



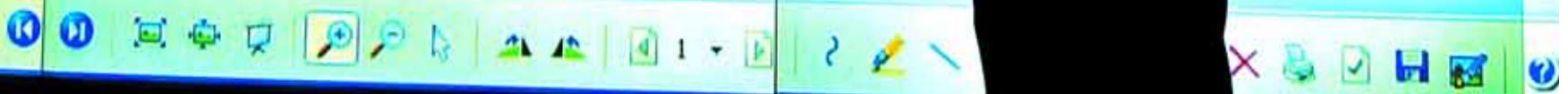
LABS ACCOMPLISHMENTS

Sandia National Laboratories

2004

Image of a Sandia computer model/analysis of foam impacting the leading edge of a space shuttle wing. The analysis helped NASA in its study of the 2003 Space Shuttle *Columbia* accident. See page 16.

(Photo by Randy Montoya)





NUCLEAR WEAPONS

To all Sandians:

At the end of each year, as I read the significant accomplishments our staff have submitted, I can actually begin to get a glimpse of what the future Sandia National Laboratories will look like. You can almost visualize how these technical achievements and process improvements can be stacked up — brick by brick — in order to build the laboratory of the future.

This 2004 report contains a large list of achievements, notable for their significance and their great diversity — from the creation of significant thermonuclear fusion reactions in the laboratory by heating and compressing small plastic pellets filled with deuterium to temperatures and pressures higher than in the sun, to the



C. PAUL ROBINSON

delivery of 10 hand-held explosives sensing devices (the "MicroHound") to a government customer. The list stretches from "break-throughs at the frontiers of science" to "everyday" improvements in the quality of the processes we use to carry out research and development across the laboratories.

Two themes should be easily recognized.

First, the emphasis placed by Sandians on continuous improvements of the quality of our processes and products is achieving major results. Sometimes the words "faster, cheaper, better" seem to be over-promises. ("Pick any two out of three" might be more realistic.) Yet, I urge you to focus on the many times when we are now making significant improvements in all three at once.

Second, the emphasis and the investments we have made in supercomputers and modeling and simulation are becoming a common route to extraordinary improvements across the board. From evaluating the performance of weapon hardware before we actually build the first one, to the evaluation of causes for the failure of the Shuttle *Columbia*, the detailed physics and engineering analyses played an irreplaceable role.

I invite you to review the many contributions that made our year such a notable one.

C. Paul Robinson
President and Laboratories Director

A GRAND OPENING — Sandia and NNSA dignitaries, joined by members of the New Mexico congressional delegation, broke ground last August on the ambitious MESA project. Pictured are, from left, Sandia Senior VP Tom Hunter, NNSA Administrator Linton Brooks, Rep. Heather Wilson, R-N.M., Sen. Jeff Bingaman, D-N.M., Sen. Pete Domenici, R-N.M., Sandia President C. Paul Robinson, and Sandia VP Al Romig. (Photo By Randy Montoya)

A major milestone was achieved on the **Microsystems and Engineering Sciences Applications (MESA)** project in FY03 with approval last May of Critical Decision 3, the formal authorization to begin construction. **Construction contracts were awarded** and construction is underway on both the Microsystems Fabrication Facility (MicroFab) and Microsystems Laboratory (MicroLab). A ground-breaking ceremony attended by our congressional delegation and NNSA Administrator Linton Brooks was held in August 2003 to celebrate this major event. (1700, 1900, 2300, 9100, 10200, 10500, 10800)

The Robust Nuclear Earth Penetrator Phase 6.2 is the **first competitive weapon feasibility study** to be initiated by NNSA and the military in more than 10 years. Two teams (from 2100 and 8200) have been formed to develop penetrator case and payload support designs for B61 and B83 warheads, respectively. Accomplishments in FY03 include preparation for a 2004 full-scale, proof-of-concept test, fabrication of the 5,000-lb penetrator needed for this test, and development of initial surety concepts and approaches to ruggedize the arming, fuzing, and firing set. (2100, 8200)

A new photonic proximity fuze sensor is being developed under the DoD/DOE Munitions MOU that **combines vertical-cavity surface-emitting lasers (VCSELs), resonant-cavity photodetectors, and micro-optics**, and yields high single-mode optical power with microwave bandwidth. The team used flip-chip bonding of AlGaAs VCSEL epitaxial material to aluminum-nitride heat sinks to obtain output powers above 20 mW/50 mW (continuous/pulsed) in a low-divergence beam without external collimating lenses. This lays the foundation for a fully integrated, miniature, high-power, electrically pumped laser for DoD/DOE/Army fuzing applications. (1700, 15300, 15400)

An **Automated Current Stack Tabbing System (ACTS)** is being developed by the Intelligent Systems and Robotics Center for the Ceramic and Glass Dept. 14192 to **automate production War Reserve gluing operations**. Dept. 14192 currently performs manual gluing operations by placing small tabs onto current stack components. To reduce part-gluing and clean-up times, the automated gluing station precisely applies conductive epoxy to the tab and current stack parts with a three-degree-of-freedom robotic manipulator. ACTS will replace human operators during FY04 once the WR qualification process is completed. (14100, 15200)

The Accelerated Strategic Computing milestone

for hostile environment electrical simulation was completed. **Revolutionary new capabilities** to model the response of nuclear weapon electrical components in hostile X-ray radiation were demonstrated. This effort (which was also a corporate milestone) showcased the capability to transport radiation through a 3-D computer-aided design model of a reentry body to determine dose rate in electronics, as well as the ability to simulate the performance of an extremely complex application-specific integrated circuit. (15300, 1700, 9200, 8200)

The Advanced Radiographic Technologies program has **successfully developed and is deploying a twin-axis flash X-ray radiographic probe** underground at the Nevada Test Site for the Armando Sub-Critical experiment. This state-of-the-art system will

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A Note to Readers

Early in each calendar year the *Lab News* highlights Sandia National Laboratories' principal achievements during the previous fiscal year. Submissions are selected by the VPs' offices. Numbers in parentheses at the end of each entry represent the Sandia center (or centers) in which most of the work on a particular accomplishment was done. The work is presented here by category. We've found over time that this organizational approach is helpful, but it is important to recognize that such categorization, particularly in a multiprogram, multidisciplinary laboratory such as Sandia, is to some extent arbitrary. Much of the work listed in the category "Nuclear Weapons," for example, could very appropriately have been listed under "Computing," "Engineering Science," or any one of a number of other categories. And the converse is certainly true. Indeed, much of the work done across all the Labs' technical divisions supports Sandia's fundamental mission-related nuclear weapons work.

For information about how to contact the researchers involved in the work mentioned here, contact *Lab News* staff member Bill Murphy at wtmurph@sandia.gov.

Sandia LabNews



<http://www.sandia.gov/LabNews>

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Sandia National Laboratories

Sandia National Laboratories is a multiprogram laboratory operated by Sandia Corporation, a subsidiary of Lockheed Martin Corporation and a prime contractor to the US Department of Energy.

HOMELAND SECURITY

The **Homeland Security Display Room** showcases national security technologies in the context of homeland defense. **Last year we conducted 118 tours**, running the gamut from senior government officials to Sandia new-hires. Program managers use the room to show customers the full range of Sandia capabilities. The room is unique because it displays the technologies in a thematic and understandable manner that incorporates not only actual hardware, but also the concept of operations and the systems context for the operations. (0080, 5900)

Two Operation America events were conducted this past year in Hawaii and Georgia to train bomb technicians. These events are designed, equipped, and staffed by Sandia personnel. They continue to draw accolades from senior officials representing the host states and government organizations. The event in Hawaii — targeting primarily military personnel — was lauded by the sponsoring admiral for its impact on his staff. The director of the Georgia Public Safety Training Center expressed his gratitude in a letter to DOE Secretary Abraham.

The RoboHound, an engineering prototype, combines a sample collector, preconcentrator, and robotic vehicle to enable remote interrogation of suspicious items for explosives. After sample collection, the operator uses a commercial chemical detector to check for explosives. The Mobile Robotics Department worked closely with the Entry Control and Contraband Detection Department to **integrate existing explosive detectors into mobile robotic platforms to provide explosives sampling of small packages**. TNT and C4 were successfully collected from a wooden crate, briefcase, 20-gallon drum, and a vehicle hatch. (15200, 4100)



ROBOHOUND interrogates a briefcase contaminated with explosives during an experimental test.

DOE must control more than 60,000 radioactive sources. The post-9/11 environment makes this job more challenging than

ever. Center 6800 has developed a **Radiological Source Registry and Tracking (RSRT) system** to ensure that DOE has the tools to do this job. The RSRT system provides a secure, online database that consolidates information on the characteristics, location, and ownership of DOE materials. The next phase will embed decision tools, so users



NEW MEXICO Governor and former DOE Secretary Bill Richardson, center, was one of many individuals who toured Sandia's Homeland Security Display Room last year. The display features many of the technologies Sandia has developed to help the country address the threats of terrorism and proliferation. Pictured here are, from left, N.M. Secretary of Economic Development Rick Homans, Gil Baca (Sandia), Albuquerque Fire Dept. Deputy Chief Bobby Halton, T.J. Allard (Sandia), Gov. Richardson, APD Sgt. Mike Heister, Labs President C. Paul Robinson, Steve Rivera (Sandia), and N.M. homeland security official R.L. Stockard.

can assess the data and prioritize risk. (6800)

Sandia scientists have demonstrated insulator-based dielectrophoresis (iDEP) for the selective concentration of live and dead bacteria. The technique uses an electric field applied across an array of microfabricated insulating posts. **The iDEP device selectively concentrates particles** based on differences in polarizability and size. The DoD and the Department of Homeland Security are interested in this technology for a pathogen detector using iDEP for selective concentration prior to protein fingerprinting by the liquid phase MicroChemLab. (8300, 8700)

In FY03, the Weapons of Mass Destruction Decision Analysis Center suite of applications was

enhanced to address a broader suite of scenarios, including facility protection. Additional models for biological and nuclear detection technologies and reach-back capabilities were developed and used to support WMD detection and response planning exercises as well as architecture deployment and trade-off analyses. Among accomplishments: conducted

an Alameda County (Calif.) Bio Terrorism Response Plan exercise and developed and conducted a simulation-based table-top exercise for Alameda County Public Health, FBI, and other agencies. (80, 8114)

A multi-organizational team consisting of the Defense Threat Reduction Agency, DOE/NNSA laboratories, and industry (Northrop Grumman Mission Systems & Applied Research Associates) successfully **demonstrated unconventional nuclear warfare defense (UNWD) capabilities** at three military installations this year. The UNWD effort showcased technology capable of protecting military installations against unconventionally delivered nuclear weapons, improvised nuclear weapons, and radiological dispersal devices. (4100, 5900, 6500, 2500)



A SANDIA-DEVELOPED isotope identification gamma detector provides enhanced security at a military installation entry control point.

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diagnose plutonium spall strength under weapon-level loadings to benchmark design code models. The advanced accelerator and X-ray sources developed for this mission are being extended in **close collaboration with the UK's Atomic Weapons Establishment (AWE), Bechtel-Nevada, and LANL** to address both NNSA and AWE future radiographic needs. (1600)

Sandia's Microelectronics Development Lab **set a record fabrication time of six weeks** (typically took 14-18 weeks previously) to complete the digital controller chip (Permafrost) for the stockpile life extension of the Trident nuclear weapon system. The chip was jointly developed by Microsystems Center 1700 and Electronics Systems Center 2300 and **functioned properly on the first fabrication effort** (first-pass success). This integrated circuit is intended to operate in extreme environments (including harsh radiation) at ultra-low power consumption.

Sandia's Primary Standards Laboratory (PSL) and the Neutron Generator Design and Production groups have formed an **alliance to improve the quality of tester data**. Sources of measurement variations and uncertainties are now more fully understood. The PSL has compared neutron measurements

between tubes and generators and between tube testers and generator testers, performed voltage waveform analyses, and performed a complete uncertainty analysis of a tester and gas measurements supporting tube production. Control measurements have been implemented which are ensuring continued quality



PREPARING for a W80-3 drop test at Sandia's Drop Tower test facility. The test, done with the ASCI program, is part of the ongoing W80-3 Life Extension Program.

of product. (2500, 14100, 14400)

NNSA approved Critical Decision One in June 2003 to fund architectural and engineering design of the **29,000-square-foot LIGA Technologies Facility (LTF)** at the California site. LTF is a cleanroom laboratory building that will enable research and development on advanced LIGA microsystems technologies to provide integrated metal, ceramic, and polymer microsystem assemblies for national security applications. Preliminary design is scheduled to be completed by May, and design approval will be sought in July. (8500, 8700)

The W80-3 Life Extension Program team successfully **executed the first full-system nuclear safety drop test of the new W80-3 design** with support from Advanced Simulation and Computing (ASC) and Weapon System Certification campaigns. PRESTO, an ASC-sponsored transient dynamic large-deformation mechanics code, was used to define the drop test configuration and to help select instrumentation and instrumentation locations. The test was performed at Sandia's Drop Tower Test Facility. (8200, 8700, 9100)

In March 2003 Sandia flew a W87 JTA-4 reentry vehicle (RV) and **successfully tested the first wide-band (20 Mbps) data link** during the Flight Test Unit 17 mission. This vehicle was the most sophisticated yet developed for a flight test at Sandia. Along with the wideband transmitter, the RV incorporated other

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new technologies, including inertial measurement units, new shock sensors, distributed wireless sensors, and GPS. Future missions will use this wideband capability to gather critical data, allowing Sandia to ensure the nation's stockpile is in good health. (8200)

The Light-Initiated High Explosive (LIHE) Restart project team has successfully completed all of its Phase I milestones: the retraining of personnel; refurbishment of equipment; procurement of state-of-the-art instrumentation and diagnostic systems; and complete renovation of Bldg. 6715. The objective of the project is to reconstitute the Sandia capability that was mothballed in 1992 coincident with the end of the cold war. The main schedule driver for the project is W76-1 qualification testing slated for early 2006. (2500, 10800)

The CMS is a modern Permissive Action Link (PAL) code management system supporting the nation's PAL-equipped weapons. The CMS for the weapons in Europe was completed in 2001, and CMS is now **being tailored for the weapons in the continental US**. We met an NNSA milestone by delivering host processor and cryptographic processor software and production keys to support initialization of CMS products at the Honeywell/Federal Manufacturing and Technology, Kansas City Plant. (2100, 2116, 2900, 12300)

A 3-year program with an ambitious goal to **improve the surveillance data infrastructure (ISDI)** was initiated during 2003. The ISDI vision is that weapon-data users will have timely access to an accurate, easily understood, and complete set of data to analyze the health of the stockpile. This program represents a partnership among several centers to address a critical business need. Early accomplishments include conversion of at-risk legacy data, institution of surveillance data reviews, inventory of surveillance data, and software improvements. (2900, 2100, 2300, 2500, 8200, 12300, 9500)

The Development Joint Test Assembly (DJTA) for the W78 Mark 12A reentry vehicle was successfully launched from Vandenberg AFB in September 2003. The reentry vehicle was deployed from a Minuteman III ICBM and impacted near the Kwajalein Missile Range. The JTA6 features an advanced, modular telemetry system with a higher data rate, improved terminal event data noise immunity, and real-time capture of detonator and neutron detector wave-



DEVELOPMENTAL JTA launched from Vandenberg AFB.



THE PEN-X PROJECT explored two aspects of a conceptual cruise missile-penetrator weapon: addressing the difficulties of integrating a penetrating warhead into a cruise missile, and increasing its level of mission surety. In January at Tonopah Test Range, a large shaped charge preconditioned a Sidewinder tuff target, and a Davis gun propelled the experimental penetrator into the target. A March experiment showed how mission surety is improved using Mission End-to-End Command and Control, which enables the weapon to intelligently respond to unexpected threats and take commands from humans via satellite communications. Here, Dave Paul installs the detonator in the largest shaped charge ever tested. (8200, 2500)

forms. The first production unit will be delivered to the Air Force for its initial surveillance flight test in 2004. (2100, 8200)

A **significant improvement in the correlation of neutron generator performance data** taken at the Sandia Weapons Evaluation Test Laboratory (WETL) with that measured in the shelf life program at Sandia has occurred. The use of small solid-state neutron detectors with improved calibration techniques at WETL has provided W87, W80, and W78 neutron generator performance data that were within 12 percent of the shelf life measurements (previously factors of four or more difference had been observed). (2500, 2900, 12300)

The Navy conducted the first flight test of a W76-1 arming and fuzing system as part of the Follow-on Commander-in-Chief Evaluation Test (FCET) series. **Early data indicate that the system performed its functions** and gathered information on the reentry environment **exactly as intended**. The Arming and Fuzing System engineering team has been able to integrate radar, flight computer, and diagnostics in a single compact assembly. The design is meeting aggressive cost goals through use of commercial parts, innovative packaging, and automated production processes. (2300, 2100, 1700, 1800, 2900, 15300)

We led a joint effort among DOE, Sandia, and the Air Force to **finalize the System 2 interface specification**, which defines the digital interface between aircraft and nuclear weapons. Developing compatible System 2 weapons will be a major improvement to the use of nuclear weapons on modern aircraft (i.e., F-35). Unique analog devices are replaced by military standard digital messages. **Weapon designers can now implement advanced operational concepts**. The aircraft benefits from standard electrical interface signals and test equipment. (2100, 2900, 12300)

In April 2003 the W76 weapon assessment team provided a **detailed surety analysis report of the W76-1 conceptual design**. Weapon assessment teams are cross-disciplinary teams of surety analysts who review new weapon designs and stockpiled systems for nuclear safety, reliability, quality, use con-

trol, and surveillance concerns. The team shared the results of its analyses with the W76-1 program group, allowing the group to focus further analyses and tests on high priority surety concerns. (12300)

The 12300 "State of the Stockpile" provides critical independent assessment information to the annual stockpile certification. The reporting process had required 12 months from research to a publication in excess of 230 pages. Applying the Lockheed-Martin Lean/Sigma tools reduced the process to six months and yielded a concise 25-page report. Cost savings from the improved process are estimated at \$340,000 in the first year and a labor-hour saving of 48 percent. (12300)



TESTING — Molly McCandless (2300) prepares a W76-1 arming and fuzing system prototype for temperature testing.

The Surety Assessment Center conducted **independent quality assessments on procedures** used in stockpile weapon systems modification, realization of Weapons Evaluation Test Laboratory equipment, and the qualification process for Sandia-designed products. Results: The effectiveness of the qualification process is dependent on the knowledge and experience of the Product Realization Team members and their interpretation of the technical business practices to conduct qualification of product. The processes in place provided sufficient guidance to accomplish the task. Opportunities for improvement were noted. (12300)

Dimming Sun 03, the largest combined nuclear weapon accident response exercise in United Kingdom history, featured some 2,000 representatives from both the UK and the US. Twenty-nine Sandians participated as part of the DOE/NNSA Accident Response Group. **Three Sandians also helped plan the exercise**. The exercise provided a realistic, challenging venue for both nations' assets to assemble, jointly organize, and execute a unified response to a simulated crash of a US aircraft carrying a cargo of nuclear weapons in British airspace. (2100, 3100, 5100, 5300, 5900, 9700, 12300, 12600, 15200)

FY03 marked the inauguration of a multiyear task to migrate the Joint Nuclear Weapons Publications System (JNWPS) from paper media to interactive elec-

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TOBOS, the Russian acronym for Safety and Security Technologies for Russian Warheads, included construction of all-weather enclosure that allowed crews to repeatedly heat and remove 1.5 meters of permafrost each day in order to pour the foundation of the TOBOS test facility.

NONPROLIFERATION AND ASSESSMENTS

Sandia began an important phase of the TOBOS program (Russian acronym for Safety and Security Technologies for Russian Warheads) to test technologies for **enhanced warhead security and safety at Russian Ministry of Defense (MOD) sites**. Construction of a unique test bed at the MOD's Weapon Safety and Security Technology Research Center in St. Petersburg was completed in 2003. Initial field trials were initiated to evaluate monitoring technologies in normal operational and storage environments, extreme environmental conditions, accident environments, and theft environments. (5300)

Ten MicroHound handheld explosive detection units have completed acceptance testing and have been delivered to a government customer. The MicroHound combines Center 4100's explosive sample collection and preconcentration technology with an Ion Mobility Spectrometer microsystem developed in Center 1700. The MicroHound is one-fourth the cost, one-third the weight (12 lb.), one-half the size, and has four times more single-charge

operating life compared to competing products in the same performance class. (4100, 1700)

A **prototype anti-neutrino detector** was deployed and tested at the San Onofre Nuclear Power Station in Southern California. Data from the experimental series indicate this is a promising approach for monitoring the state of reactors. (8100)

Sandia has developed and built the first of a new generation of integrated microsystems for satellite applications. This microsystem provides a **significant improvement in performance by processing data 10,000 times faster** with dramatically reduced power consumption. This revolutionary packaging concept integrates a number of Sandia-developed technologies into a 3-D sensor package, which reduces both size and weight by a factor of 2,000. This technology is broadly applicable to other sensor array applications. (5700, 1700, 1800, 14100)

Sandia pursues technical options as a means of **reducing tensions in the South Asian region**. Sandia hosted retired Rear Admiral Vohra from India and Rear Admiral Ansari from Pakistan to conduct joint research on cooperative boundary delineation, enhanced maritime trade and port security, establishment of a fishermen zone of disengagement, and improved communication between India's Coast Guard and Pakistan's Maritime Security Agency. Influential retired naval officers from both India and Pakistan have supported the results of this work. (5300)



Rear Adm. (ret.) Ravi Vohra (India) and Rear Adm. (ret.) Hassan Ansari (Pakistan) studied implementation of South Asian maritime confidence-building measures.

The Russian Transition Initiatives' first commercial joint venture was established by teaming

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tronic technical manuals. JNWPS publications contain policy and maintenance procedures for stockpiled nuclear weapons used by DoD and DOE personnel. The Technical Publications organization in coordination with DoD successfully **conducted a technology evaluation, developed requirements, and made significant progress** toward single-source publishing. FY04 will consist of staff training and document conversions; FY05 will see the achievement of full capability. (2900)

A rigorous **"design-to-analysis" process** for the development of the structural dynamics model of the W80-LEP and shipping container **was highly successful**. Centers 9100 and 2900 staff contributed to the project success through detailed planning and teamwork. The team integrated efforts in several areas: geometry simplification, element size and type, mesh-interface schemes, Patran and Cubit finite element modeling, element quality metrics, model check-out simulations, and model management. (9100, 2900)

We have successfully **demonstrated a novel MEMS-based acceleration switch** that can sense the unique environments associated with weapon re-entry. The Silicon Reentry Sensor (SiReS) is fabricated using Deep Reactive Ion Etching (DRIE) and Silicon-on-Insulator (SOI) processes developed at Sandia. More than 20 prototype units have been successfully fabricated, packaged, and tested. The project represents a spiral development effort that, if successful, could result in the first Sandia-designed MEMS device

introduced into the enduring stockpile. (1700, 1800, 2300, 2600, 9100, 12300, 14100, Kansas City Plant)

A partnership among several Sandia organizations and the Kansas City Plant has successfully created science-based processes, models, and methodologies that will **allow commercial off-the-shelf (COTS) microsystem components** to be used in War Reserve applications with high confidence. The predictive



COTS — Commercial components like these are being studied for use in the stockpile.

models have been validated with accelerated testing, and the models and processes are being implemented with parts for two ongoing Life Extension Programs, the W76-1 and the W80-3. (1700, 2300, 2600, 8200)

The **first production lot of a new power supply** was accepted on schedule in February. We developed this battery to replace a silver/zinc battery as the main JTA power source. The power supply uses commercially available lithium/sulfur dioxide "D" cells contained in a rugged battery pack. Small production lots of this power supply at EaglePicher are planned for the Concurrent Design and Manufacturing Program over the next several years to support NNSA

requirements. (2500, 9100, 14100)

The design definition continued to mature during the third year of the W76-1/Mk4A Life Extension Program. **The team passed the Conceptual Design Review**, produced development hardware, and began critical tests. The first evaluation of an Arming, Fuzing, and Firing System passed all electrical functional requirements. The electrical interface between the Arming and Fuzing Subsystem and missile was successfully demonstrated. Fuzing hardware to measure radar performance was delivered on schedule for FY04 flight testing. (2100, 1700, 1800, 2300, 2500, 2600, 2900, 8200, 9100, 12300)

An NNSA Milestone Reporting Tool (MRT) has been developed by Sandia's Nuclear Weapons Strategic Management Unit. This tool **tracks the status of all negotiated Level II milestones**. The MRT is available to all sites and site offices in the nuclear weapons complex. The tool produces site-specific information on each milestone that can be rolled up by a federal program manager to assess the program status. A formal change-control process is an integral function of the tool that ensures complex-wide agreement on any program changes. (9700)

A successful new enterprise has been established — the MESA Technology and Operations Prototype (MESA-TOP). The focus of MESA-TOP is to **accelerate the development of advanced microsystems for use in real-world weapons applications**. The MESA-TOP team includes experts in microsystems design, development, packaging, testing, analysis, reliability science, and systems engineering. The MESA-TOP facility includes offices for about 70 personnel and contains 5,000 square feet of world-class cleanrooms. The facility is located directly outside the Eubank Gate at 10420

NONPROLIFERATION

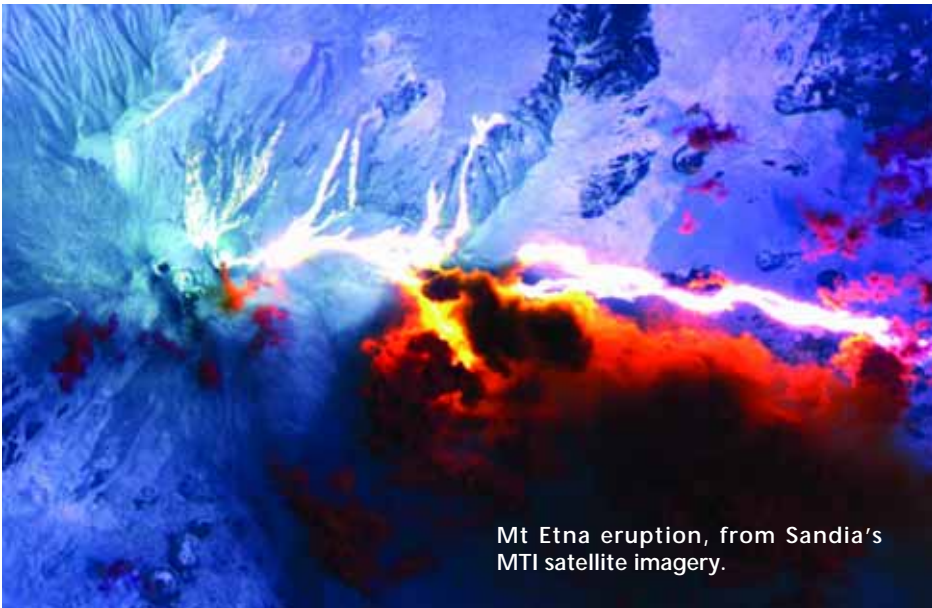
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ENERGY SECRETARY Spencer Abraham announces a commercial joint venture teaming US company Numotech with Russian firm Spektr-Conversion.

Numotech (a US medical devices firm) with Spektr-Conversion (a Russian entrepreneurial start-up). The joint venture will design and manufacture medical equipment, components, and devices, and will **employ up to 500 people, many of whom were previously employed in Russia's nuclear weapons program** near the closed city of Snezhinsk. Sandia has been a key player in the improvement of Numotech's products and in the development of Spektr-Conversion's technical and business infrastructures. (5300, 15200)

On March 12, 2003, the **Multispectral Thermal Imager (MTI) satellite exceeded its operational mission goal of three years.** This satellite is a space-based research and development project sponsored by the NNSA Office of Nonproliferation Research and Engineering. MTI has completed more than



Mt Etna eruption, from Sandia's MTI satellite imagery.



DEPICTION of how the Ares lidar could be deployed in urban areas for detection of biological material releases.

20,000 orbits and has gathered more than 8,500 images for a number of government researchers. Using MTI as a research and development platform, Sandia has developed a number of novel analysis techniques and tools for multispectral and thermal data. (2600, 5700, 6500, 9600, 14100)

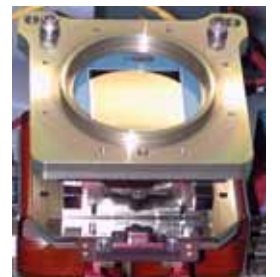
Sandia provided physical protection training and technical expertise to the International Atomic Energy Agency's (IAEA) International Physical Protection Advisory Service missions in Lithuania, Ukraine, and Turkey. Sandia supports the IAEA's effort to prevent sabotage of nuclear facilities and theft of materials from facilities around the world. Also, physical protection training courses were conducted in China for participants from five countries; in the Czech Republic for

participants from eight countries; and in Albuquerque for participants from 26 countries. (5300)

The **Ares lidar**, a biological weapons standoff detection system developed for NNSA, **successfully completed several weeks of extensive field test** evaluation at Dugway Proving Ground, Utah. The Ares system was developed to provide advanced warning of biological weapons threats and is focused on homeland security applications. The system operates in an autonomous fashion scanning the horizon and providing near-real-time analyzed inputs. In November, a CRADA with Smiths Detection Edge-wood was finalized to support transfer of this technology to industry. (1100, 2300, 5700, 8100)

The **Sandia Multispectral Analyst Remote sensing Toolkit (SMART)** was released under government license. This remote sensing science and exploitation work focused on exploitation algorithms and methods targeted at the analyst. SMART is a "plug-in" to commercial remote sensing software that provides algorithms to enhance the utility of the Multispectral Thermal Imager (MTI) and other multispectral satellite data. This toolkit has been licensed to 22 government organizations. (5700)

Sandia has completed fabrication of the first functional prototype of an **enhanced optical radiometer for the nuclear detonation (NUDET) detection** payloads developed for the next generation of GPS satellites. This sensor prototype has 4096 optical sensors in a 64x64 array. Signals from this detector array are sampled, digitized, and processed by 256 custom radiation-hardened application specific integrated circuits (ASICs) designed and fabricated at Sandia. This NNSA-funded sensor integrates a number of Sandia-developed technologies into a highly integrated multi-layer 3-D sensor package. (1700, 1800, 5700, 14100)



The final release of the Nuclear Verification Information Tool (NVITool) was delivered to the US State Department in August 2003. The NVITool was developed for the Bureau of Verification and Compliance for the Office of Nuclear Affairs (VC/NA), which is responsible for State's nuclear-test-verification activities. A web-based product, NVITool provides a wide range of capabilities associated with **collection and tracking of nuclear weapons tests and preparations.** With this added capability, the tool can be used for non-nuclear projects and workflow by other organization within the State Department. (5700, 6500)

SECURITY

DOE's Office of Assurance and Independent Oversight (OA) conducted Security Force-on-Force exercises in October 2003 to test the protection of Sandia. **Sandia's Protective Force did an outstanding job in both exercises.** They were assisted by many in Security who did an excellent job of planning and setting up the operation, and the staff in Facilities and the Motor Pool who provided support. Exercise observers included top management from Sandia, NNSA/HQ, and NNSA's Sandia Site Office, as well as staff from Sen. Grassley's and Rep. Shay's offices. (4200)



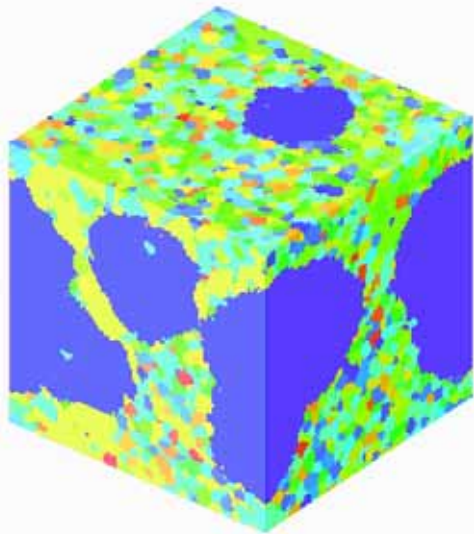
Safeguards and Security management hired **external experts in job task analysis, curriculum development, and training** to help restore

the Protective Force training program. The Protective Force Training Approval Program (TAP) was reviewed and approved by the Sandia Site Office (SSO), NNSA, and NNSI in September 2003. SSO congratulated Sandia for submitting a "professional, well-documented TAP." A training plan covering other Safeguards & Security topical areas was also submitted and approved. (4200)

The Sandia-led Chemical Defense Assessment Team — **formed in 2000 to develop defenses against chemical attacks on Sandia/New Mexico sites** — was tasked by DOE to assess several office complexes and to suggest defenses. In a continuing effort to build our technical base, we built a chemically hardened vehicle for security police officers, fielded an improved chemical detector, and installed prototypical collective protection shelters at a nuclear site. Finally, we wrote a three-volume report, "Guide to Defending DOE Sites Against Chemical Attacks." (4100, 8100)

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MATERIALS, PHYSICS, AND CHEMISTRY



IN A 3-D computer simulation, tiny crystallites (dark blue) grow at the expense of their neighbors, providing nuclei for the recrystallization process.

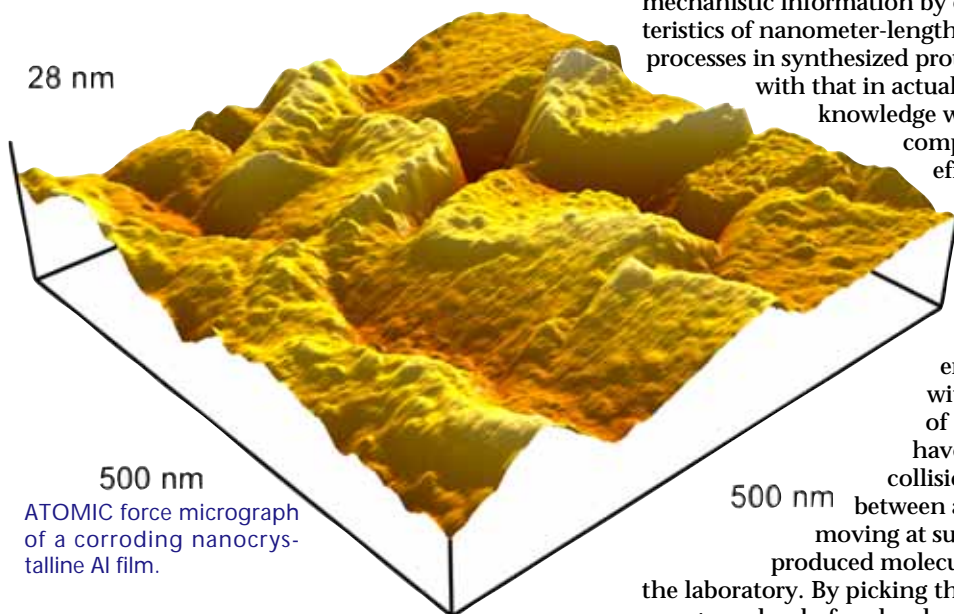
Recrystallization removes damage and defects from a deformed piece of metal, **leaving tough, ductile, perfect crystals behind.** What recrystallization does is well-known, but how it begins is a long-standing mystery. Using advanced mesoscale computer models, we performed **the first full-physics**

simulations of a deformed aluminum substructure. We find that one in a million tiny, pre-existing crystallites grows quickly and large, supplying the nucleus for recrystallization. These observations provide the basis for a new, physically based understanding of this pervasive metallurgical process. (1800)

Stress in mixed silicon/germanium films, grown under precisely controlled conditions, causes the **spontaneous formation of remarkable nanoscale quantum dot molecules** in square fortress-like shapes with highly uniform sizes. The special electronic properties of such solid-state “molecules” could lead to revolutionary quantum computing devices with logic, storage, and wiring elements that actually build themselves. Furthermore, a focused ion beam can selectively seed the self-assembly process, demonstrating the potential to create complex nanoscale circuits exactly where we want them. (1100)

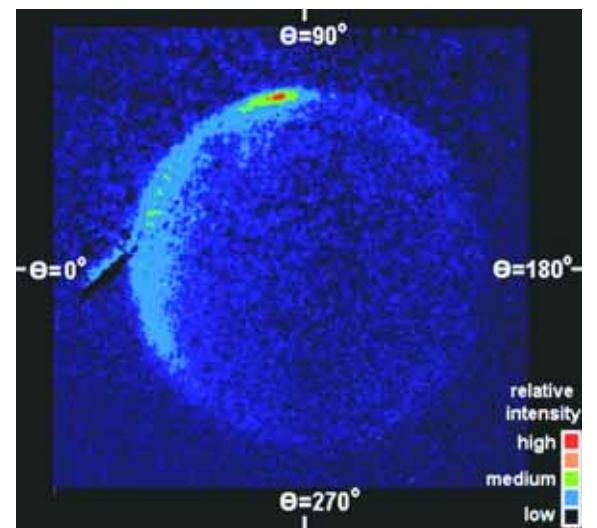
Metallic photonic crystals were fabricated at Sandia’s Microelectronics Development Laboratory that experimentally demonstrated that thermally excited emission from metallic 3-D photonic crystals can **exceed the values predicted by Planck’s law for planar emitters** over particular temperature ranges and for a relatively narrow band of wavelengths. Potential applications could include thermal to electric energy-conversion devices. (1700, 1100)

We have adopted a novel approach using engineered defects and newly developed analytical techniques to **unravel the mysteries of how localized corrosion initiates in aluminum.** We’re generating mechanistic information by comparing the characteristics of nanometer-length scale degradation processes in synthesized protective oxide structures with that in actual alloy systems. The knowledge we’re gaining is a critical component in our ongoing effort to develop predictive models of materials aging. (1800, 1100)



ATOMIC force micrograph of a corroding nanocrystalline Al film.

Using a **crossed molecular beam apparatus**, Sandia scientists, in collaboration with Prof. James Valentini of Columbia University, have cooled molecules by collisions. A single collision between an atom and a molecule moving at supersonic velocities has produced molecules almost stationary in the laboratory. By picking the appropriate collision energy, a cloud of molecules having a temperature



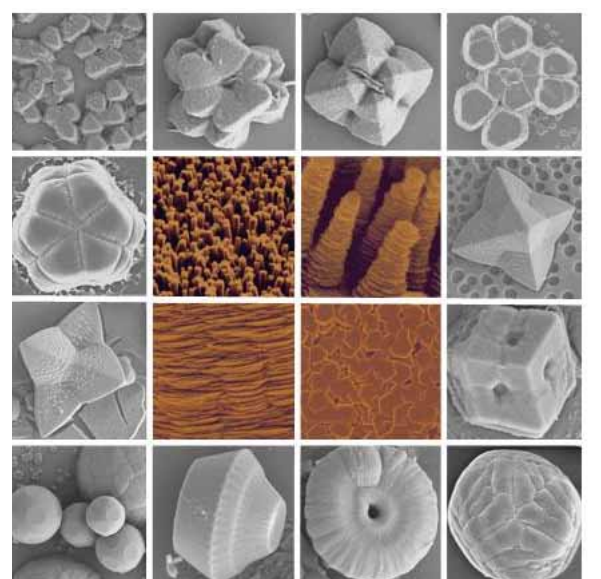
VELOCITY-MAPPED ion image for collisions between nitric oxide and argon. The intense spot at the top of the scattering sphere is the result a collapse of the velocity spreads of the molecular beams for those molecules whose scattered velocity vector cancels the center-of-mass velocity of the collision pair, thereby forming a cloud of molecules.

of approximately 30 millikelvin has been produced. This achievement **opens the possibility of trapping and evaporatively cooling a large number of molecules** to even lower temperatures where their wave nature can be investigated. (8300)

We have made **significant improvements in ultra-high-temperature ceramics** for use in advanced thermal protection systems. We made fully dense ZrB₂-SiC and HfB₂-SiC ceramics in composition ranges not previously available. These materials melt above 3,200°C and are strong and resistant to thermal shock. Such materials are needed to manage the 2,000°C temperatures expected from aerothermal heating of maneuverable, hypersonic vehicles that are proposed for a number of defense, surveillance, and space missions. (1800)

Historically, the complexity of glassy polymer behavior made it nearly impossible to evaluate design changes or reliability in encapsulated components without extensive experimental testing. Based on molecular simulations (conducted with New Mexico Tech) linking a polymer’s viscoelastic friction to its potential energy, **we developed a thermodynamically consistent theory** and 3-D analysis code requiring no adjustable parameters to predict quantitatively the wide range of glassy polymer response. Our new methodology has been reported in a series of four recent journal articles. (1800, 9100)

We have devised a general, environmentally benign, chemical-synthesis approach to build complex **nanomaterials that are strikingly similar to those observed in biominerals** (seashells and diatoms). The key to this new approach is to control nucleation and growth events and crystalline surface chemistry. We hope this new class of nanomaterials will lead not only to novel applications in microdevices, sensing, energy storage and conversion, catalysis, etc., but will also add to our understanding of how complex biomaterials are formed. (1800)



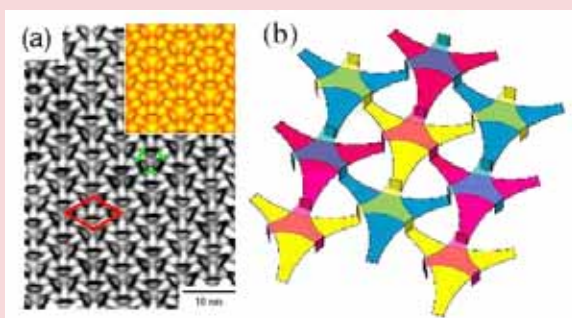
BIO-INSPIRED— This figure shows seashell-like zinc oxide (colored in the middle) and diatom-like silicate crystals (black and white).

BIO/NANO/COGNO

Electronic and mechanical parts often contain interfaces between dissimilar materials. Such interfaces often crucially affect overall materials strength of a part. **We have discovered a totally new structure for such interfaces**, with perfect metal on both sides separated by a single layer of specially arranged metal atoms. This single layer contains an intricate perfect array of nanoscale dislocations that mate to the two different bulk metals. This structure promises to provide an extremely strong shear-resistant bond. (8700)

Motor proteins are molecular machines that enable many materials-assembly and actuation functions in living organisms, including cell division, organelle transport, and muscle contraction. **We are exploring the use of these active proteins** to assemble and reconfigure nanomaterials in artificial systems. As a first step toward creating programmable nanomaterials, we have demonstrated that the motor protein kinesin can transport inorganic materials such as gold nanoparticles and quantum dots in lithographically patterned microfluidic channels. (1100, 1700, 1800)

We have developed a novel computational and experimental approach to the determination of membrane protein structures and dynamics in a native membrane environment. The approach employed chemical crosslinking, proteolysis, and mass spectrometry to determine a set of nine pairwise interatomic distances in rhodopsin, a membrane protein critical to the vertebrate visual signal transduction pathway. These pairwise distances were used in conjunction with computational tools developed at Sandia for the construction, optimization, and simulation of membrane protein structures to determine the transmembrane domain structure of rhodopsin at moderate resolution. (8100, 1100, 1800, 8300, 9200)



INTERFACE — (a) shows an experimental (gray scale) picture of the nanoscale dislocation array along with a matching theoretical (colored) picture of the structure. (b) shows a schematic diagram of the perfect array of nanoscale dislocations which are interwoven to lock the two bulk metals together.

COMPUTING

Design of the Red Storm supercomputing system was completed in a joint effort with Cray Inc. With a peak speed of more than 40 trillion operations per second, **Red Storm will be the world's fastest computer** when delivered in the fall of 2004. This 10-fold increase in computing capability over Sandia's current system will enable dramatically enhanced simulations of weapons performance and safety, leading to important new insights in stockpile stewardship. (9200, 9300, 9900, 9100, 8900)

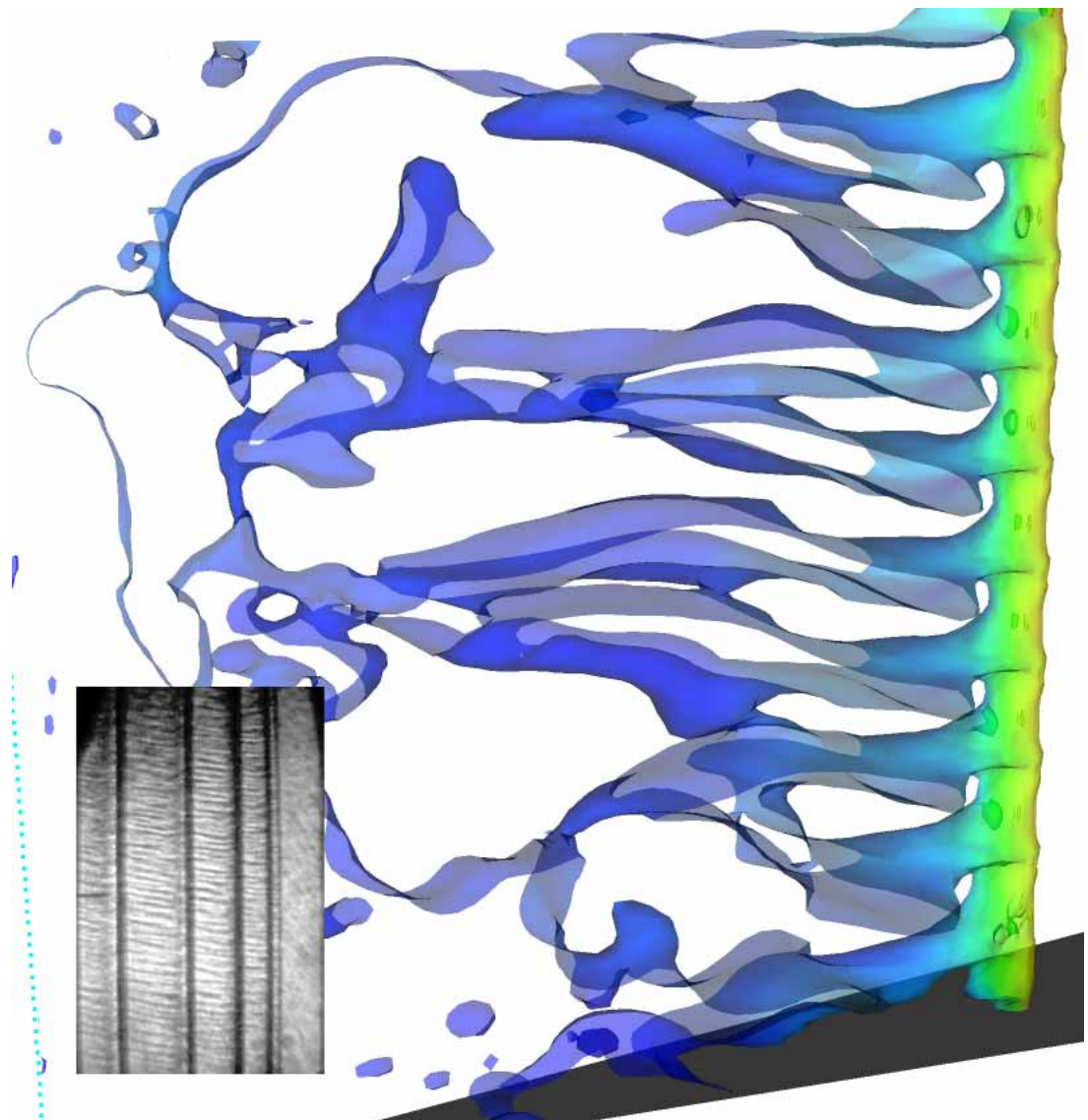
3-D resistive magnetohydrodynamics (MHD) modeling implemented in Sandia's ALEGRA code has been used to simulate Z-pinch wire array implosions at levels of detail never before attempted. **Nonuniform plasma streamers like those observed experimentally** have been computed and can be understood in terms of interactions between local and global magnetic field topologies. Such new physical insights into these phenomena, gained by collaboration of computational physicists and experimentalists, are critical to scaling up to higher currents and radiation pulses on Sandia's Z machine. (9200, 1600)

The new Supercomputer Annex (SCA) was built in preparation for the Red Storm computing system. This ~20,000-square-foot facility will provide up to seven megawatts of electrical power and 4,000 tons of cooling. Additionally, a network infrastructure for Red Storm was developed and will provide a total of 1.2 terabits of switched capacity. (9300, 10800)

An essential ADAPT milestone was reached with a demonstration of the secure collaborative engineering and manufacturing environment being developed for the Nuclear Weapons Complex. The demonstration consisted of **an eight-site classified videoconference with 70 participants**; the system has the capacity to handle up to 24 sites. This milestone was the first step in an overall plan that will lead to model-based qualification of War Reserve assembly at Pantex. (8200, 8900, 9900)

The Common Component Architecture was founded in 1998 as a grass roots organization of DOE laboratories and universities dedicated to developing a software component system for high-performance computing. **Software components are an approach to constructing computer simulations analogous to the way that a radio is constructed** out of electrical components. In this way, mixing and matching components can create many different high-performance applications. Using pre-built components for a simulation can meet national needs more quickly and bring together the knowledge of potentially hundreds of researchers. (8900)

Sandia's circuit modeling code, Xyce, running on the ASCI White supercomputer, was used to **simulate the largest circuit (14 million devices) ever attempted** to be modeled. Xyce is a new massively



ALEGRA-HEDP 3-D simulation of non-uniform wire-array ablation. The isosurface illustrates how a wire's local magnetic field regularly disrupts mass forced toward the array axis by the array's global magnetic field. Non-uniform wire ablation is seen experimentally via laser probing (see inset) and contributes to the shape of the X-ray output from Sandia's Z-machine.

parallel object-oriented circuit simulation code. Xyce has also been used for predictive modeling of radiation effects in electronics and has been applied to the Permafrost Application Specific Integrated Circuit. New time-parallel algorithms are being developed to enable long-time simulations. (9200, 1700)

Sandia researchers have **worked with the Cancer Research and Treatment Center at UNM** to develop a methodology to computationally design more potent inhibitors of LFA-1/ICAM-1 binding reaction that is important to leukocyte trafficking. Our novel methodology is based on the transfer of molecular design technology that was previously applied to materials work. This work has **successfully resulted in potential new compounds**, and we have applied with UNM to the National Institutes of Health to continue this work. (9200)

The **Trilinos framework** was developed and released to facilitate the design, development, integration, and ongoing support of **mathematical software libraries for modeling and simulation** applications. A suite of packages including scalable solvers and efficient implementations of common routines are already available with the framework. Trilinos was released publicly on Oct. 1, 2003, and there were more than 100 downloads in the first month. (9200)

Sandia has a large, complex enterprise network of applications, servers, databases, network service, router/switches, and PCs. Maintaining the integrity of this system is critical because it is integral to Sandia's mission work. This year a **prototype Cyber Enterprise Management (CEM) system was deployed**, creating a framework for an integrated set of tools and processes for end-to-end improvements in security, performance, configuration, and faults. A purpose-built facility,

the Integrated Network Security and Reliability Center, was completed in November 2003, enabling collocation of subject matter experts for better communication, coordination, and more rapid response to events. (9300)

Under the corporate plan for enabling wireless networking for business purposes, prototype networks have been deployed at the California and New Mexico sites. Wireless is a key element in network communication advances that will enable



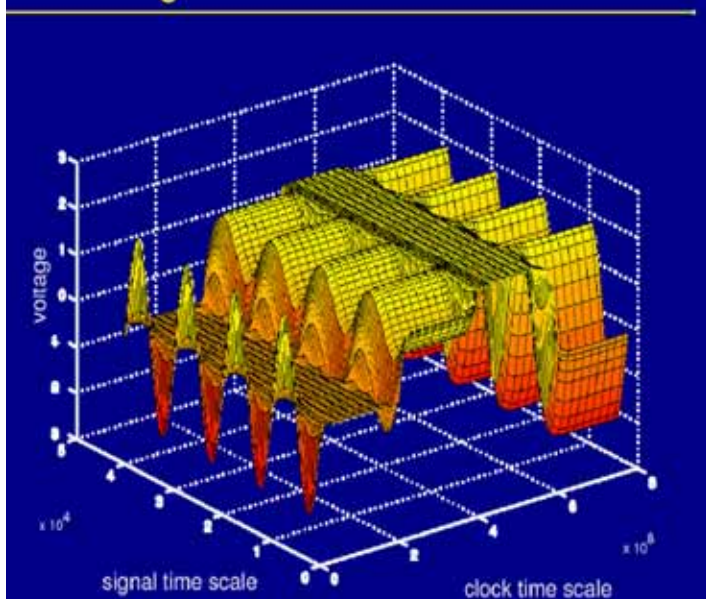
THE INTEGRATED Network Security and Reliability Center was completed in November 2003.

portable connectivity and increased functionality. A wireless security plan for corporate use of wireless has been approved by DOE/SSO, and limited deployment is scheduled to begin in 2004.

In September, **Sandia's newest High Performance Computer resources were released** to the entire Sandia user community. The resources, named Institutional Computing Cluster, are composed of three Linux-based high-performance clusters totaling more than seven teraflops in raw computational power and 25 terabytes total disk storage. There are two 256-node systems in New Mexico, and a 128-node cluster in California. (9300, 8900)

In May, Telecommunications Dept. 9334 was the
(Continued on next page)

SC Integrator: Multi-Time Simulation



TIME PARALLEL methods are being developed to simulate long time-scale effects in electronics.



ENERGY AND INFRASTRUCTURE ASSURANCE

The Atmospheric Radiation Measurement–Unmanned Aerospace Vehicle program conducted the **first scientific flights using a new aircraft** — the Proteus (see above) — and an all-new instrument payload with satellite links, allowing over-the-horizon control. Over 75 hours of flight data were collected, with flights from the DOE Cloud and Radiation Test-bed site in Oklahoma south to the Gulf of Mexico and west to Colorado. The measurements will enable bet-

ter understanding of cirrus clouds and their role in atmospheric phenomenology. (8100, 8200)

Sandia and Lockheed Martin Missile and Fire Control (LMMFC) in Orlando forged the **first-of-a-kind agreement with the government of the Republic of China (Taiwan)** that makes a win-win-win situation for the three entities. Sandia will provide technology to Taiwan's geologic repository science program,

thereby helping Taiwan maintain its nuclear power program and safely dispose of its spent nuclear fuel. LMMFC will fund Sandia's work and simultaneously earn credit towards Lockheed's contractual obligations to the Taiwanese government. (6800)

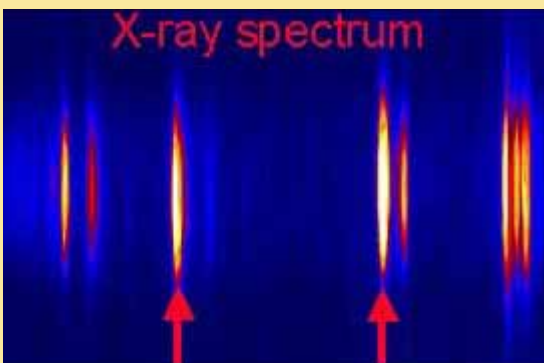
Paul Robinson and five DOE laboratory directors presented a **Nuclear Energy R&D Action Plan** in May to Deputy Energy Secretary Kyle McSlarrow. The plan calls for activities on the part of all six laboratories, with **Sandia acting in an integrating capacity**. The action plan recommends an emphasis on higher temperature reactors that can efficiently produce hydrogen, advanced fuel cycles that minimize waste, and incorporation of advanced sensor, information, and manufacturing technologies into future nuclear fuel cycles for improved safety, transparency, and process controls. The plan recommends a 10-year, \$10 billion research effort. (6000)

Sandia is developing key technologies to enable the hydrogen economy. We are unlocking the mechanisms of hydrogen solid-storage materials through coordinated experiments and modeling, in partnerships with universities, national labs, and industries. We have established a multi-year engineering program with a major industrial partner, and a new DOE hydrogen engines project. Additionally, we have been assigned the responsibility to provide the science needed to draft domestic and international codes and standards for hydrogen

(Continued on next page)

PULSED POWER AND RADIATION EFFECTS

The deuterium fuel in Inertial Confinement Fusion (ICF) capsule implosions has been **heated to temperatures found at the center of the sun** (approximately 11 million° C), as measured via X-ray



spectroscopy (see image below left) of argon dopants in the deuterium fuel. This temperature measurement, coupled with measurements of the emission of 2.45 MeV D-D neutrons, confirms the thermonuclear origin of neutrons from ICF capsule experiments driven by a 20 MA Z-pinch dynamic hohlraum. Scaling predicts ideal ignition at about 30 MA. (1600)

The dynamic material properties team (1600, 15300, Ktech, Bechtel) has developed a containment system that can **shocklessly compress materials to >1.5 million atmospheres** of pressure (one-third the pressure at the center of the earth) using Z, then hermetically seal the chamber in 10 microseconds. Six shots have demonstrated its reliability to contain hazardous materials, including a radioactive P32 tracer at 100 rem/hr of activity. This system enables revolutionary dynamic materials studies.

COMPUTING

(Continued from preceding page)

first large department at Sandia to obtain **certification under the 2000 version of the ISO-9000** standard. Using these certified processes, we completed the upgrade to the 5ESS switch; established telecommunications service to the MESA-TOP (EMCORE) facility; deployed the new "all-fiber" standard in Bldgs. 752, 753, and 969; and activated the telephone firewall (Telewall). (9300)

The **Engineering Sciences Analysis Process** supports the analysis processes used by several Labs organizations by providing an automated method to organize and manage planning documents, analysis artifacts, reviews, and documentation. A development plan and initial implementation pilot was delivered in FY03 and the remainder of the functionality is being added. The process **provides a defined level of formality** for analysis work that can be managed and tracked with the workflow tool. (9500, 9100, 8700, 15300)

Weaponers now have nearly instant access to engineering information on our nuclear weapons

stockpile via the classified network. The **Nuclear Weapons information environment (NWIE)** portal is a secure web-based application being developed jointly by personnel from 9500, 2900, and 9900. The portal provides access to design definition drawings, engineering bill of materials, system summaries typically found in the Bomb Book, Major Assembly Releases, Military Characteristics, Stockpile-to-Target-Sequence documentation, weapon development reports, and other resources. (9500, 2900, 9900)

The computing and procedural support infrastructure has been established that will **enable Labs design engineers to remotely access Interactive Electronic Procedures (IEPs)** at Pantex from their classified thin-client or desktop computer. The IEP project is resident at the Pantex Plant with representation across the nuclear weapons complex. Remote access involves connection to Pantex through SecureNet, using authentication protocols. The procedural infrastructure involves provision for help desk support and official documentation for system upgrades. (9600, 9300)

The Advanced Simulation and Computing element of the Simulation Enabled Product Realization

Program achieved two major programmatic **Level 1 milestones** to:

- Develop capabilities to predict STS hostile environment electrical response to X-rays, and
- Achieve a capability environment for Tri-lab computing on the Q Platform at Los Alamos.

These milestones are critical steps in providing required applications and computing environment to certify that the W76-1 and W80-3 Stockpile Life Extension Programs will meet their Stockpile-to-Target-Sequence requirements. (1700, 9200, 9300, 8200, 8900, 9100, 9900, 15300)

A web-enabled US Savings Bond application was developed and deployed, **allowing employees to manage their bond purchases online**. Features include updating bond deduction amounts, bond types, co-owners, and beneficiaries. The previous online capability generated forms that were manually input by Payroll. The new application provides real-time input into the PeopleSoft system. Eliminating duplicate data input reduced the administration time by 97.9 percent. The application increased data accuracy and timeliness and won a gold President's Quality Award. (3500, 9500, 10500)

ENERGY AND INFRASTRUCTURE

(Continued from preceding page)

commercialization. (8300, 8700)

The 2007 EPA regulations for both light- and heavy-duty vehicles call for **significant reductions in particulate matter (PM) emissions**. To meet these requirements, industry has a critical need for new



SANDIA'S soot team.

instrumentation capable of real-time PM measurements with high sensitivity. Sandia's collaborative effort with the National Research Council Canada and Artium Technologies has led to Artium's development of a **commercial instrument using laser-induced incandescence**. The technology developed has been evaluated at test facilities at Ford and Cummins and on-board a diesel passenger car in collaboration with ChevronTexaco. (8300)

The threat of bioterrorist attacks on US dairy and beef cattle can't be ignored. BRAT™ for Dairies, a prototype biosecurity risk-assessment tool, will **allow dairy owners to assess and mitigate herd risks arising from natural and man-made hazards**. Based on Sandia's patented RAMPART™ technology, this first-of-a-kind software puts the power of risk assessment directly into the hands of dairy owners. As each dairy reduces its own risk, risk to the US herd as a whole is also reduced. (6800, 6500)

The MELCOR Severe Accident Analysis Code, long applied to the analysis of core meltdown accidents in nuclear power plants, is finding new applications in the area of spent-fuel pool accident evaluation, motivated by homeland security concerns. Recent MELCOR studies of water drain-down accidents have been performed to assess the potential for zirconium fire initiation and subsequent release of fission products to the environment. These studies have attracted congressional attention and will be the subject of a National Academy of Sciences review. (6400)

The Linear Threshold Model for the MELCOR Accident Consequence Code System (MACCS) computer code **enhances greatly the level of detail in radiation health effects analysis** by taking into

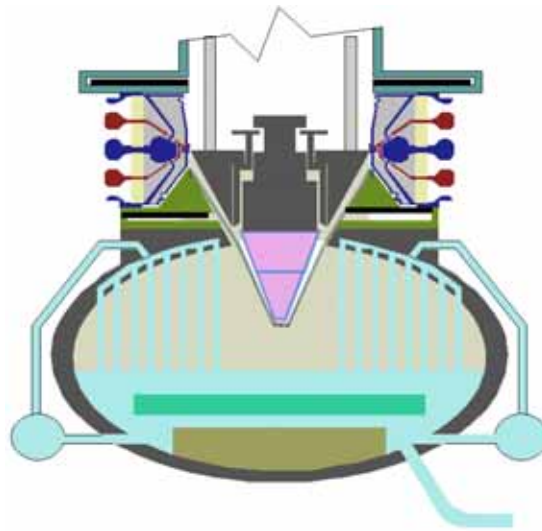


SANDIA PRESIDENT C. Paul Robinson signs a Memorandum of Understanding with officials from Russia's Kurchatov Institute to cooperate on a lab-to-lab basis on a number of technologies of mutual interest.

account a dose threshold to ionizing radiation effects. The Linear Threshold Model required a major restructuring of the MACCS computer code to include additional dimensions to the problem. The new code enables the Nuclear Regulatory Commission to create more efficient evacuation scenarios and better long-term plans. (6400)

Sandia, in conjunction with 44 regional industry, government, and academic partners, has established the **Southwest Regional Carbon Sequestration Partnership** to determine an optimum strategy for minimizing greenhouse-gas intensity in the Southwest. Ultimately, the goal is reduction of global warming associated with high concentration of atmospheric carbon dioxide. The partnership is establishing a framework for assessing optimum sequestration strategies for the region, and will also identify potential gaps in monitoring and verification approaches needed to validate long-term storage efforts. (6100, 6010)

A Pitzer database to predict evaporative aqueous system evolution was compiled and validated for use on the Yucca Mountain Project for high-level nuclear waste disposal. This specialized thermodynamic database is used with the equilibrium speciation and reaction path modeling code EQ3/6. Chemical compositions of multi-component systems including concentrated brines and solutions formed by salt deliquescence are modeled. The results are used to evaluate the potential for waste package corrosion — a significant factor in overall



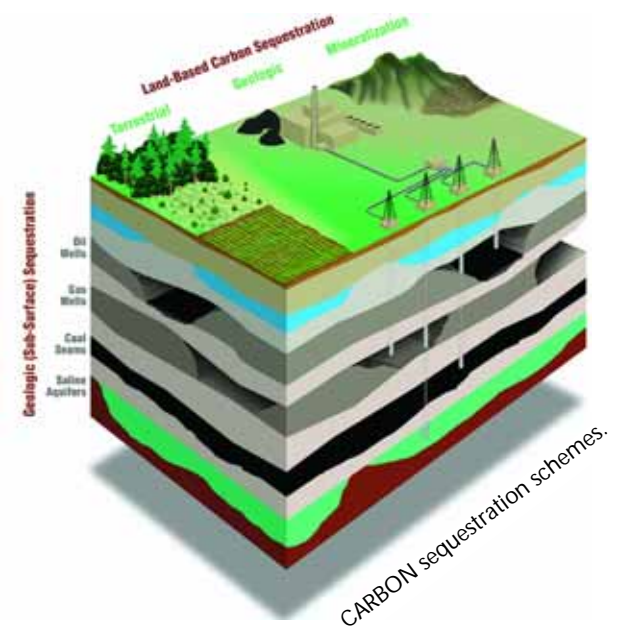
Z-pinch power plant fusion chamber.

repository performance. (6800)

A unique concept for **using Z-pinch fusion technology to generate electrical power** has been completed. Using advanced manufacturing technology, critical components are remanufactured every 10 seconds to support a **high-yield fusion pulse** generated by a driver based on Sandia's Z accelerator technology. This radically different, yet simpler, approach to fusion energy will compete with other fusion concepts. (6400, 1600)

Sandia has expanded its Supervisory Control and Data Acquisition (SCADA) program facilities to Bldg. 10510 in Research Park. This Center 5500 program, with support from several organizations (4100, 5900, 6200), **provides engineering solutions, education, and training to secure the control systems** used to manage the nation's critical infrastructures (e.g. electric power grid, water treatment and distribution, oil & gas pipelines). The new facilities include labs for technology demonstration, integration, training and video conferencing. Sandia is leveraging these resources in its role as co-lead in DOE's National SCADA Testbed.

Sandia researchers and their Russian counterparts took the first small steps under a new memorandum of understanding (MOU) between the Labs and the Kurchatov Institute in Moscow, signed in January 2003. The **ultimate goal of these important first steps is to create a world that is more environmen-**



tally sustainable, economically prosperous, and politically stable. The next step will be to expand the partnership to include multilab groups in the US and Russia — an effort that is now also beginning.

A Sandia-Los Alamos team led by the Nuclear and Risk Technologies Center (6400) **produced a state-of-the-art vulnerability assessment of commercial aircraft attacks on two nuclear power plants** for the Nuclear Regulatory Commission. The project analyzed the ability of aircraft to strike specific plant locations, resulting structural and fire damage, effects on critical safety systems and core melting, the resulting health consequences, and options to mitigate the damage. The computational/experimental capabilities of Centers 9100 and 9200 were key to the project.

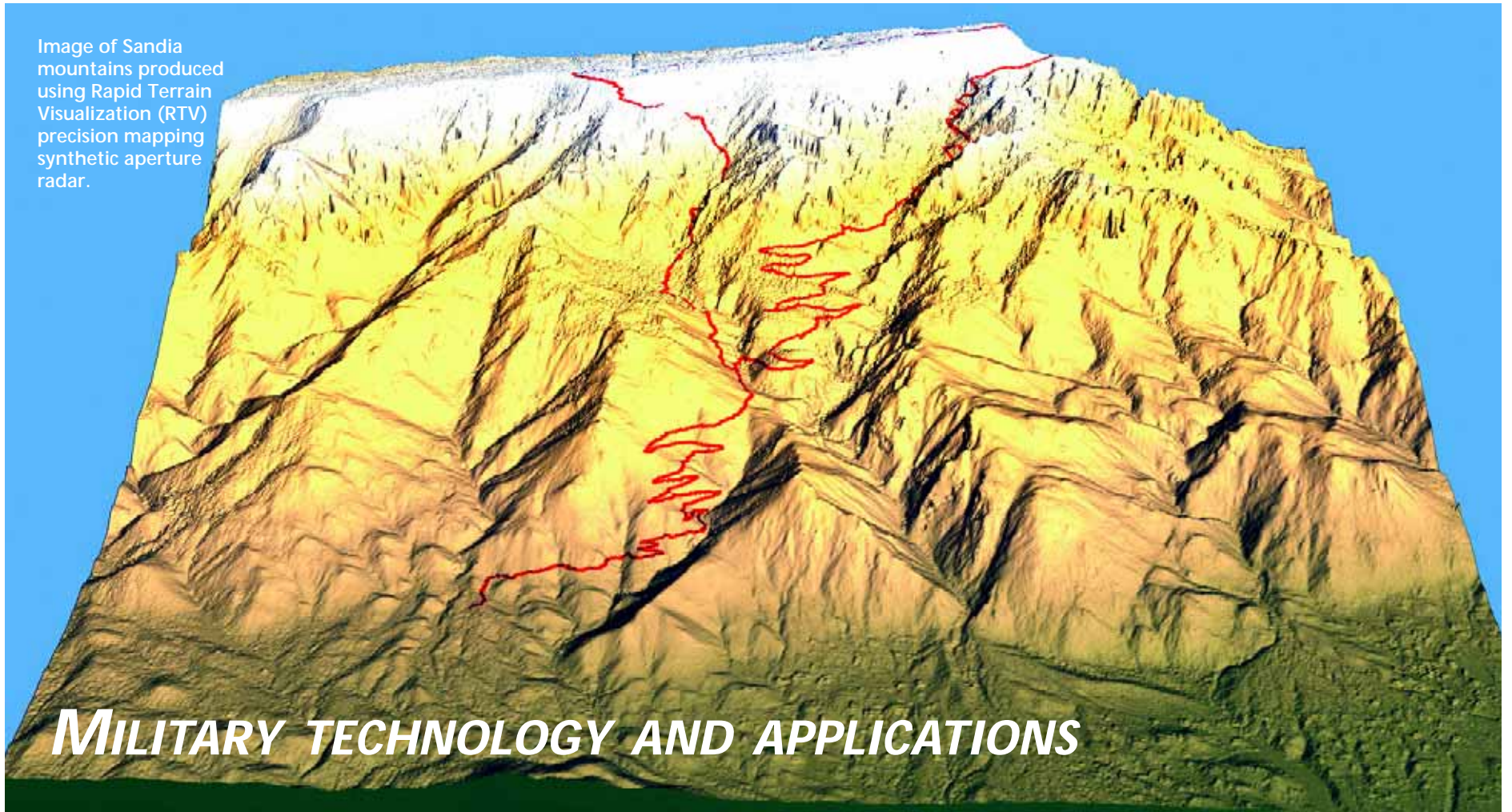
A series of **NRC-certification drop tests for two transportation cask designs** were successfully completed. The first cask was a half-scale model TRUPACT III cask; testing was also performed on a full-scale Mixed Oxide (MOX) fresh-fuel cask. Both test series comprised multiple drops at different heights, cask orientations, and temperatures. This testing continues the significant contribution Sandia has made to the national and international programs for safe transportation of radioactive materials. (6100, 9100)

Sandia **developed and installed an electronic monitoring tool** that has continued (for more than 50 days) to track temperature and pressure changes in a Coso Naval Test Range well at a depth of 3,100 feet and ambient temperature of about 193°C (379°F). The test data confirm **improvements in reliability** derived from utilization of manufacturer-qualified



COSO — The US Navy's California geothermal well containing Sandia's hi-temp silicon-on-insulator tool. The solar panels are used to power the satellite transmitter and the tool located 3,100 ft below the surface.

Image of Sandia mountains produced using Rapid Terrain Visualization (RTV) precision mapping synthetic aperture radar.



MILITARY TECHNOLOGY AND APPLICATIONS

Sandia's Scannerless Range Imaging (SRI) technology leads the world in high-resolution 3-D imaging. We are in the midst of providing an SRI system to NASA, a key to NASA's early return to flight. SRI will allow the NASA/Sandia team to detect and quantify catastrophic damage in orbit, thus providing for safe return of the crew. Also, we have delivered a development system to the Navy for imaging through murky littoral waters. We continue advanced work on facial recognition and seeker munitions. (2600, 2300, 2900, 1700, 5700, 5900, 9200, 12300)

To say that **reliably transmitting and collecting real-time data from a penetrator** traveling through rock or concrete is difficult is an understatement, to say the least. In a joint collaboration with departments 2665 and 15412, an initial test of a penetrator instrument package was conducted with the potential to do all of the above. The 6.2-cubic-inch device measures, records, and transmits 3-axes of acceleration data real-time. This development is critical to enabling end-game weapon communications in the future. (2600, 15400)



ROBUST penetrator instrument package.

The Defense Ammunition Center has funded Sandia for two robotic disassembly systems based on technologies developed under the DOE/DoD Memorandum of Understanding program. The first system, which **disassembles a projectile containing 36 mines**, will be part of a new Munitions Demilitarization Cryofracture Facility under construction at the McAlester Army Ammunition Plant. The second system will disassemble 8-inch rocket-assisted projec-



A ROBOTIC DISASSEMBLY system, like the one shown here, enables safe dismantlement of aging munitions.

tiles at the Blue Grass Army Depot. These systems will remove people from potentially fatal hazards that occur annually in a worldwide industry.

The Split Hopkinson Pressure Bar Facility is fully operational. The high-strain-rate material properties measured in this facility are provided to the penetration community for use in selecting penetrator case materials, assessing the penetrability of targets, and benchmarking material behavior models in codes. Through careful design and

unique methods of pulse-shaping, the facility is at the forefront of high-strain-rate materials testing technology and provides data unparalleled in fidelity and reliability. (15400)

Sled Test #1 for the Tactical Missile System-Penetrator program was **successfully conducted in June 2003 at Sandia's 10,000-foot sled track.** The test assessed the surviv-

ability of a weapon fuze and high-explosive package during the penetration event. Predicted depth of penetration was achieved, the fuze was functional after the test, and data were downloaded from the internal memory. The high-explosive showed no signs of cracks or failure and the bond with the case wall was still intact. The penetrator was extracted from the concrete target using a remotely operated demolition tractor fitted with a jack-hammer.

The **SnifferStar chemical sensor**, a lightweight, low-power, rapid-responding chemical warfare agent sensing module for unmanned aerial vehicles, was selected by R&D Magazine as **one of the 100 most significant technologies** introduced in 2003. The technology is a joint development between Sandia and Lockheed Martin, funded through Lockheed Martin's Shared Vision program. In addition to the R&D 100 award, SnifferStar has been highlighted in numerous media articles and has received other recognition, including a Sandia team Employee Recognition Award. (1700)

Sandia-developed **Rapid Terrain Visualization (RTV)** precision mapping synthetic aperture radar,

designed for military applications, has proven valuable a little closer to home, too. Recently, data collected and processed by the system have been provided to the Albuquerque Mountain Rescue Council, a volunteer search and rescue group, for two recent missions in the Sandia mountains. The RTV maps used in both missions significantly enhanced on-the-spot knowledge of the terrain, thus helping to determine the safest, most efficient routes to the subject, demonstrating a real potential to help save



SLED TEST for the Tactical Missile System-Penetrator program was successfully conducted at Sandia's 10,000-foot sled track.

lives. (5900, 2300)

The **first Sandia-designed-and-built satellite laser threat warning sensor** was launched into polar orbit onboard an Air Force weather satellite from Vandenberg AFB in October 2003. Successful laser illumination testing verified its detection and reporting capabilities. Validation testing over the next year will determine the optimum satellite configuration to perform its Air Force mission. An updated warning sensor is being developed under a \$15.6 million technology transfer agreement with Northrop Grumman Space Technologies. (5700)

Personnel at Tonopah Test Range (TTR) played a key role in the successful completion of the **Joint Air-to-Surface Missile (JASSM) Initial Operational Test and Evaluation (IOT&E) Flight Test Program.** The test program consisted of six separate JASSM missile launches from a B-52H over the Nevada Test and Training Range. The missiles flew pre-

(Continued on next page)

THE SWING FREE controller was demonstrated in an open-water exercise in October 2003. While traveling at roughly three knots, the crane successfully transferred cargo between the USS *Flickertail* and her sister ship, thus demonstrating underway replenishment capability.



MILITARY TECHNOLOGY AND APPLICATIONS

Continued from preceding page)



JOINT AIR-TO-SURFACE MISSILE flight tests being conducted at Sandia's Tonopah Test Range in Nevada. Top photo shows missile in flight; bottom photo shows bunker target.

planned routes and impacted specially prepared targets at TTR. The TTR test team collected high-speed system performance data as the missiles impacted the targets. (15400)

Sandia's Cognitive Systems Program strives to model human cognition from a psychological and physiological basis. In FY03, in support of a DARPA program, **cognitive models of two individual Airborne Warning and Control System (AWACS) operators were constructed** and demonstrated agreement with their human counterparts for approximately 90 percent of the cues and contexts recognized. Potential human errors were prevented through the "discrepancy detection" mechanism whereby a human's own cognitive model of a complex task was used to mitigate fatigue or distractions. (15300, 15200, 6500, 8900, 12300, 9200, 4100)

The US Navy's Strategic Systems Programs (SP-11) selected Sandia to be its **systems engineer/integrator for all Navy strategic weapon security loca-**

tions. The Navy's selection followed Sandia's delivery of high-quality System Effectiveness Assessments (SEAs) for the Navy's submarine bases in Bangor, Wash., and Kings Bay, Ga. Sandia's first major activity as the system engineer was to deliver air threat analysis reports that provided structural/thermal modeling of critical facilities at each base. (4100, 9100)

Umbra software brings the best together for rapidly analyzing technology impacts. Noteworthy team accomplishments include: analysis of distributed ad hoc communications and small robotic air platforms on situational awareness in urban conflict (completed in three months); rapid design changes to compensate for radio shortcomings in unattended ground sensor networks (completed in two weeks); and analysis of networked microsensors in urban military operations (completed in one month). (15200, 15300, 6500, 9100, 2500)

Leveraging technologies developed for nuclear weapons programs, Sandia's Technologies for Systems Analysis and Simulation group is **developing an integrated, knowledge-based Support Enterprise Modeling (SEM) capability** for the Joint Strike Fighter (JSF) program. The SEM capability will enable Lockheed Martin Aeronautics to determine the best-value JSF business approach and to assess and optimize performance/cost as the JSF program moves forward. An Integrated Enterprise Modeling capability is being developed that includes an interoperability architecture enabling the federation of SEM with other models, tools, and databases used within the JSF program. (15300, 9200, 9500, 1400, 2900)

The flight hardware for projects conducted in support of Missile Defense and Strike Systems is fabricated and checked out in 15400's Test and Assembly Laboratory. Major accomplishments in 2003 included payload suites for Missile Defense Integrated Flight Test 14 and 14 Backup, Strategic Target System Flight Test Units 6, 7 and 8, and Strike Systems penetrator payloads for the Army Tactical Missile System, including two ground tests, two pyroshock tests, and one flight test unit. (15400, 2600)

The US Navy has adopted Sandia's "Swing Free"



UMBRA — Understanding technology impacts in evolving military conflict situations.

crane controller for its advanced shipboard crane technology demonstrator. Developed for moving nuclear materials and equipment, Swing Free control **accelerates and decelerates the crane in such a way that little payload swing is induced.** The technology was enhanced for the Navy by combining Swing Free with an automatic ship-motion compensation algorithm. In tests at port and under way in open water, Swing Free has demonstrated high container throughput. The Navy hopes the technology will enable beachside resupply of marines and



CENTER 15400's Test and Assembly Laboratory.

TECHNOLOGY PARTNERSHIPS

Working under a single-laboratory/multi-partner CRADA, **Sandia and four leading bit manufacturers jointly conducted extensive field tests** that validated the hard-rock drilling capabilities of state-of-the-art drag bits and the utility of Sandia's new Diagnostics-While-Drilling (DWD) system, which provides novel real-time downhole and surface data for controlling the drilling process. The tests have effectively promoted the continued development and adoption of advanced drag-bit and instrumentation technologies for achieving significant reductions in the drilling costs associated with difficult geothermal, oil, and gas applications. (6200)

Responding to an increased need for assessing vulnerabilities of dams, transmission lines, water utilities, and chemical facilities, **Sandia has developed risk-assessment methodologies (RAMsSM) and vulnerability-assessment methodologies (VAMsSM)** and streamlined procedures to deploy these tools through more than 200 licensees. Other licensed technologies with homeland security applications include decontamination formulation, shooter identification, and microchem-lab. We have also modified the automated Work for Others system, eWFO, enabling automated, rapid processing of Department of Homeland Security proposals while meeting DOE requirements. (1300, 1700, 2500, 4100, 6200, 8500, 11700)

The **Sandia Science and Technology Park attracted four new tenants** in FY03: Materials Processing & Coatings Laboratory, Zia Laser, MESA TOP, and Ktech Corporation. Additional highlights included Roadrunner Level Recognition by Quality New Mexico, the Park's five-year anniversary, and the completion of the Eubank Expansion Project. The Park boasts 16 companies and 850 employees. Total investment in the Park exceeds \$120 million. An economic impact analysis performed this year determined that the Park has created more than 2,300 direct and indirect jobs, with the salary of each job averaging \$45,000. (14030, 14031, 1300)

The rock blasting computer code, DMCBLAST, has been extended to include 3-D simulations. This work is the **result of a 17-year collaboration with Orica USA Inc.**, the largest manufacturer of commercial explosives in the US. The capabilities of DMCBLAST have driven the conversion of the US surface coal mining industry to a practice called "cast blasting" wherein surface mining blasts are overloaded with explosives and the blasthole-to-blasthole detonation timing is controlled to maximize the explosively induced rock movement. (15300)



MANUFACTURING AND PRODUCTION

Before FY01 began, the concurrent design and manufacturing (CDM) program at Sandia had never had a full year with a perfect record of on-time, on-budget deliveries to NNSA/DOE. At the end of FY03, **CDM had achieved a perfect record for three full years** in which CDM delivered 93 lots with a total of 11,591 components from seven technologies, delivered to support all of the seven weapons systems at Sandia. In FY03, CDM delivered 22 lots, with a total of 2,390 components. (14000, 1700, 2500, 2600, 2100)

The **Manufacturing Working Group (MWG) was formed in early FY03** by Sandia and a wide range of industry, government, and university partners to identify and develop solutions on what New Mexico needs from its local manufacturing supply base, focusing on Design-for-Performance manufacturing. Also, a committee of the group is **developing a High Tech Manufacturing Strategy** for New Mexico. Sandia is seeking to strengthen its supplier base and improve the services offered to its internal SMUs. (14000, 10200)

New multi-tasking machining equipment in the Manufacturing Enterprise has **enabled reduced timelines and cost for hardware fabrication** for customers. Turning and multi-axis milling capability are combined on these single machine tools. This results in reduced machine set-up and time. For example, use of a multi-tasking machine tool to fabricate a prototype cone ballast for the B61-11 development resulted in time and cost savings to the customer of 30 percent over fabrication on traditional tools. (14100, 2100)

The **Neutron Generator Production Center held 44 rapid improvement events** in FY03 that resulted in span time reduc-

tions, yield increases, prioritization and identification of work, collaborative teaming efforts coupled with streamlined project planning, and 6S achievements. The Neutron Generator subassembly floor was recognized by Lockheed Martin for setting the standard in 6S. These achievements were also highlighted in a successful presentation given to a large, receptive audience at the 2003 Productivity Lean Management/TPM Conference in Nashville. (14400)

Developing entirely new processes, Sandia's model-based Product Acceptance Product Realization Team (PRT) **achieved first-ever, model-based fabrication, measurement, submittal, and DOE/NNSA acceptance** of MK-quality product into the stockpile. The Division 14000 PRT included members from Sandia, Kansas City/Honeywell, and DOE/NNSA. Diamond stamping the preflight controller product, by DOE/NNSA, established a milestone design-to-manufacturing capability for the nuclear weapons complex. These processes are now the benchmark for model-based work, fully usable by PRTs choosing to employ this modern standard for model-based manufacturing. (14100, 12300, 2600, DOE/NNSA, Honeywell/KCP)

Sandia's Logistics Center and Quality Assurance Center partnered to design, manufacture, and deliver an NNSA/Sandia Site Office-approved **Nuclear-Explosives-Like-Assembly (NELA) Transport Vehicle alternative** to the NNSA/Office of Secure Transportation (OST) courier services. The process improvements resulted in a customer process time of seven days for the new process compared to 106 days for the old process. Labor-hours improved to 27 "touch-time" hours for the new process compared to 317 hours for the old process. (8500, 12300)



COMMUNITY OUTREACH

Our volunteer and corporate contributions programs completed a phenomenal year with another Habitat House completed, a successful Make a Difference Day, even more Shoes for Kids, further involvement with Roadrunner Foodbank, and many other projects. We have doubled our volunteer roster over the past four years and now have more than 3,400 registered volunteers in the program. Our corporate contributions program provided grants and gifts benefiting more than 50 community organizations with more than 70 percent of the money used for youth and educational programs and activities. (12600, Labs-wide volunteers)

Sandia's Education Partnership programs have continued to grow in scope and support. Family Science Nights (see photo at right) have grown to more than 40 a year. Strengthening Quality in the Schools has shown correlation to improved student performance and a lower drop-out rate, Science Bowl school participation has grown by more than 40 percent. And this year we launched an essay contest, "The Write Thing to Do," as well as our first Sandia Student Science Symposium. We continue to provide leadership in community/education/business partnerships as we continually strive to improve the quality of education and student performance in our state. (12600)



Photo by Randy Montoya

INTEGRATED ENABLING SERVICES

I.E.S.

"Time" is an important, simple-to-understand and measurable productivity improvement that effective "integrated" and "enabling" services return to mission organizations for mission work. Each of us feels the pressure of not having enough time to do his or her work — with too many interruptions. In FY03, according to the IES SMU Productivity Report, **IES services and projects returned approximately two hours per week per employee** of time actually given back for mission work. (7000)

Integrated Enabling Services supported three mission programs with Integrated Response Teams; delivered four new services (Integrated Moves, Integrated Management of Property, the IES Help Desk, and Service Finder); and supported Sandia's growth of 285 employees, 171,000 square feet of space, and \$99.9 million increase in purchases with no IES baseline cost growth. (7000)

IES/Health and wellness

In January 2003, the **Life Design Center (LDC) opened its doors** to 500-plus customers at the California site. The LDC serves as an auxiliary facility to Benefits and Health Services programs and services: !SALUD! health and wellness promotion; physical therapy rehabilitation; flu clinic; and ancillary benefits. Through the LDC, Sandia personnel have access to a variety of nontraditional benefits that encourage work/life balance and help foster a positive work environment. (3300, 8500)

In June 2003, the **California site Health Services clinic earned accreditation** from the Accreditation Association for Ambulatory Health Care. This accreditation resulted from an intense quality effort, requiring an extensive project plan and collaboration between Centers 8500 and 3300. The clinic was evaluated against 24 medical industry standards, and received a three-year accreditation — the longest incremental period possible. This achievement was also recognized with a Turquoise President's Quality Award in November 2003. (8500, 3300)

IES/Human resources

A prestigious postdoctoral fellowship has been established by Sandia to attract the nation's outstanding new PhDs in science and engineering. **The Harry S. Truman Fellowship in National Security Science and Engineering** provides the opportunity for recipients to pursue independent research of their own choosing that supports the national security mission of Sandia. A team of representatives from the Staffing and University Research organizations helped define the new position. The first fellow(s) will be selected for a fall 2004 start. (3500, 1000)



SALUD! Program Coordinator Morgan Edwison (with clipboard) conducts an evaluation of California site staff as they exercise on some of the cardiovascular equipment that is available at the Life Design Center.

Sandia has been recognized by the American Society for Training and Development as having **one of the 23 best training organizations in the world**. The award recognizes organizations that demonstrate enterprise-wide success as a result of employee learning and development. These organizations use learning as a strategic tool and have the support of senior leaders who champion a learning culture. They have demonstrated that learning is vital to individual and organizational performance, training is not a discretionary item, and even in times of uncertainty and downturn, continued investment in employees is the key to future success. (3500)

The annual Staffing Plan, part of the IES Integrated Planning Initiative, was enhanced to associate hiring needs with financial projections, permitting Sandia to **more quickly assess and respond to funding and business changes** that impact staff size. To assist with correlating financial projections to headcount, a staff-planning tool was developed within the HR Graphalyzer. Information gleaned from the plan is used for external hiring allocations, possible retraining areas, student employee needs, potential temporary employee impacts, and other purposes. (3500)

Built on the success of the Health Services Center's diabetes clinic pilot program, **the Disease Risk Management Clinic (DMRC) is an integrative approach to managing the health outcomes** of populations at risk for diabetes, high cholesterol, and high blood pressure. It deploys a team of Sandia health care professionals, contract specialists, medical case managers, and community providers. With early intervention and accessible, comprehensive, and aggressive treatment options, the DMRC provides a continuum of care to Sandia employees and has proven to make a difference in the progression of today's prevalent diseases. (3300)

To assure high quality in patient care, the **Health Services Center renewed its accreditation** with the Accreditation Association of Ambulatory Care,

whose standards were developed to encourage voluntary attainment of high-quality care in organizations providing health care services. **The accreditation process provides rigorous clinical performance measurements** across each health service and program and includes a thorough evaluation of the processes by which health care is delivered, as well as the outcomes patients experience. (3300)

Sandia's Hands On/Minds On Technologies Program earned a DOE "**Best Practice in Equal Employment Opportunity and Diversity**," and a National Association of African Americans in Human Resources "**Diversity Recognition Award**." The program promotes academic achievement in minority communities underrepresented in engineering, science, and medicine, and a cadre of volunteers and role models engage 6th-12th graders with hands-on experiences. Participants strengthen reading comprehension, scientific reasoning, and math skills as they learn about HTML, electricity, solar power, energy, and anatomy. Former participants since hired by Sandia often return as instructors/volunteers. (3500, with American Indian, Black, and Hispanic Leadership and Outreach Committees)

IES/Financial

Using a Monte Carlo simulation tool, we **completed a comprehensive forecast of future pension plan funding levels** for Sandia's Retirement Income Plan. The modeling was performed to incorporate the impact of recent changes and expected future asset returns. Sandia's Investment Committee is responsible for establishing pension investment and funding policies, and the forecasting results were used by the Committee to re-establish guidelines for allocating pension funds among different asset classes, such as stocks and bonds, in the future. (10500)

The International Procurement Team has achieved ISO 9001:2000 certification for its service process. The team members worked with the corporate ISO group to prepare for the certification audit of this internationally recognized certification of quality. The International Procurement Team is now better able to ensure the quality of its process in a customer-focused continuous improvement environment. (10200)

Sandia Procurement was one of four recipients of the Lockheed Martin "Straight to the Top" awards for its Value Stream Analysis work in Acquisition Planning. Led by Procurement, this team's work resulted in **decreased cycle time, touch time, process steps, approvals, and hand-offs**. Due to their tremendous follow-through, customers experience increased agility and decreased hassle. (10200)

The Accounts Payable Invoice Web page is a result of feedback received from our line customers. It provides customers with a **simple, user-friendly interface for reviewing an invoice** and responding to an invoice action. The Web page provides a one-stop venue for Sandians to query the disposition of an invoice in one of three ways: (1) by supplier invoice number; (2) by purchase order number; or (3) by supplier. This implementation has resulted in significant cost savings.

With filling and covering of the engineered containment cell, **the mission for Sandia's Corrective Action Management Unit (CAMU) has been completed.** The CAMU, unique in the DOE complex, has been used for the staging, treatment, and containment of hazardous and toxic waste generated during soil remediation. The CAMU's cell contains more than 31,000 cubic yards of contaminated soil excavated from the Chemical Waste Landfill. Conventional off-site disposal of this material would have expended more than \$250 million of taxpayer funds. (6100, 3100)

Based on results of quarterly inspections and sampling at Sandia monitoring stations, the City of Albuquerque awarded Sandia five gold awards for compliance with wastewater discharge permits. The Model Validation Design Team won DOE Pollution Prevention (P2) and White House Closing the Circle awards for incorporating sustainability into facility design/construction. A P2 award was received for a site-wide energy-savings contest. Sandia's P2 efforts were recognized as models for other large federal and private institutions. (3100)

Emergency Management deployed more than **1,350 Tone Alert Radios (TARs)** at the New Mexico site through the SPAN (Sandia Protective Action Notification) program, enabling the Emergency Operations Center to communicate time-urgent information, protective actions, and instructions to onsite personnel located indoors. TARs can broadcast pre-recorded and impromptu messages by building, groups of buildings, tech area, or Labs-wide. In special applications, TARs are supplemented with strobe lights and text message boxes. Additionally, approximately 125 Building Evacuation Teams were trained, enhancing evacuation procedures and implementation of shelter-in-place actions.



A CREW prepares to receive another load of contaminated soil at Sandia's on-site Corrective Action Management Unit (CAMU) facility. The CAMU completed its mission last year.

Center 3100's waste management departments **reduced Sandia's environmental risk by disposing of legacy waste.** This included some 60,000 lb. of explosive waste consisting of WWII ammunition/gunpowder, ProForce training ammunition, field-test waste, and obsolete rocket motors (approximately 36,000 lb.), as well as emergency explosive

waste (diethyl ether) and routine waste from ongoing programs. Additional waste reduction included 456 cubic meters of legacy low-level radioactive waste shipments to Nevada Test Site, which exceeded the volume of radioactive waste shipments to that location in any previous year. (3100)

IES — FACILITIES/ADMINISTRATION/LOGISTICS

The Planning and Executive Support Organization collaborated on a corporate strategic planning process that began with a set of global planning assumptions agreed to by the Laboratory Leadership Team and Mission Council. These assumptions **helped to establish a new Strategic Management Unit structure for FY04.** The new SMUs produced extensive 10-year, 5-year, and 1-year corporate plans that will be housed in the Corporate Plans and Performance Assurance (CPPA) database. (12100)

At the request of executive management a study of **"quality of life" issues for administrative managers was undertaken.** This study, developed by a team of administrative managers, included a number of focus group sessions and a survey questionnaire sent to all administrative managers. The study identified four major issues that negatively impact administrative managers' quality of life. In response to these issues, 13 action items were identified and are being pursued by the appropriate individuals or teams. (12100)

An Enterprise Risk Management (ERM) System was begun at Sandia. This ERM system consists of goals and principles, process guidance documentation (including addendums that assist risk identification and provide exemplary case studies of risk management), training, a website, and great progress on clarifying roles and responsibilities and implementing requirements. (12100)

Sandia became an official member of the Santa Fe Institute's Bus-net, an influential network of 50-plus public and private sector entities committed to developing practical applications for the emerging area of complexity science. Recognized as the world leader in this field, the **Santa Fe Institute co-hosted with Sandia a workshop on terrorist behavior that drew a record number of participants.** This was a Labs-wide collaboration involving the Science, Technology and Engineering SMU (funding), the Advanced Concepts Group (workshop), and Executive Staff (catalyst and POC). (12100)

The **2003 Logistics Forklift Safety Rodeo** was successful in achieving a Silver President's Quality award. The event, in its third year, showcases the skills and training of Sandia's forklift operators with a tremendous emphasis on safety and detail. The event boosts morale and fosters good customer rela-



A FORKLIFT operator lines up a shot during the annual Sandia Forklift Safety Rodeo.

tions, creates and maintains networking and partnering opportunities with other organizations, and promotes teaming, one of Sandia's core values. (10200)

The Distributed Information Systems Laboratory (DISL) achieved a major milestone with the completion of building construction in November. DISL will provide the Simulation Enabled Product Realization (SEPR) program with office and laboratory space to invent the future of distributed computing through computer sciences research and development. DISL will also stimulate deployment of SEPR-developed technology to weapons workgroups located in classified spaces in DISL. (8500, 8900)

A new Moves Process went into effect at Sandia/New Mexico in January 2003, **simplifying what customers have to do** to coordinate relocation of their phone line, network connection, computer, furniture, and boxes. The new Moves Process links the move-related responsibilities of Facilities, Computer Support Units (CSUs), and Telecommunications through the use of a software tracking application that keeps all service providers automatically aware of the current status of each planned move. (9300, 9600, 10800)

At a major annual cleaning industry symposium, **Sandia's Custodial Services won two awards, best custodial audit and the top honor, best overall custodial program.** Sandia competed against more than a hundred participants from across the US, including Boeing, the University of Massachusetts at Amherst, Sodexo, and the University of Texas. Custodial Services has used Operating System One, or OS1®, an innovative and nationally acknowledged large-scale team cleaning system, for the past several years to improve efficiency and save costs. (10800)

The Corporate Projects Department completed several Institutional General Plant Projects (IGPPs) in FY03. These included the new parking lot on the former site of Bldg. 852, an addition to Bldg. 750, and two new buildings — Bldg. 752 in Tech Area 1 and Bldg. 969 in Tech Area 4, providing 46,000 square feet of much-needed general office space at Sandia/New Mexico. Thanks to a design/build contracting strategy, each project was designed and built in six to eight months. (10800)

Sandia's Decontamination and Demolition program removed almost 67,000 square feet of substandard space in FY03, including Bldg. 841, which freed up needed real estate in Tech Area 1. At 39,900 square feet, Bldg. 841 is the largest structure the program has removed to date at the Sandia/New Mexico site, at least until Bldg. 805 (75,300 square feet) comes down in FY04. In preparation for this effort, the program devoted significant FY03 resources to decontaminating Bldg. 805. (10800, 10200, 3100)

FY03 inventories of equipment and attractive assets produced "outstanding" (99.65) and "excellent" (99.39) results. With the assistance of Logistics, Procurement, Facilities, Security, and the CIO, line property coordinators located in just six months more than 55,000 assets within the 1,274 government-owned buildings that total more than 6.272 million square feet. FY03 results revealed improved property stewardship over FY99 performance and demonstrated successful implementation of sound management practices — retaining assurances of system integrity to Lockheed Martin and DOE/NNSA, while reducing line effort, thereby maximizing contractor resources for mission work. (10200)



UV LEDs — Sandia researcher Mary Crawford (top photo) was part of a Sandia team that won a DARPA award for its breakthrough work in ultraviolet LEDs. (Photo by Randy Montoya)

ELECTRONICS

Our **breakthrough in deep ultraviolet (UV) solid-state, light emitting diodes (LEDs)** has led to continuous optical powers of 1.3 mW at 290 nm and 0.5 mW at 275 nm, and peak output power exceeding 8 mW at 290 nm under pulsed operation. These LEDs have been used in demonstrations of bio-agent detection and a non-line-of-sight communication system. Further development could enable water purification, decontamination, and thin-film curing. Team members received an award for excellence from DARPA. (1100)

Two-Dimensional Metal: Fact or Fiction? We have studied the physics of electrons confined to two dimensions (as seen in silicon transistors) to determine whether this system is a metal or insulator at temperatures near absolute

zero. Metallic behavior would mean radical new physics and perhaps even new technology. While experiments by other groups over the last two decades have shown indirect evidence for a metallic state, our experiments and associated theory reveal insulating behavior, upholding conventional ideas. There is no true metallic state. (1100)

With MIT, we have achieved **world-record long-wavelength lasing** from quantum cascade lasers (QCLs). We have generated wavelengths as long as 141 microns (frequency >2 THz) and record operating temperatures in this regime (137K pulsed and 93K continuous operation). THz spectroscopy has potential for rapidly identifying chemical and biological agents and for imaging applications. Sandia is one of only three laboratories worldwide that has demonstrated the sophisticated compound semiconductor growth required for these structures. (1100)

ENGINEERING SCIENCE

Sandia played an integral role in **helping NASA understand the underlying cause of the shuttle Columbia accident**. Sandia staff conducted computational analyses and experimental studies to confirm that foam from the external tank impacted and severely damaged the wing leading edge on takeoff. More than 35 Sandians contributed to the investigation in the areas of continuum/non-continuum computational fluid dynamics, aerothermodynamics, impact analyses, and material characterization. Sandia's simulations of the foam impacting the wing leading edge showed the potential for significant damage, and were later confirmed by full-scale impact tests. (9100, 1800, 6100, 8700, 9700, 15400)

Sandia hosted the **7th National Congress on Computational Mechanics** with a record-breaking attendance of 1,200 representing 36 countries. The congress featured 62 mini-symposia with 27 parallel sessions each day. Cutting-edge applications and numerical methods research were represented. The main objective was to bring together the diverse communities in computational mechanics, promoting interactions between government/academia/industry. The congress was administered by a web-centric database that accommodated mini-symposium proposals, abstract submission, registration, and technical program administration. This tool will be used with future Sandia-sponsored conferences. (9100)

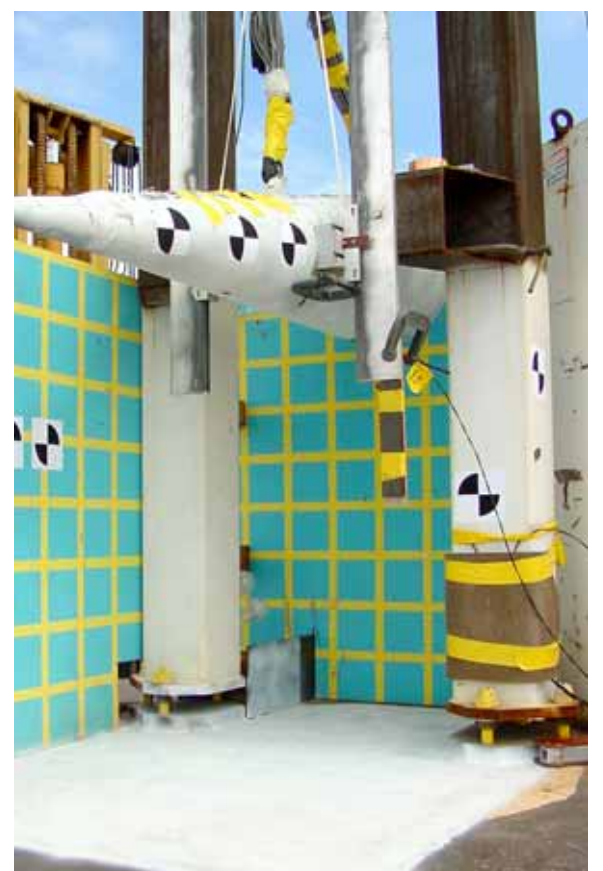
The Test Capabilities Revitalization team completed the design of the first phase of a \$118 million construction line item that will restore critical test capabilities and provide new qualification, weapon development,

and model validation capabilities for the 21st century. This \$47 million first-phase project will enhance the aerial cable facility mechanical testing capabilities and construct a one-of-a-kind thermal test complex to perform abnormal thermal environment testing of weapons systems and conduct fire physics R&D. (9100, 10800, 1200)

The Joint Test Program **completed a multi-year process designed to develop a Salinas finite element model** to simulate mechanical shock from hostile encounters. A series of model validation tests culminated with system impulse tests which provided excellent data to assess the model utilizing statistical measures of unit-to-unit variability. The data confirmed the conservative quality of the million-element Salinas model. The model simulated responses of multiple non-testable environments, confirming that Sandia components have the capability to survive hostile shocks. (9100, 2100)

ASCI-enabled analysis is supporting W76-1 development and has significantly impacted the fireset mechanical design. **Simulations identified design deficiencies and subsequent modifications** for meeting requirements. In combination with analysis, a 22-foot drop test in September provided experimental discovery data to reduce modeling uncertainties for the W76-1/Mk4A. Acquired data will also define AF&F (arming, fuzing and firing) component environmental specifications for future qualification testing. This highly instrumented test successfully met all objectives under an aggressive schedule to complete the project before the end of FY03. (9100, 2100)

Sandia LabNews



PHYSICAL TESTING, like this drop test of a weapon casing, is used in conjunction with supercomputer simulations to make weapons safer, more secure, and more reliable.