comprises four engineered layers, including three layers of compacted soil and a biointrusion rock barrier. These layers and the native plants will control water infiltration, thus isolating the wastes from the biosphere. The construction of the cover was completed on schedule, on budget, and without any safety incidents. (6700) ER&N

Environmental managers Mike Mitchell (6765) and Don Schofield (4133) on the evapotranspirative cover of the Mixed Waste Landfill. (Photo by Randy Montoya)

Encouraging safe driving on site with signs and radar guns.

Independent Audit and Advisory Services Center 12800 completed a study of practices commonly found in Sandia organizations successfully implementing ES&H requirements. **During a time when ES&H requirements may seem overwhelming, the study offers adoptable practices for less stressful implementation of the requirements.** The three main practices are strong ES&H leadership at the center and department levels, having embedded ES&H professionals in organizations, and application of quality methods such as Lean Six Sigma. Specific examples of the practices may be found in the study report. (12800, 1600, 4800) IES

Water use by fiscal year at Sandia/California



Implementation of a state-of-the-art computerized irrigation system has changed Sandia/California's landscape watering practices. The new system has resulted in a **program that maintains the site's landscaping while implementing cost savings and reducing water usage.** SNL/California realized a 5.1 million gallon (7.4 percent) decrease in FY08 water usage from FY07. The water use reduction resulted in a $16,000 savings. (8500) IES

Governance, leadership, & management

The Corporate Contracts & WFO/CRADA Management group successfully negotiated the contractual requirements for the American Recovery and Reinvestment Act (ARRA) of 2009, which were incorporated into Sandia's Prime Contract. A significant effort was undertaken to make sure Sandia has an established process to mitigate Organizational Conflict of Interest (OCI) concerns. This effort has **enabled Sandia to accept DOE ARRA Work Authorizations and will allow Sandia to perform Work for Others funded by ARRA.** This group provides ongoing support to support this effort. (10010, 10600, 6700, 10500, 10200, 11100) IES

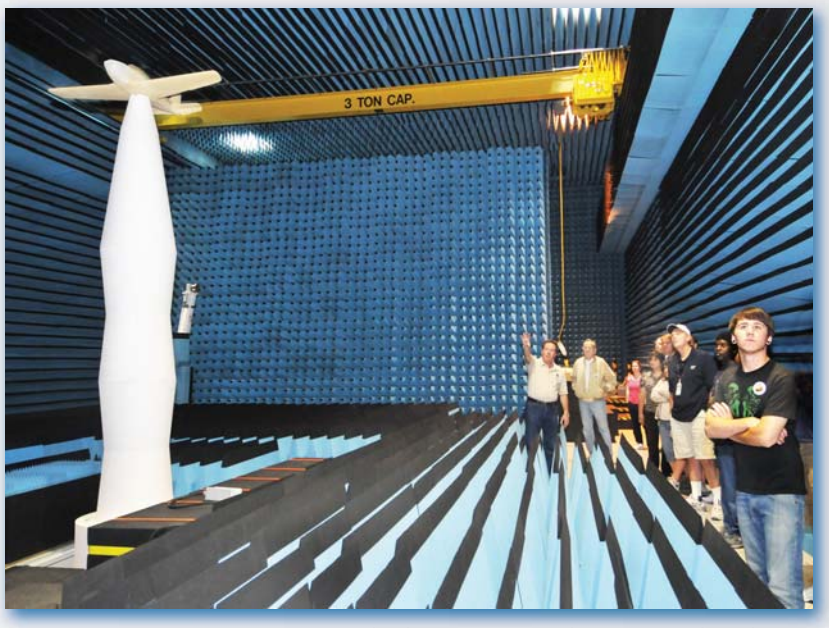
Sandia received ISO 9001 certification by the British Standards Institute (BSI-Americas). The scope includes mission activities (nuclear weapons program management, design, fabrication, and production of unique equipment, weapon components, neutron generators, and ASICS) and policy areas (facilities, human resources, information management, corporate governance, supply chain management, integrated safeguards and security). **Certification provides assurance to Sandia and its customers that our management system, ILMS, is effective** and allows us to focus on continuous improvement in mission results by building on a solid base. (Multiple organizations) All SMUs

We defined for the first time a single set of overarching processes and procedures (Mission Execution Policy Area) to execute the Labs' mission using industry standards and best practices. This effort was **designed to drive consistency across the SMG/SMUs, while enabling programs and projects to deliver on customer commitments.** The Mission Execution Policy Area partnered with the other policy areas to create the Clearing House Requirements Management Process as an initial effort to better integrate between all policy areas, and reduce overall Lab complexity. (All Divisions, EO) All SMG/SMUs

Supporting the corporation's efforts to reduce complexity, the Institutional Development Center led a value stream analysis to increase the effectiveness of the Labs' performance measurement and reporting process. **The goal: a greatly simplified approach to performance measurement.** The outcome: consolidation of the Performance Evaluation Plans (PEP) and Objectives, Goals, and Milestones (OGM) processes, resulting in a significantly more efficient process, a concise, deliberate set of objectives (reduction from 21 to 11), and elimination of duplicate work — a solid first step to one process, one language, one data call and one tool. (12100) Various SMG/SMUs

NNSA acknowledged Sandia's Parent Company Contribution (PCC) process, reporting that "Sandia's efforts that focus on formalizing and institutionalizing the Parent Contributions and Sandia Reachback process by involving Lockheed Martin Corporation expertise in governance processes, proactive communication with SSO, support of Sandia executive management, and inclusion of the Governance Committee [of the Sandia Board of Directors] are considered exemplary." **The PCC process is one element of Sandia's Contractor Assurance system, which demonstrates management and operational excellence.** (12200)

Community involvement, customer relations, institutional development



Kurt Sorensen, manager of SAR Sensor Technologies (5345), conducts a tour of the radar cross-section facility. (Photo by Randy Montoya)

On Wednesday, Sept. 16, 2009, Sandia marked its 60th anniversary at the Capitol Visitor Center in Washington, D.C., by hosting a technical exposition commemorating "60 Years of Exceptional Service." During the two-hour event, **members of congress, industry leaders, federal agency representatives, and business partners were informed about the Labs and the vital work it performs in the interest of the nation.** Speakers included DOE Deputy Secretary Daniel Poneman, AT&T Executive Vice President James Cicconi, US Senators Jeff Bingaman, Tom Udall, and Byron Dorgan, and US Representatives Martin Heinrich and Jerry McNerney. (12100, 3600) All SMG/SMUs

During the Washington-based 60th Anniversary activities, AT&T Executive VP James Cicconi presented Labs Director Tom Hunter with a copy of the original 1949 President Truman letter calling for establishment of Sandia. (Photo by Lloyd Wilson)

On Saturday, May 16, 2009, **Sandia opened its doors, welcoming visitors to the first Family Day in a decade.** Sandia's Family Day was attended by 12,523 people, including Sandia employees and their family members and friends who were able to participate in tours, exhibitions, presentations, and demonstrations. Attendees reported the solar tower, Z machine, robotics vehicle range, and JCEL visualization as some of the day's highlights. An indication of the Family Day planners' dedication to the Labs-wide austerity initiative, Family Day was conducted under budget. (All organizations) All SMG/SMUs

Attracting more than 450 attendees from 40 countries, **Sandia was host to the 27th International Conference of the System Dynamics Society.** In between Athens 2008 and Seoul 2010, Albuquerque welcomed academics, students, and practitioners for a six-day event in Old Town Albuquerque. A special feature of the conference was the first-ever inclusion of the K-12 system dynamics education community and presentations by middle and high school students. Sessions ranged from business strategy to international conflict. (6700, 6300, 1400, 3600) ER&N, HS&D

The National Security Technologies and Systems display area in Bldg. 810/C109 showcases classified and unclassified components, systems, videos, and demonstrations that depict the wide range of Sandia's support for US national security. It is available for tours by external customers or for Sandia organizations that may wish to know more about the true breadth of the Laboratories' overall mission space. Since being set up in the winter of 2001, the **display area has hosted more than 1,100 tours totaling over 8,500 visitors.** (4, 5200, 10600) DS&A, ER&N, HS&D

Sandia realized a long-standing goal in its enduring partnership with a nonprofit organization, the National Atomic Museum Foundation, as the two teamed to complete construction and begin operation of a new National Museum of Nuclear Science & History (http://www.nuclearmuseum.org) on a 12-acre parcel of Labs'-controlled land about a mile northeast of Sandia's main complex. This state-of-the-art, 30,000-square-foot, $10.5 million **facility houses new and historical materials and exhibits, and features new educational and community outreach spaces for use by the public.** (3600, 4100, 4800, 10200, 11000) IES

(Photo by Randy Montoya)

Sandia and Lockheed Martin give to local communities where the Labs operates, and in 2009 we again showed how much we care. The Employee Caring Program (ECP) raised more than $4 million for the United Way of Central New Mexico with more than 77 percent of our employees participating. **That level of participation had not been achieved since 1994.** Our retirees gave more than $500,000, showing that the spirit of giving never ends. The Shoes for Kids Program, supported by Sandians' donations, received $14,000 to help local school children in 2009. Lockheed Martin contributed more than $1.4 million to nonprofit organizations, demonstrating a commitment to the vibrancy of the community. In a difficult economic year, the Labs and its civic-minded employees and retirees rose to the needs of the community. (All centers) IES

Ethics & business conduct

In partnership with the *Sandia Lab News*, the Ethics and Business Conduct Center launched a new series titled "Ethics in Action," based on actual Sandia ethics and corporate investigation cases. Research shows that Sandians want to know what types of cases are investigated and how Sandia handles unethical conduct. This series highlights factual background information, states the facts, and details the resolution including any discipline. In Sandia's learning culture, **this teaching tool helps members of the workforce understand ethical dilemmas, outcomes, and related Sandia policies.** (12400, 3600) All SMG/SMUs

Research scientist Chris Petzold (4827), and postdoc researcher Alyssa Redding check the spray tip on the mass spectrometer at DOE's Joint BioEnergy Institute (JBEI).
(Photo by Dino Vournas)