

Labs Accomplishments

Sandia National Laboratories

Sandia LabNews

2006

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THE LITTLE ROBOT THAT COULD . . .
Meet the Sandia robot that helped
secure a radiation source at White
Sands Missile Range. Details on page 5.





ON A DAY that Sandia Labs Director Tom Hunter called “the most terrific day in our history,” President George W. Bush chose Sandia National Laboratories in Albuquerque as the venue to sign the Energy Policy Act of 2005. The landmark bipartisan legislation, sweeping in its scope, includes provisions to boost alternative energy R&D, nuclear energy, clean coal technologies, and modernized energy infrastructure. In the photo above, Tom discusses a Sandia solar energy pro-

ject with President Bush, Secretary of Energy Samuel Bodman, US Sen. Pete Domenici, US Sen. Jeff Bingaman, and Sandia engineer Chuck Andraka (6218). During remarks prior to signing the legislation, President Bush praised Senators Domenici and Bingaman, along with Texas Rep. Joe Barton, for representing “bipartisanship at its best” in shepherding the complex legislation through the labyrinthian Congressional process. (Photo by Randy Montoya)

To all Sandians:

Welcome to this year’s edition of the annual *Lab News Labs Accomplishments*.

Throughout this 16-page document, you’ll find a resounding affirmation of the depth and breadth of Sandia’s research and development capabilities — and a reminder that our people are the very best at what they do.



Tom Hunter

It has been my privilege to lead this laboratory over the past year and to share with many distinguished visitors, including the President of the United States, the evident passion that exists here for the important work we are charged to do. As I walk through and fly to our facilities and

interact with our colleagues, I find that passion everywhere; I believe it is one of the distinguishing characteristics of our workforce.

From crucial milestones met in our key mission areas to fundamental insights gained via our own discretionary Laboratory Directed Research and Development program, this Labs Accomplishments issue demonstrates that we are fulfilling the charge — with gusto — that underpins our approach to our work: “To provide exceptional service in the national interest.”

Tom Hunter, Sandia Laboratories Director



Cover photograph by Randy Montoya

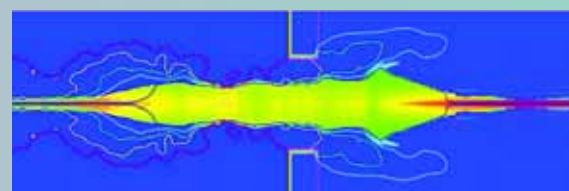
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SANDIA’S THUNDERBIRD CLUSTER requires clusters of cabling.



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ALEGRA CODE used in armor penetration studies.



In the first quarter of each calendar year the *Lab News* highlights some of Sandia National Laboratories’ principal achievements of the previous fiscal year. Submissions are selected by the VPs’ offices. Numbers in parentheses at the end of some entries 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, e-mail *Lab News* staff member Bill Murphy at wtmurph@sandia.gov.



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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’s National Nuclear Security Administration.

Nuclear weapons

Sandia's **Red Storm** computer met three Advanced Strategic Computing milestones last September and ran several simulation problems never previously possible. Analysts from Sandia, Los Alamos, and Lawrence Livermore national labs demonstrated the scalability of the system, using 5,400 to 7,200 processors, producing first-of-their-kind details in simulations of fire, polar atmospheric phenomena, and destruction of an asteroid in deep space. Teaming with Los Alamos and Lawrence Livermore researchers, we demonstrated platform stability and user-environment functionality and produced unique visualization results from these large runs on Red Storm. (4300, 1400, 1500, 1900, 8900)

Measurements of transient neutron damage have been made at the Los Alamos Neutron Science Center spallation neutron source at times as early as 8 μ s. The previous record had been about ~250 μ s for data gathered at fast-burst reactors. **Observing the early neutron damage is critical** to finding ways to certify Sandia components to weapon radiation requirements without the use of fast-pulsed reactors such as the Sandia Pulsed Reactor (SPR). The use of such reactors is being curtailed due to security concerns about protection of special nuclear materials.

Center 1700 delivered the proof-of-design multiprogram application-specific integrated circuit (MPA) for the concurrent design/manufacturing program in a record six-and-a-half months. **The MPA was designed, simulated, verified, and laid-out in four months.** The first fabrication lot was processed in our Microelectronics Development Laboratory in a record eight weeks. The test program was completed in five days, with first silicon yielding 71 percent (2,000 parts). Fully functional parts were packaged in-house, tested across temperature/voltage, and delivered to the customer in October 2005.

Centers 2700 and 2900 **used Lean/Six Sigma process improvement techniques to streamline the engineering change order process** for neutron generators. The process flow was reduced from 58 to 10 steps, reducing cycle time by 20 percent, virtually eliminating rework, and reducing average processing time from 33 days to two-and-a-half days. The net impact represents an annual savings of \$38,000, increased capacity, and significant gains in customer satisfaction. (2900, 2700)

We have completed a four-year, **\$10 million project to re-establish the Light Initiated High Explosive (LIHE) facility** and test capability at Sandia. Using remotely spray-painted, light-sensitive high-explosive applied directly to a test unit (to simulate an exoatmospheric cold X-ray hostile shock environment) the facility will provide validation data to support the Science Based Engineering & Technology concepts of rigid body mechanics, deformable mechanics, and thermal-structural response. These models will be used in the hostile-environment qualification of nuclear weapons systems. (2500, 2100, 10300, 10800)

The B61-11 team developed and executed a new Type 6C test configuration as a cable pull-down unit at Sandia's Aerial Cable Facility. This was the first fully scoreable surveillance test of a B61-11 using the facility and was performed in lieu of a flight test at Tonopah Test Range. By closely controlling the impact conditions during testing, this new surveillance capability allows for worst-case testing of the B61-11 never before achievable through standard flight testing. (2900, 1500, 2100, 12300, LANL, KCP, BWXT)



B61 pull-down test at Aerial Cable Facility.



Very high voltages can be produced by passing a shock wave through properly prepared ("poled") lead zirconate titanate (PZT) "active ceramic" material. Sandia neutron generator production requires a special PZT chemistry not commercially available. To meet this need, **a new solution chemistry PZT powder synthesis process was developed** and patented. Production-scale batches of PZT have been prepared, and parts have been qualified to full weapon requirements. These successes build on years of collaborative development work to optimize PZT chemistry, powder synthesis, sintering procedures, and component fabrication. (2400, 2500, 1800)

An 18-month New Mexico/California **design competition was launched in May 2005 for a Reliable Replacement Warhead** for use in Navy and Air Force ballistic missile configurations. The goals: preserve military effectiveness, provide greater design margins, assure cross-platform compatibility, and integrate surety options that enhance stockpile security and eliminate nuclear safety exceptions, while simultaneously incorporating process and cost-control improvements across the weapons complex. (2100, 8200)

The W76-1/Mk4A design definition continued to mature, with **reentry body and arming, fuzing, and firing systems attaining Final Design Reviews.** System qualification activities included successful testing for blast, impulse, abnormal thermal and mechanical, radiation, electromagnetic, and normal transportation environments. Four reentry bodies that included a fully functional AF&F and new Joint Test Assembly were assembled and delivered to the

Navy for flight testing in early FY06. The program received unconditional approval from NNSA to proceed to Production Engineering Phase 6.4. (2100, 1700, 1800, 5300, 2500, 2600, 2900, 8200, 1500, 12300)

The W76-1/Mk4A Life Extension Program (LEP) **successfully flew four test bodies** on the submarine-launched ballistic missile Follow-On Commanders Evaluation Test (FCET-32). This test included several important firsts: integration of the W76-1/Mk4A Reentry Body Assembly to a D5 missile; flight of the Sandia-designed MC4700 Arming, Fuzing, and Firing sub-systems; and demonstration of the Sandia-designed telemetry package on the Joint Test Assembly (JTA1). This major program milestone is a critical element of the overall W76-1 LEP and builds significant confidence with our DoD/Navy customer. (2100, 1500, 2500, 2600, 5300, 8200)

We undertook an aggressive program to replace aging field test neutron generators by the end of July 2005. Neutron generators have a finite life, and new hardware was required to maintain the capability — if ordered — of returning to underground nuclear testing, a national readiness requirement. Many technical issues had to be resolved to manufacture this reliable neutron source for the National Test Readiness program. The program exercised our design capability and validated our manufacturing capability to produce the higher-output, electronic, variable-timing, field test neutron generator. The final two neutron generators were qualified through environmental testing on July 30, 2005, allowing Sandia to deliver nine generators, against the eight required. (2500, 2400, 5100)

The High Accuracy Sensor Package (HASP) successfully flew on a W87 JTA4 MK21 flight launched from Vandenberg AFB in California last September. The Flight

Test Unit (see inset image) was deployed from a Minuteman III and impacted near the Ronald Reagan Ballistic Missile Defense Test Site on the Kwajalein Atoll in the Pacific. HASP features a high-performance, small-volume inertial sensor package measuring reentry vehicle flight dynamics through boost, separation, coast, and reentry phases. The package has better performance in half the volume of earlier generations. (5300, 8200)



Our thermal battery production team successfully **submitted new, Sandia-fabricated Joint Test Assembly telemetry batteries** to NNSA in support of directive schedule requirements. This production run was the first diamond-stamped lot fabricated entirely in Sandia dry room facilities following the loss of a major thermal battery supplier in 2004. A dedicated team of personnel procured tooling, qualified processes, and completed fabrication, inspection, and testing of the lot in less than half the time normally allotted for a typical thermal battery production run. (2500, 1800, 2700, 12300)

(Continued on next page)



IRRADIATIONS AT CRYOGENIC TEMPERATURES using liquid helium cooling have been conducted at fast burst reactors, spallation neutron sources, ion beams, and pulsed gamma sources to slow down damage annealing and permit a detailed investigation of early-time defect annealing as the temperature is slowly brought up to 300K. These studies support the Qualification Alternatives to SPR-III (QASPR) program and are designed to provide data supporting first-principles modeling of early-time damage annealing. The goal is to permit calculations and experiments at pulsed simulation facilities to replace the need for fast-burst reactor testing.

THE FIRST W80-3 ENVIRONMENTAL FREE FLIGHT TEST was conducted at the Utah Test and Training Range in September 2005. The test unit, installed in an advanced cruise missile, was launched from a B-52H aircraft and flew, as planned, for some five hours. Flight environments (vibration, thermal, and acoustics) were collected and transmitted by the onboard telemetry system. The information will be used to update the stockpile-to-target sequence and the W80-3 environmental specification. Center 8200 designed and built the data telemetry equipment, and coordinated the flight test activities with the Air Force.



Nuclear weapons

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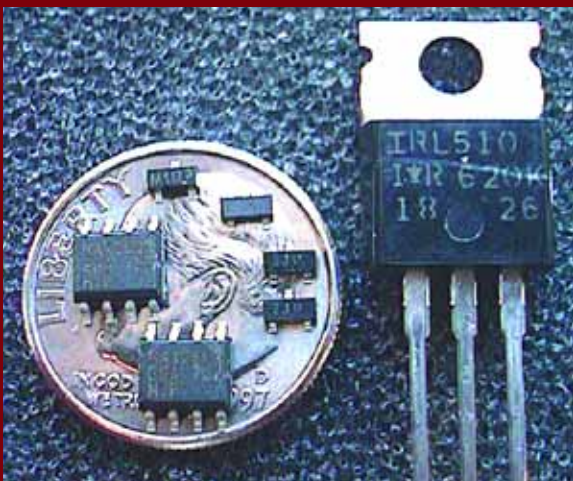
Integrated Stockpile Evaluation (ISE) is a **transformation initiative that aims to integrate and transform the programs and activities** used to evaluate the US nuclear weapons stockpile. Key objectives include strengthening our knowledge of and confidence in the stockpile, while significantly increasing the cost-effectiveness and responsiveness of the stockpile evaluation program. ISE accomplishments during the past year include overall transformation planning in conjunction with the NNSA Stockpile Evaluation Transformation Leadership Team, the development of an alternative stockpile evaluation sampling rationale, and the formation of Technical Basis Realization Teams to develop the stockpile evaluation requirements for the future. (2900, 2100, 8200, 12300)

In December 2004, following a complex-wide cost study, NNSA assigned the neutron tube target-loading mission to Sandia. A finding of no significant environmental impact was issued in June 2005. Cost projections indicated a greater than \$5 million cost decrease, largely enabled by **successes in Neutron Generator Production's Lean/Six Sigma processes**. Target-loading consolidates neutron generation production at Sandia, resulting in a 60-day decrease of neutron tube production time. Target-loading with deuterium is now fully operational in Bldg. 870 and will be an integral part of production by the end of February 2006. (2700)

The MC4300 Neutron Generator Product Realization Team is modeling the concurrent engineering practices advocated in Technical Business Practices-Product Realization Process. Members of the design and production agencies have co-located, providing seamless cooperation and promoting design for manufacturability **using Lean/Six Sigma and mistake-proofing principles**. This effort has resulted in an estimated 30 percent (i.e. \$10,000 per unit) cost reduction of the MC4300 neutron tube as compared to its predecessor. Recent yields have already surpassed those for the previous unit. (2700, 2500)

Sandia production delivered more than 7,300 components

COTS comes through



HELPING TRANSFORM the nuclear weapons complex by providing lower-cost, rapid response parts for weapon systems, the War Reserve COTS Insertion Process project implemented new processes and procured the latest-technology, commercial-off-the-shelf parts for the W76-1 and W80-3. The project integrated design agency, production agency, and third-party test houses into a virtual corporation with test and part data trackers, and automated workflow. More than 400 of the approximately 500 life-of-program-buy part types (involving some two million parts) were procured, saving more than \$100 million on life-of-program costs. (1700, KCP)

to customers, including the successful submission of new thermal batteries to NNSA (the first diamond-stamped lot fabricated entirely at Sandia — see entry above). Production includes 6,868 Concurrent Design and Manufacturing components, 299 neutron generators, and 168 neutron generator packaging kits in support of the Navy, Air Force, other weapons complex production agencies, and the United Kingdom. **An on-time delivery percentage of 100 percent** was achieved for these products, which support all weapon systems in the stockpile. (1700, 2100, 2500, 2600, 2700)

We used W78 Modeling Pro/Engineer mechanical design software to generate **highly detailed solid models of the entire W78 war reserve** and joint test assembly mid-section assemblies. These models accurately represent the geometry and mass properties of every component and follow Sandia's material list structure exactly. The models were ultimately translated into a virtual reality environment for analysis, which made possible a far more accurate W78 use-control assessment than would otherwise have been possible. (2900, 12300)

DOE's Office of Security and Safety Performance Assessment has assigned **Sandia's Protective Force Component Testing and Development Team** to assess, develop, and improve capabilities of our protective forces to withstand potential terrorist attacks against the nuclear weapons complex. During the past year, the team has developed a new armored vehicle with a remotely operated weapon system and an "augmented reality" system to improve training effectiveness. The team has also made strides in mechanical breaching, a new multirole weapon system, and testing and evaluation weapon capabilities to breach security fencing and penetrate hardened adversary assets.

The new Stockpile Dismantlement Database System is now **available on-line through the NWie** on the Sandia Classified Network and can be accessed ultra-securely by other nuclear weapons complex sites. This web-based Java application provides users an easier-to-use interface and better reporting capabilities in support of nuclear weapons dismantlement activities. The successful deployment of this system met an NNSA Level II Milestone. (4500, 2900)

A novel **Chemical Imaging Precision Mass Analyzer** (ChIPMA), developed by Sean Maharrey (8300), Richard Behrens (8300), and Robert Bastasz (8756), is the first of its kind to couple ion beam and laser surface probes to a high-performance Fourier Transform ion cyclotron resonance mass spectrometer. ChIPMA uses the AXSIA image analysis package, developed by Mike Keenan (2400) and Paul Kotula (1800), to chemically map complex materials. As recognized by a DOE/DP Award of Excellence, ChIPMA is uniquely suited to understanding the long-term reaction processes that affect the safety, aging, and performance of nuclear weapons components.

We successfully **developed an aluminum-resist substrate** for improved yield and new capabilities in metal microfabrication by LIGA (X-ray lithography, electroforming, and molding). By reducing secondary radiation during X-ray exposure, this low-z substrate eliminates delamination of the X-ray resist, reduces small-feature loss, and improves dimensional accuracy. Through use of this substrate, we demonstrated process yields near 90 percent and new capabilities to fabricate isolated features as small as 5 µm and feature aspect ratios up to about 300. These are the largest feature aspect ratios ever produced by LIGA. (8700)

Surviving endoatmospheric attack



Hostile blast testing for the W76-1 Life Extension Program was completed in FY05. This is the culmination of a three-year testing and analysis program designed to ensure that redesigned components will survive an endoatmospheric nuclear blast from an adversary weapon. This effort tapped a broad range of Sandia's modeling capabilities, including codes CTH, SACCARA, and Salinas. Additionally, the uncertainty and repeatability of the blast tube environment was statistically characterized for the first time. The data and uncertainty bounds will be used to validate the computational model of the system response. (2100, 1500)

Engineering Design Services Dept. 8948 joined with Dept. 2990 and the Kansas City Plant in a **tri-site joint value stream mapping effort** to identify and streamline the engineering authorization process in the nuclear weapons complex. Agreements and changes are being implemented that will shorten the process to one-to-three days. In related activity, we organized and presented three sessions last year (two at the end of June and one in August) of a mandatory engineering authorization training class for all individuals involved with the engineering authorization process.

The ability to positively secure high-value, high-consequence materials is essential. The Integrated Surety Solutions/End-to-End Command and Control demonstration **showed the integration of critical technologies for the secure transport** of these materials while retaining positive control. The demonstration was carried out by the 2005 California weapon interns and members of the W84 and Advanced Systems Dept. 8222 and Surety Design Engineering Dept. 8226. Various scenarios were explored and demonstrated, validating that positive control over materials can be assured with minimum risk and interference to authorized users. (8200)

(Continued on next page)

MODELING AND SIMULATION tools are impacting the design and evaluation of mechanical stronglinks. The Science Based Engineering & Technology concepts being applied to stronglinks include deformable mechanics (to simulate mechanical shock response); rigid-body mechanics (to simulate complex mechanisms); and thermal-structural mechanics (to simulate welding). Simulations of detailed models of the W76-1 and W80-3 stronglinks have demonstrated their value to product realization for the life extension programs. Detailed models of stockpile stronglinks have



been constructed through the Enhanced Surveillance Program, to enable a simulation-based approach to life-cycle performance evaluation. (1500, 2600, 2900, 8700)

Advanced concepts group

The Advanced Concepts Group (Sandia's forward-looking in-house think tank) and WET Design, Inc., have demonstrated a **large hydraulic impulse device** capable of stopping a moving vehicle, breaching structures, and disabling IEDs. The device, a pneumatically driven water cannon, shoots a column of water hundreds of feet. This proven technology is similar to the impulse fountains used world-wide; the fountain at the Bellagio Hotel in Las Vegas, Nev., is a familiar example. (7000)

The Bi-National Sustainability Laboratory opened its doors in November, a project initiated and championed by Sandia's Advanced Concepts Group. The laboratory, funded by the US and Mexican governments and by the State of New Mexico, **aims to establish a string of research centers** stretching from the Gulf Coast to the Pacific. Its ultimate goal is to serve as an engine of research excellence for sustained economic development along the US-Mexico border.

The ACG held a fest focused on leveraging the public to prevent and mitigate terrorism at soft targets in the US, such as airports, shopping malls, and sports events. One idea developed at the fest is a sophisticated national **multimedia campaign** called "The Art of Freedom" designed to build community, increase resilience, and give the public actionable information about homeland security. The Albuquerque Sunport has funded Marshall Monroe Magic, Inc., to further develop the proposal. The Sunport will serve as the pilot site. (7000)

HYDRAULIC IMPULSE DEVICES, using technology similar to that which drives impulse fountains such as the famous display at the Bellagio in Las Vegas, may help foil various terrorist tactics. (Photo courtesy Bellagio Hotel and Casino)



Nuclear weapons

(Continued from preceding page)



The W87 System Engineering Group flight-tested (see image above) the first of a new series of Joint Test Assembly (JTA) reentry vehicles (designated JTA4) on August 25, 2005. **The near-flawless performance** of the advanced modular telemetry and instrumentation system provided critical qualification data for the new W87/Minuteman III weapon configuration. The JTA4 series is designed to provide an enhanced fidelity measurement platform for obtaining stockpile surveillance flight test data for the

W87 and Minuteman III programs. (8200, 1700, 2500, 2600, 5300, 12300)

Sandia deployed a Radiological Assistance Program team to assist White Sands Missile Range in resolving a problem with a stuck 15 kiloCurie Cobalt-60 source at its Gamma-Irradiation Facility. The RAP team, consisting of personnel from Emergency Response Systems Engineering Dept. 12345 and Mobile Robotics Dept. 6644, **successfully returned a source to a safe condition** with minimal radiation dose to personnel. Activities included tooling development, robot repair, entries into a potentially lethal radiation area, and dynamically modifying a Sandia robot to perform the most hazardous operations. The front cover photo shows the robot modified by the team to solve the problem. (12300)

In February 2005 the W76 Weapon Assessment Team **provided an independent nuclear surety assessment** of the W76-1 final design. The team's assessment considered analysis representing the following disciplines: nuclear safety, reliability, quality, surveillance, and security and use control. The assessment is prepared for the Executive VP and Chief Engineer. The formal analysis allows the W76-1 Weapon Project Team to focus further surety efforts on high-priority nuclear surety concerns. (12300)

The MESA project accomplished 25 percent of the overall work scope last year on time and on budget. The overall project is **some three years ahead of schedule, more**

than 70 percent complete, and projecting significant cost savings. The MESA project team's major achievements last year included: a New Mexico Quality "Road-runner" recognition award, start of the Weapons Integration Facility construction, ISO Class 4 cleanroom certification in the new MicroFab facility, start of MicroFab tooling subproject, and support to the Sandia corporate Earned Value Management System certification by DOE.

The Nuclear Weapons SMU Corrective Action Tracking System (CATS) is an integrated process/tool that enables more effective, sustainable solutions for managing required corrective actions. Sandia and NNSA's Sandia Site Office are users. CATS, based on nuclear weapons complex and industry best-practices, is a key component of NW Performance Excellence and an ISO-9000 management system. The system incorporates a key process, workflow application, status/trending tool, online help, full training, and user support group. (200, 2000, 4000, 10000, 12000)

Model Based Performance Analysis is using modeling and simulation to **gain a broader and deeper understanding of weapon electrical system performance**. Circuit variability analysis results estimate uncertainties and quantify margins for key subsystem requirements. Modeling the W76-1 Firing Set is supporting the Life Extension Program by enabling understanding of design margins. (12300, 8200)



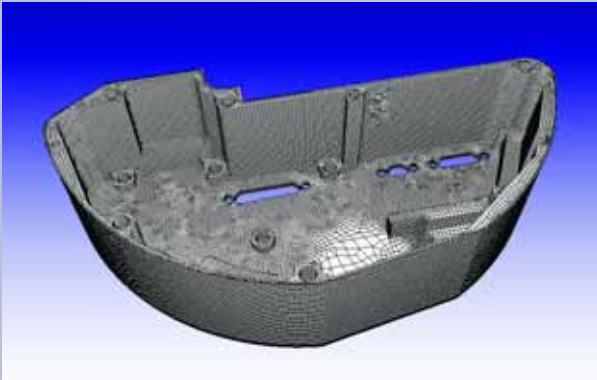
THE CAPABILITIES OF THE CODE MANAGEMENT SYSTEM were significantly increased to support use-control functions for several additional weapons in the stockpile (in addition to the previously supported B61-3,4,10). The Code Management System will next be employed by the Air Force Materiel Command to replace its aging, less-capable

system. Four years of development culminated in the completion of an NNSA Level II Milestone composed of software and hardware product Qualification Engineering Releases. First Production was accomplished by the Honeywell/FM&T plant ahead of schedule. (2100)

Computing

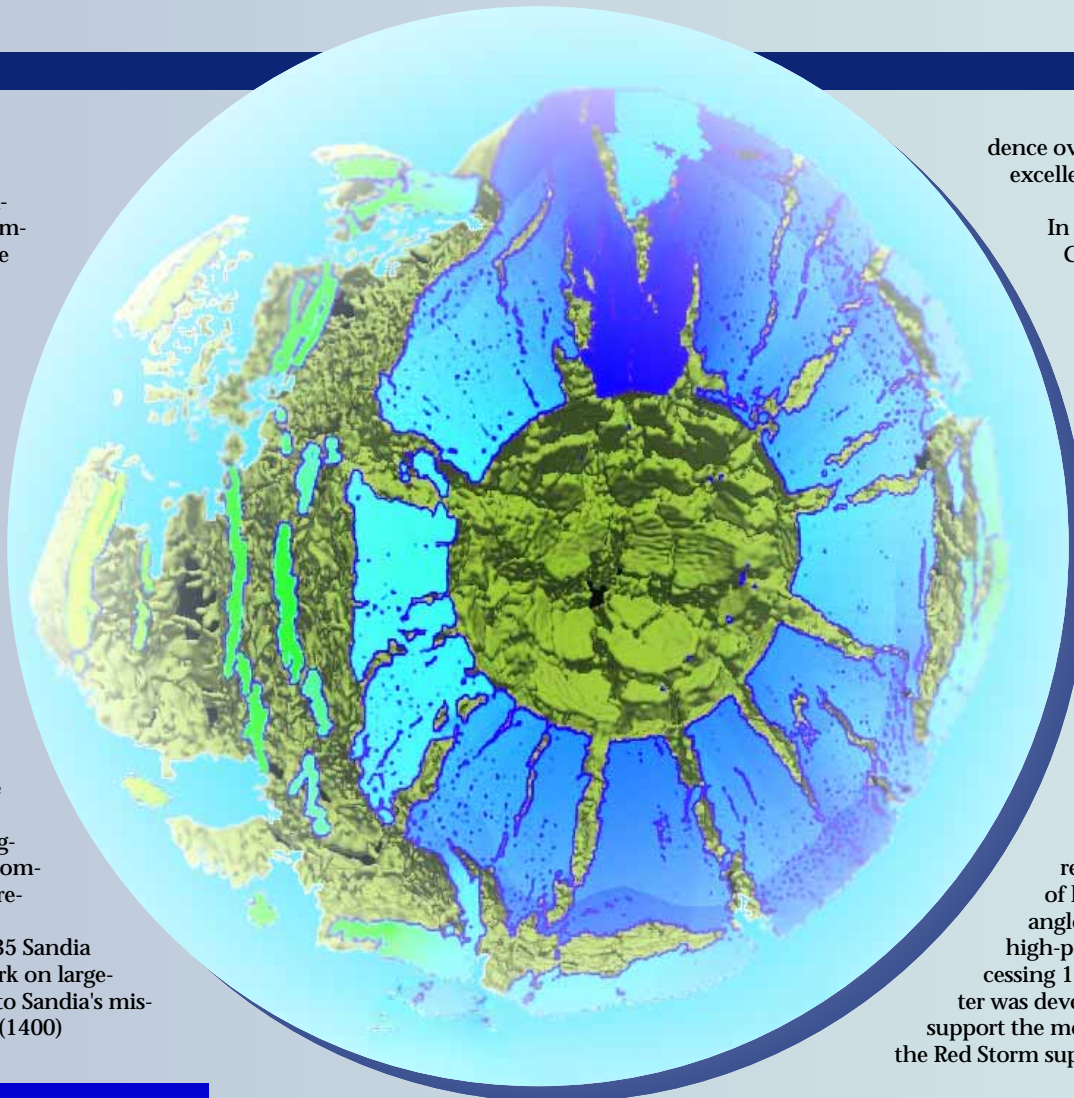
Sandians, working with Cray Corporation, brought the Red Storm supercomputer into limited availability. (For more on Red Storm's accomplishments, see first entry under "Nuclear weapons," page 3.) Delivery of the hardware during the summer of 2005 enabled the team to meet several NNSA milestones. Our **Linpack benchmark performance was 36.19 Teraflops** on 10,848 processors, placing Red Storm at number six on the Top500 (ranking of supercomputers). Efforts are now focused on addressing the nuclear weapons capability computing workload, improvements in system reliability, and parallel file system performance. (1400, 4300, 8900)

Sandia's **Computer Science Research Institute** broke ground in August on a new building "outside the fence" to enable university researchers and students to more easily work alongside Sandia researchers on large-scale computational problems. The 34,500-square-foot building at Sandia Science and Technology Park will accommodate 135 Sandia researchers and 55 collaborators to work on large-scale computational problems critical to Sandia's mission and US technological leadership. (1400)



A COMPLEX MECHANICAL part meshed with the DART tool, CUBIT (see description below).

The DART environment is a collection of software tools that reduce the time required to build, analyze, and understand complex finite element analyses. The DART team, with participation from Centers 1400, 1500, 4300, 4500, 5700, 6200, 8700, and 8900, deployed the initial DART



SANDIA'S RED STORM SUPERCOMPUTER ran a 15-hour shock physics simulation of an asteroid being split apart by a nuclear blast. The simulation offers detail not seen in lower-resolution models.

production release on the Sandia Restricted Network in September 2005. The environment provides **capabilities such as consolidated analysis artifact management, improved meshing and model-building tools**, unified ASC platform and code access, and improved visualization. DART tools interoperate through the use of metadata, which frees analysts from manually translating data between tools.

Last April, **Center 4500 was awarded the Software Capability Maturity Model (SW-CMM) Level 3 designation** from the Software Engineering Institute. "Certified processes" is often a factor in qualifying providers in the defense industry. Though CMM is a global standard and a focus of other Lockheed Martin companies, Center 4500's certification is the first (known) among the DOE weapons labs. The certification represents a first step toward "evi-

dence over assertion" for software performance excellence. (4500)

In a collaborative effort involving several Computing and Integrated Enabling Services organizations, Sandia procured and installed the new Thunderbird Computer Cluster. This team worked safely over an intensive six-month period to complete the procurement, installation, integration, and testing of this new machine in unprecedented time. Thunderbird went into production last October to provide more than 8,000 processors delivering 60 Tera-OPS (trillion operations per second) to meet the laboratory's growing demand for capacity computing. (1400, 4300, 8900, 1900, 10200, 10800)

Sandia's **Red RoSE cluster achieved production status** in August 2005 and became one of the world's most capable visualization and data management computer systems. Red RoSE set a record for highly interactive visualization of large data sets by rendering 8 billion triangles/second. Red RoSE also set a record for high-performance disk storage systems by processing 15 gigabytes/second. The Red RoSE cluster was developed and deployed by Center 4300 to support the modeling and simulation environment for the Red Storm supercomputer.

Sandia and Lockheed Martin researchers applied state-of-the-art optimization methods from Sandia's DAKOTA software to **design the external fuel tank for the F-35 Joint Strike Fighter aircraft**. The DAKOTA toolkit made possible a "virtual prototyping" design process by reducing both the number of expensive computer simulations and the number of expensive wind tunnel tests needed to refine the fuel tank shape. Subsequent test data validated the predicted performance of the new aero-shaped fuel tank for low observability (stealth), fuel efficiency, and flight safety. (1400, 1500, 10100, Lockheed-Martin)

The **Interactive Design Center (IDC)**, Sandia/California's premier facility for viewing high-resolution computer-generated graphics, became operational in January 2005 and was recently accredited for classified computing and display. Funded by the NNSA's Advanced Simulation and Computing Program, the IDC's high-fidelity display systems and advanced computational platforms enable designers, engineers, and analysts to interactively view, discuss, and comprehend complex large-scale weapons models and simulations in real time.



Homeland Security

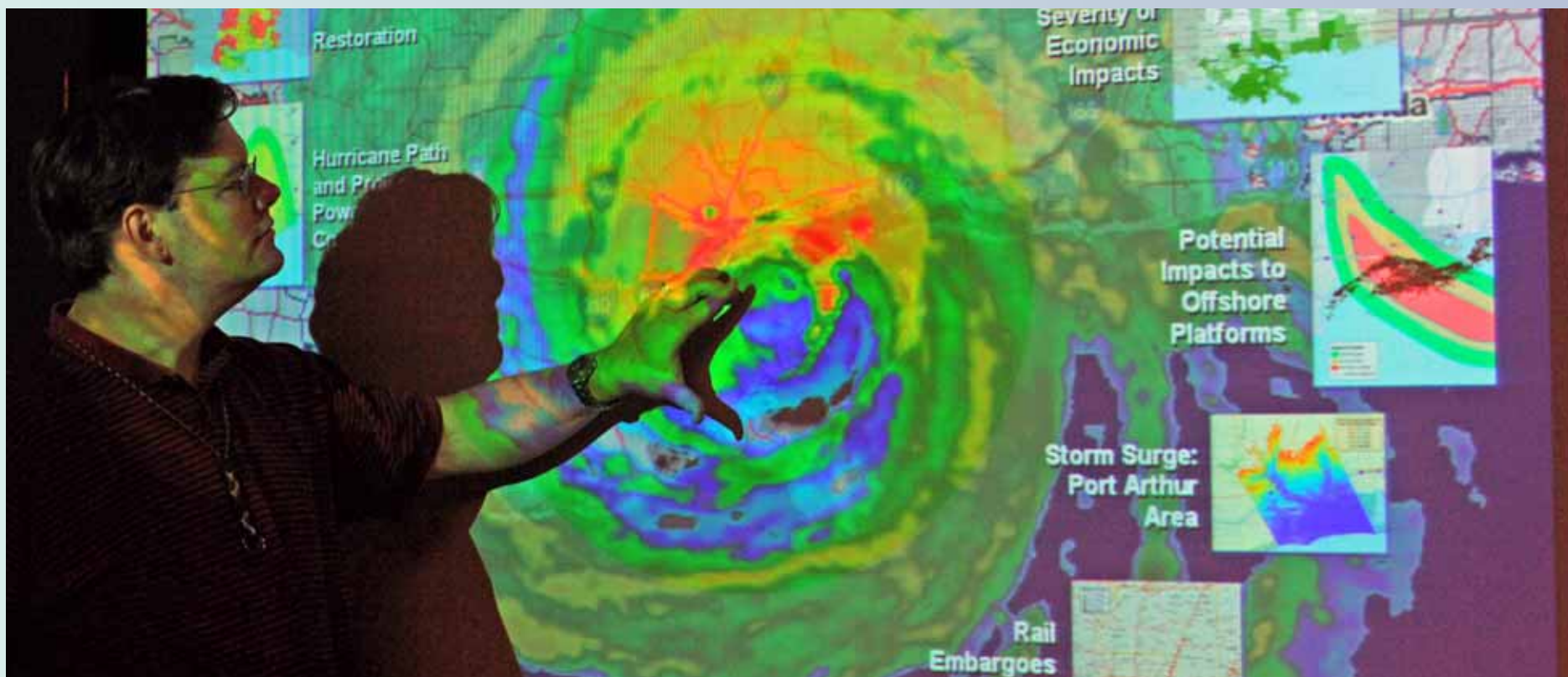


Photo by Randy Montoya

In the wake of Hurricane Katrina, Sandia's National Infrastructure Simulation and Analysis Center supported the Department of Homeland Security by performing a **detailed analysis of the potential long-term impacts** of the hurricane on the US economy (see image above). NISAC staff, working with six economists, labored for 36 hours straight and reported the estimates of impacts directly to Secretary Chertoff. Subsequently, DHS praised NISAC for providing estimates that were very close to those released by the US Congressional Budget Office. They arrived at DHS a week before the CBO estimates. (6200)

The **Operations Research & Computation Analysis (ORCA)** provided key infrastructure and modeling analysis to NISAC's Fast Analysis Support Team as part of Sandia support to the DHS after hurricanes Katrina and Rita (see entry above). ORCA used the Railroad Network Analysis System, which it designed and developed, to determine the hurricane-related impacts to the national flow of commodities on the rail system. Rail outages were also tracked to provide DHS with a comprehensive status of the rail system.

The **Sandia Gauntlet** was subjected to rigorous performance assessments at the Explosives Applications Laboratory, Site 9930. A new gun, necessary for these tests, was developed by Dept. 5122 personnel. The penetration velocity for the four fragments exceeds the requirement for the Army's interceptor body armor. The final round of testing included a commercially available Kevlar material (KM2). Ten sets of gauntlets have been delivered to the US Army for testing and evaluation, and 50 sets are being finished for the US Air Force Battle Lab. A patent application has been prepared and submitted. (5100)



Photo by Randy Montoya

In November 2004, a fire started in the Rocket Shear Machine at the Umatilla (Oregon) Ammunition Depot during demilitarization processing of M55 rockets (see image below). Months later, two additional incidents



occurred at the facility during the same process. The Chemical Materials Agency (CMA) asked Sandia to provide an **independent review of the depot's processes**. Representatives from Explosives Applications Dept. 5122 visited the facility and developed a report identifying likely problem areas and suggesting possible improvements. Plant operations were restarted after process improvements were implemented, based in part on the report. No subsequent accidents have occurred. (5100)

Sandia led completion of **Remotely Operated Weapon Systems (ROWS)** — see photo below) at two sites this year, the Y-12 Plant and a US Air Force installation. The system's advantages include the ability to respond to multiple threats and locations from one command center, and increased firepower with reduced costs, with accuracies that approach and sometimes exceed those of humans. Sandia continues to refine the effectiveness of ROWS by providing operators with situational awareness and targeting tools. (6400, 6600)

With sponsorship from the National Institutes of Health, we have developed lab-on-a-chip technologies for **rapid detection of periodontal disease biomarkers** using tiny amounts of saliva. In many applications, saliva is preferred over other body fluids as it can be noninvasively and inexpensively collected. The device being developed is portable and targeted for point-of-care application such as a doctor's or dentist's office. Our lab-on-a-chip technology is also applicable to diagnosis of a wide range of oral and systemic diseases, including potential exposure to biological agents.

A team of Sandia engineers, analysts, and computer scientists has completed initial development of a **powerful set of tools to help protect our borders**. The focus of this Grand Challenge LDRD was to develop simulation-based systems analyses characterizing the security of the US border and the impact of new detection technologies. Preliminary analyses of seaport, airport, and land crossing checkpoint operations have generated significant interest from Customs & Border Protection, the Domestic Nuclear Detection Office, and various government contractors. (6200, 6400, 6600, 8100, 8200)

The BioDAC (Biological Decision Analysis Center) simulation was developed and used successfully for DoD and Department of Homeland Security-sponsored bioterrorism exercises and analyses through the BioNet Program. In

the exercises, **civilian and military role-players used their response strategy** in scenarios and examined how their ConOps and physical systems might be effective in detecting and characterizing an attack. Participants included senior DoD and DHS officials; local public health officials; and US Navy health, fleet, and installation commanders. (8100, 8500, 8900, 4500)

A BioDAC simulation exercise.

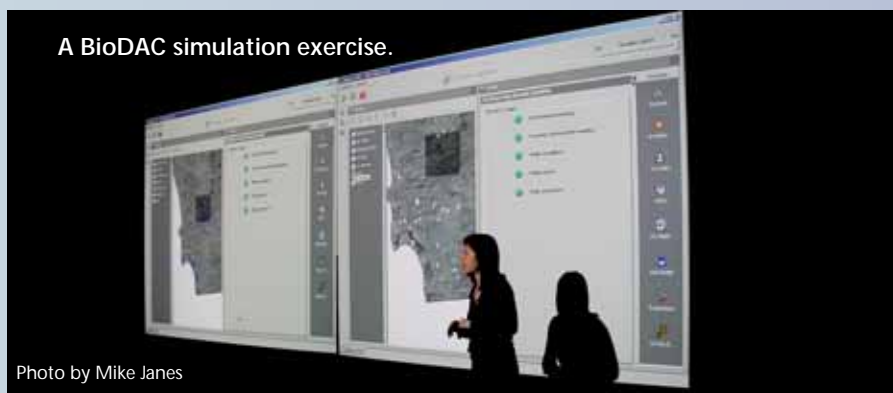


Photo by Mike Janes

The **Rapidly Deployable Chemical Defense (RDCD) system**, designed for the Department of Homeland Security, is an early-warning chemical detection system to protect against chemical threats at National Special Security Events. A multilaboratory team (Sandia, Lawrence Livermore, Pacific Northwest, and Los Alamos) developed a system solution that includes a ground-based detection system, dispersion modeling, meteorological information, and an air-based detection system. Sandia serves as the program lead and developed the ground-based detection system consisting of eight nodes, which include detectors, communications, video surveillance, and a multi-communication mode Sensor Management Architecture. (8100, 8200, 8500)



Operation America, a five-day workshop on advanced bomb-disablement technology for bomb squad personnel, was conducted in November in Albuquerque. The program, hosted by Sandia, was cosponsored by DOE and the Albuquerque Police Department bomb squad. Sixty-five participants from 12 states, all branches of the US military, and Canadian police and armed forces units attended. Three days of technical presentations, tools, and techniques were followed by live-range demonstrations and participation in realistic scenarios held throughout the Albuquerque area (see image above taken during a scenario exercise at a local high school).

Defense systems and assessments

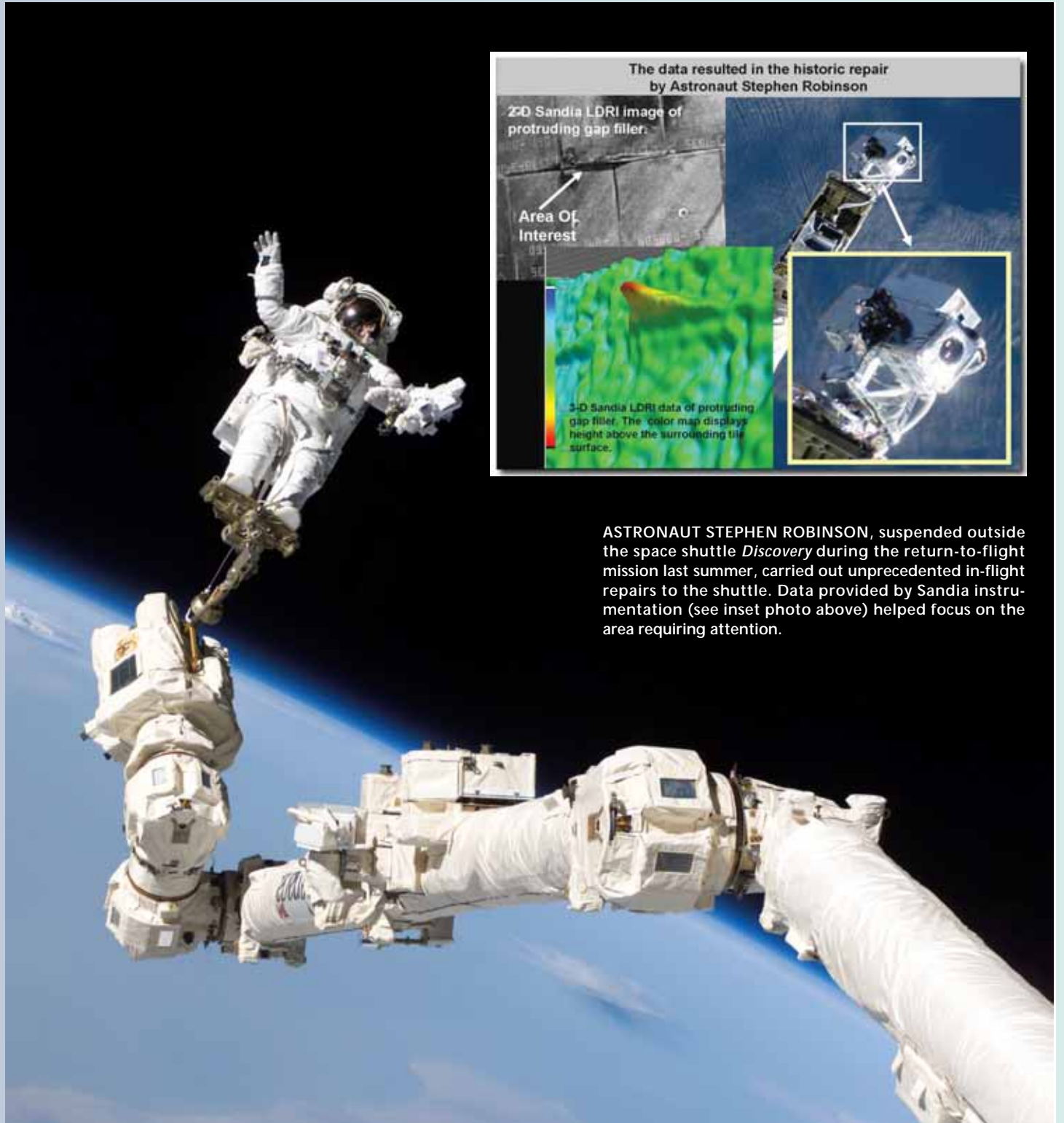
The Laser Dynamic Range Imager (LDRI), developed in Dept. 2624, was the primary tool of choice for NASA to inspect the space shuttle *Discovery* while in orbit, during the historic "Return to Flight" mission. The sensor was used by astronauts to identify and characterize potentially catastrophic damage to the shuttle's thermal protection system. Along with the LDRI sensor, we developed and delivered an extensive imaging processing capability for Mission Control. The Sandia mission control team produced enhanced visualization and vibrometry data during the mission. (2600, 1500, 2300, 2400, 4300, 5400, 5600, 5700, 5900, 12300)

RF (radio frequency) microelectromechanical systems (MEMS) are being developed for applications that demand world-class electrical performance and extremely high reliability. Understanding of the behavior of these designs through observation or measurement is difficult due to the designs' microscale time- and length-scales. These technical challenges have been successfully tackled by a cross-center team at MESA-TOP led by Dept. 1742. The team used advanced simulation capabilities and microsystem diagnostics to reveal and address unanticipated dynamics, thereby achieving significant advances in reliability. (1500, 1400, 1700, 2600)

Sandia developed the Global Positioning System (GPS) Joint Program Office crypto-processor used in military receivers. The crypto-processor implements critical security functions necessary for US battlefield superiority, including Over-The-Air-Rekey (OTAR). OTAR lets military receivers securely update crypto keys in the field via satellite data transmissions, greatly simplifying crypto key management. In FY05, Dept. 2622 supported a full system test of the OTAR capability using Control Segment broadcast to live satellites. This demonstration was a resounding success and an essential step toward full operational capability of the next-generation GPS security. (2600, 1700, 5600, 12300)

We participated in two launches last August as part of the Missile Defense Agency's Critical Measurements and Countermeasures Program. This program involved Sandia, Orbital Sciences Corp., and MIT's Lincoln Laboratory. The flights launched from Sandia's Kauai Test Facility. The missions are a vital part of the Ballistic Missile Defense System risk-reduction effort, testing critical system elements and system-level issues. The successful flight test campaign provided the most challenging target scenario to date to support ballistic missile defense development. (2600, 5300, 5400)

Penetrator Technology Dept. 5431 successfully conducted full and subscale tests with the mobile guns at the White



ASTRONAUT STEPHEN ROBINSON, suspended outside the space shuttle *Discovery* during the return-to-flight mission last summer, carried out unprecedented in-flight repairs to the shuttle. Data provided by Sandia instrumentation (see inset photo above) helped focus on the area requiring attention.

Sands Missile Range last fall. We met our Defense Threat Reduction Agency customer objectives, collecting onboard projectile deceleration data in the full-scale test units. Using the Sandia 3-axis millipen hi-G data recorder and a SIPE fuze, we were able to collect data in two targets with two different size projectiles. We demonstrated survivability of a jointed case versus a monolithic case under conventional velocity impact conditions. (2100, 2600, 5400)

Development of the Support Enterprise Model (SEM), an enterprise-scale logistics simulation tool, passed critical milestones in 2005. SEM is being used on the Joint Strike Fighter program by LM Aeronautics, JSF Program Office, and international partners to help support multi-billion-dollar design decisions and trade studies. Sandia successfully completed a major upgrade, received formal

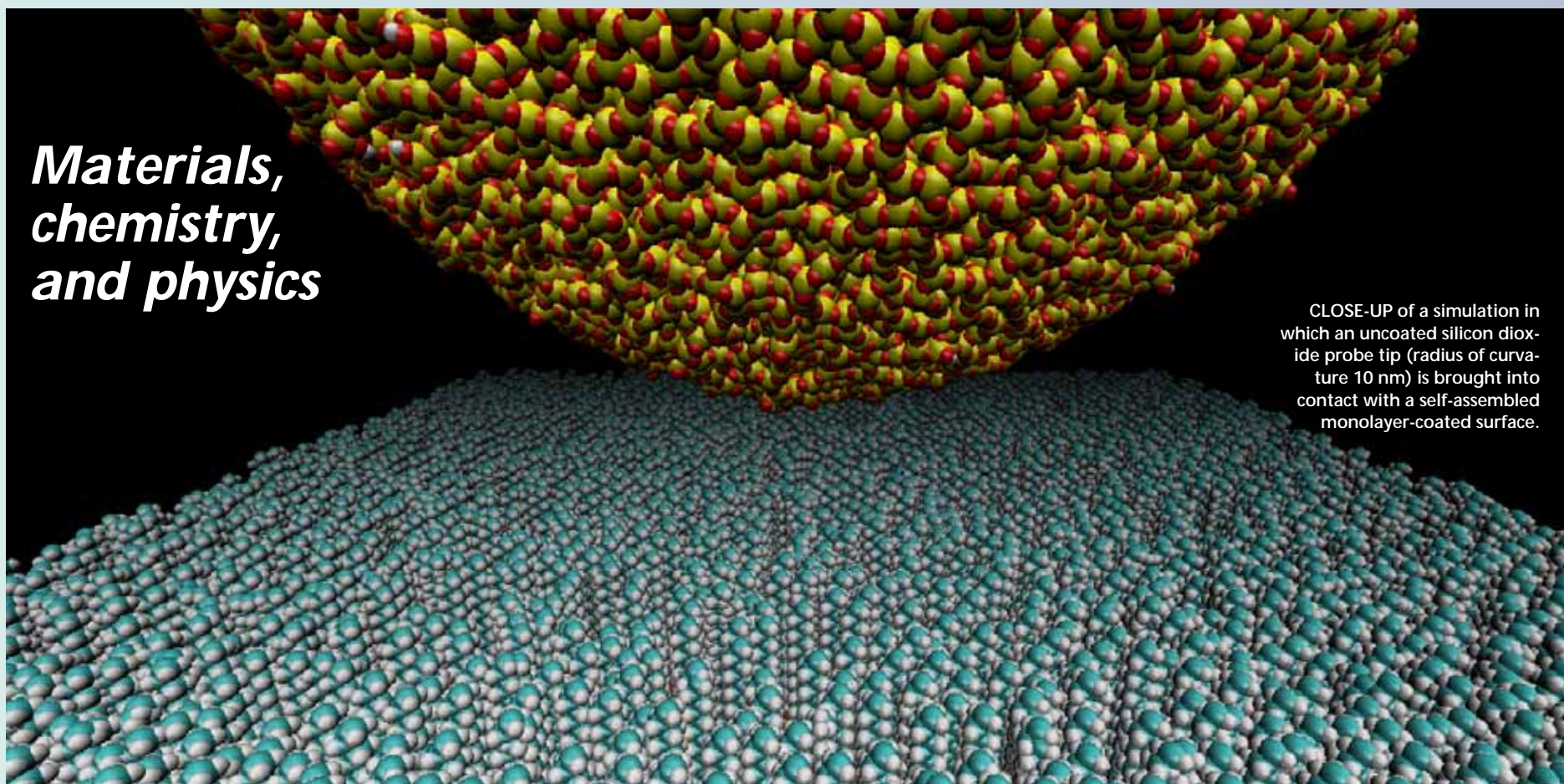
SEM code verification, and earned JSF Program User Acceptance. Software development is being led by 6642 (with 1415 providing optimization expertise) under a Lockheed Martin CRADA. (6600, 1400)

The fiber laser LDRD Grand Challenge has reached a major milestone for the laser community. Roger Farrow, Paul Schrader, Dahv Kliner, and Alexandra Hoops (8300) have demonstrated >1.2 MW peak power from a Yb-doped double-clad fiber amplifier. More recently, with a 2.3 ns seed source developed by Randy Schmitt (1100), they generated >1 mJ of pulse energy with an essentially diffraction-limited beam quality. This achievement enables a wide range of applications, such as secure communications, remote sensing for reconnaissance, and 3-D mapping (ladar). (8300, 1100)



THE SANDIA-DEVELOPED Support Enterprise Model is being used to help design a global sustainment system for the Joint Strike Fighter. (Photo courtesy Lockheed Martin)

Materials, chemistry, and physics



CLOSE-UP of a simulation in which an uncoated silicon dioxide probe tip (radius of curvature 10 nm) is brought into contact with a self-assembled monolayer-coated surface.

Using Sandia's powerful supercomputers, we've developed a new capability to **accurately simulate the probe tip of an atomic force microscope**. These simulations mimic experiments that study the origins of adhesion and friction in microelectromechanical systems, while providing an unprecedented level of detail. Friction in these systems is lowered through a self-assembled monolayer coating, but wear and degradation of the coatings, particularly in the presence of water, is still a concern. Simulations will allow researchers to understand factors that influence coating degradation and help designers improve overall performance. (1800)

Peter Schultz developed an innovative numerical method to accurately **compute electronic energy levels** associated with defects in semiconductors using first-principles density functional theory. Accurate knowledge of these levels is essential to predict the electrical response of semiconductor devices in radiation environments. This breakthrough overcomes a longstanding bottleneck in modeling defect properties and enables

building physics-based defect models that meet a key need for the multiscale modeling and simulation effort in support of developing qualification alternatives to the Sandia Pulsed Reactor.

We performed cutting-edge computational research aimed at **elucidating details of wetting in multicomponent polymer systems**. The work was featured on the cover of *Langmuir* (August 16, 2005). The scenario we investigated (relevant to a wide range of coating technology) is one wherein a component in the liquid does not, in its pure state, wet the surface. By simulating mixtures of non-wetting and wetting material, we demonstrated unique dependencies of spreading behavior on droplet composition as well as the various interaction energies in the system. (1100, 1800)

High-explosive hexanitrostilbene (HNS) has been successfully machined into **miniature rods, called "rate sticks,"** using a femtosecond laser. The laser ablates the HNS, but each pulse is so short that it does not ignite.

The resulting rate sticks are believed to be the first of their kind machined from HNS, with previously unachievable small diameters of less than 0.5 millimeter. At these diameters, **investigators can examine fundamental detonation phenomena** at length scales previously unattainable. Sandia continues to investigate fabrication of additional miniature test geometries to further enhance fundamental understanding of explosive behavior. (2400, 2500, 8300, 6100, 1700, 6600)

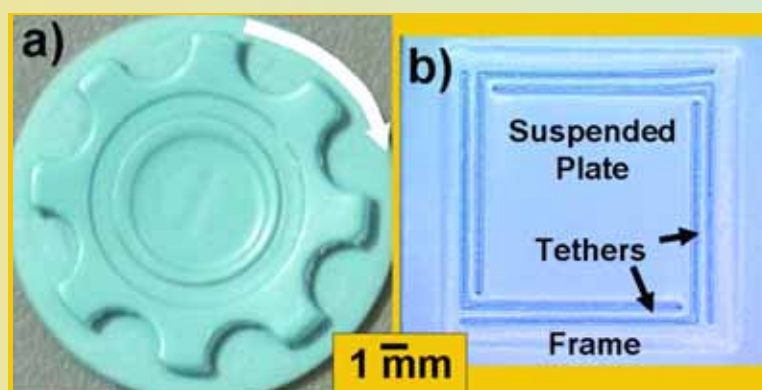
Interest in the indirect bandgap Ge⁰ nanocrystals (see image below) has increased since the recognition that they can behave as a direct bandgap material. This new understanding opens the possibility of using Ge nanocrystals as **light-emitting or power-generating elements**. For the first time, we have developed convenient, simple, single-source solution synthesis of Ge⁰ nanodots, rods, or wires, the morphology of which is dictated by the molecular precursor design. Recent results with specially prepared Ge⁰ nanocrystals demonstrated the utility of these species as bioimaging agents for mast cells.

Microsystems

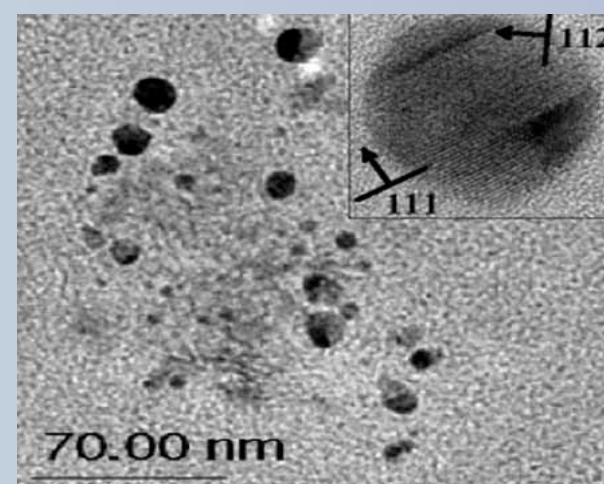
Under Sandia's Truman Fellowship program, researchers in Center 1700 set a MEMS switching speed record by changing states in less than 500 ns with a total displacement of 1.8 μm and using just 35 V. This is roughly **10 times faster than all other MEMS switches** with comparable displacements and voltages. Strain energy stored in the switching structure is recycled to drive high-speed switching operation and to reduce switching energy. Potential applications include RF, free-space optical, and integrated optical (waveguide-based) MEMS switches. (1700)

Sandia's Low Temperature Cofired Ceramic research team has **created an important new class of mesoscale (millimeter size range) components**. A sacrificial material technique eliminates processing steps and creates the world's first cofired impeller and suspended proof-mass (Fig. 1). Other cofired structures include "smart" channels for gas (e.g., toxin) analysis, pressure transducers, heaters, temperature/flow sensors, switch structures, and critical elements of micro "total analysis systems." This new integrated functionality in a small volume opens the door to innovative designs and enhanced capabilities for weapon systems, homeland security, and commercial applications (see next entry, below). (2400, 8300, 6100, 1700, 6600)

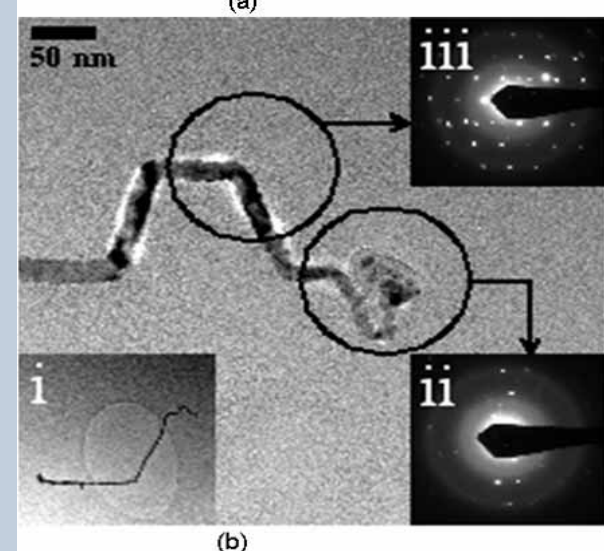
Integrating microfluidic devices into complex microsystems — key to analytical chemistry and life sciences success — has been a barrier to microsystems development. As featured on the September cover of the *International Journal of Applied Ceramic Technology*, a Sandia breakthrough has been made that uses low temperature cofired Ceramic manifolds with internal passageways to **marry miniature devices to standard connectors**. This enables easy integration and testing of microsystems using silicon microfluidic valves, mixers, pumps, and sensors. Potential applications for such integrated microsystems include braille readers, biological cell characterization, and weapon systems. (2400, 8300, 6100, 1700, 6600)



MESOSCALE COMPONENTS — a) The first-ever functional-as-released freely spinning impeller in low-temperature cofired ceramic has survived one million revolutions; b) Proof-mass is suspended by low temperature cofired ceramic tethers.



(a)



(b)

Ge⁰ (a) nanodots and (b) nanowires formed from Ge(II) precursors: (a) amide, and (b) aryloxide.

Engineering sciences

The Test Capabilities Revitalization project team completed phase 1 (\$47.2 million) of a congressional line item project to **restore Sandia's test capabilities**. The project provides new qualification, weapon development, and model validation capabilities. Phase 1 enhanced the Aerial Cable Facility mechanical testing capabilities and constructed a one-of-a-kind Thermal Test Complex to perform abnormal thermal environment testing and fire physics R&D. The cable facility has already supported multiple B61 and B83 surveillance and B61 ALT 357 certification tests. The Thermal Test Complex will be used this year to support W76 and W80 LEP qualification efforts. (1500, 10800)

The Advanced Simulation and Computing Verification and Validation milestone "W76-1 Hostile Mechanical Response to Blast" was completed in August 2005. The body of work represented the culmination of a **three-year effort to enable a new approach to model validation** based in an uncertainty framework with quantitative assessments of model validity. The ASC advisory panel praised the team's "dedication and commitment to producing quality work" and further acknowledged its historic contribution to the development of tools and methods for modern predictive science.

Sandia staff have contributed to the **development of the next-generation destroyer** for the US Navy, with experiments, analysis, and model development. In partnership with Navy labs and contractors, we have conducted a series of experiments to help understand the behavior of energetic materials in various accident environments. The data have been used to develop new models of propellant and high-explosive behavior. The models are now being used with Sandia-developed codes to design key aspects of the weapon delivery system.

Structural ceramics are used for armor, but they also appear in myriad commercial applications wherever a lightweight, strong, and heat-resistant material is needed. Recognizing that fabricated brittle materials



THERMAL TEST COMPLEX

share many of the modeling challenges intrinsic to naturally occurring rock, Geomechanics Dept. 6117 teamed with departments 1431, 1674, and 1647 to provide the Army Research Laboratory with enhanced models, resulting in

unparalleled mesh-independent and accurate predictions of cracking patterns and penetration resistance. This will help the Army more efficiently determine armor characteristics to protect our troops. (6100, 1400, 1600)

Biotechnology/Nanotechnology

THE SIDE VIEW of a single hollow μ Post. The μ Post is used for the capture and measurement of proteins using a fluorescent dye (green hue).



A partnership between Sandia and Compa Industries has developed a medical sensor called μ Posts (microposts) that could give physicians a greater understanding of a patient's health in a shorter amount of time. μ Posts (see above) are micron-scaled posts that painlessly penetrate the skin of a patient and detect many significant biological markers. With the μ Post medical sensor, hundreds of measurements may be taken simultaneously. To date glucose and heart attack markers have been measured in skin. (1700, 2500)

A computer cognitive model of an automobile driver uses information from the vehicle such as wheel speed and steering wheel rotation to infer driving contexts (e.g. entering roadway). Based on these driving contexts, the vehicle recognizes when the driver is in a difficult situation and can adapt appropriately. For instance, an incoming cell phone call may be momentarily blocked. This technology has been integrated into a Mercedes G-Wagon for operational testing by the US Marine Corps. (6600).

The continued growth in energy demand is driving increasing interest in renewable energy. Solar energy is a promising candidate, but much progress is necessary to overcome efficiency and economic factors. Nanostructures may present a unique solution to the problem, by offering new electronic structure, low losses, and entirely new functionality. Francois Leonard (8764) and Derek Stewart (now at Cornell) calculated that a single carbon nanotube, just a nanometer in diameter, can serve as a broadband optical energy conversion material. This fundamental understanding may pave the way for future all-carbon solar cells.

ES&H

The Environmental Restoration Project completed the final phases of its last two major remediation projects. A cover was installed on the Chemical Waste Landfill, completing more than eight years of remedial activity that included extraction of a solvent vapor plume and exhumation of a wide variety of materials disposed by Sandia between 1962 and 1985. Also, the last of more than two million artifacts dug up from the Classified Waste Landfill were demilitarized and sanitized. This activity concluded six years of effort since excavation of the landfill began in 1999. (6100)

Teamwork was evident during the highly successful chemical inventory reduction campaign of 2005 at Sandia/California. The effort resulted in a reduction of 15 percent of the total chemical container count (approximately 5,000 items) including some 700 of the most hazardous items. This campaign began as an Emergency Management/ES&H effort to reduce the inventory to minimize risk to on-site personnel and the surrounding community. We achieved synergy by blending a corporate self-assessment "House-keeping" finding corrective action and an Environmental Management System-established 10 percent inventory reduction goal.

Employee accidents and injuries dropped for the fourth consecutive year. The Total Recordable Case Rate (injuries requiring more than first-aid treatment) dropped to 2.6 during the 2005 calendar year from 3.0 in the same period last year — and down 37 percent from 2002. Last year, Sandia achieved the first week in five consecutive years without a recordable injury. There were no recordable employee injuries for the week of Sept. 12-18. The last time this occurred was in September 2000.

Among the prestigious awards bestowed last year on Sandia's Environmental Management Program were several top national and local honors. Sandia earned three NNSA Best-in-Class Awards for such work as the Joint Computational Engineering Laboratory (Bldg. 899) and Sandia's first green building (Bldg. 805). Sandia/DOE earned The City of Albuquerque's Top Wastewater Prize in the "Industrial Pretreatment Excellence Award for Wastewater Program." Sandia also received the White House "Closing the Circle Award" for green purchasing and the EPA's "Waste Wise Annual Award" for solid waste reduction.

To reduce accidents and injuries, a behavior-based safety process was implemented in Division 10000. It involved workers anonymously observing colleagues to reinforce precautions in safe use and provide information and reminders to help implement precautions and identify obstacles. Implementing the process has been shown to lower injuries by at least 25 percent within the first year and up to 80 percent in three years. Several precautions were identified to prevent 62 percent of Division 10000's injuries: body alignment, getting help, footings, line of fire, eyes on path, and hands/eye personal protective equipment.

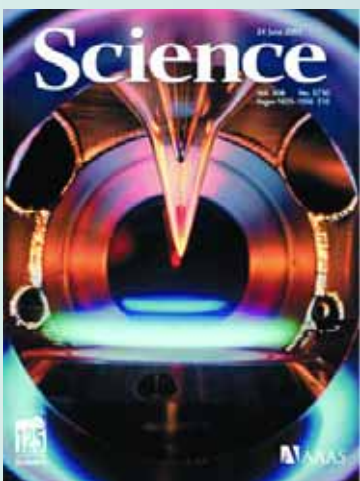
Energy, security, and defense technologies

Combustion researchers Jacqueline Chen and Evatt Hawkes were awarded 2.5 million hours — more than five percent — on DOE's Office of Science supercomputer at Lawrence Berkeley National Laboratory to carry out a combustion simulation of unprecedented complexity (see image at right). The computing time, awarded on the basis of a national competition, enabled the researchers to run the **largest-ever 3-D direct combustion simulation** of a turbulent CO/hydrogen flame in which the fuel and oxidizer are not premixed. The data will be used to understand turbulence-chemistry interactions required to design more fuel-efficient, cleaner-burning engines.

The Directed Energy Laser Applications Department (5100) has built the **world's highest peak-power laser** in the mid-infrared region (1.5-5 μm). The Optical Parametric Chirped Pulse Amplifier (OPCPA) uses a parametric mixing process to generate high peak-power pulses at wavelengths of 1.55 and 3.4 microns. Both wavelengths are important for remote sensing and nonproliferation applications. This source has allowed the group to make unique discoveries in the field of nonlinear optics, which are being unveiled to the scientific community for the first time through several upcoming publications.

Many Sandians worked together to plan and execute an event celebrating **President Bush's signing of the Energy Policy Act of 2005** Aug. 8, 2005 (see event photo on page 2). The event at Sandia included a 20-minute tour of the National Solar Thermal Test Facility, conducted by Tom Hunter, prior to the bill signing. President Bush was accompanied by DOE Secretary Samuel Bodman and N.M. senators Pete Domenici and Jeff Bingaman. The event highlighted the role Sandia can play as a contributor to the nation's energy security.

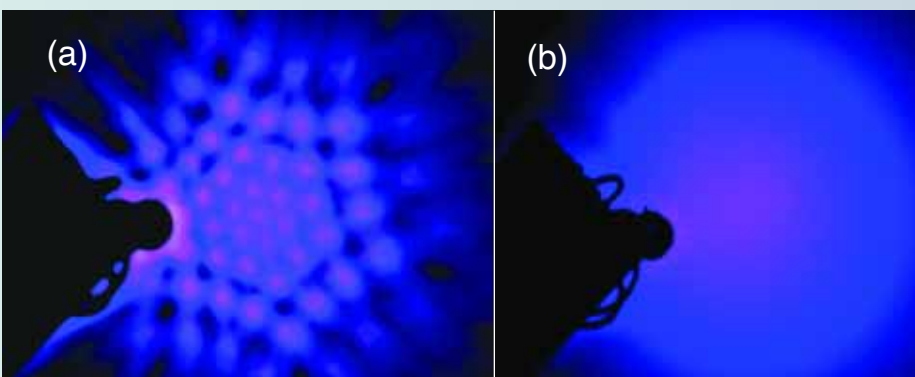
Predictive combustion models require detailed chemical mechanisms. Recently an international team, led by Combustion Research Facility researchers Craig Taatjes, Nils Hansen, and Andrew McIlroy, **discovered that a class of molecules** absent from present oxidation models, the enols, is ubiquitous in hydrocarbon combustion. Enols are the less-stable isomers of well-known combustion intermediates such as aldehydes and ketones. Erlenmeyer predicted their existence in 1880, but none were directly observed until 1973. Hydrocarbon oxidation mechanisms must be modified to account for the chemistry of these unexpected compounds. The work was featured as the cover story in *Science* magazine last June.



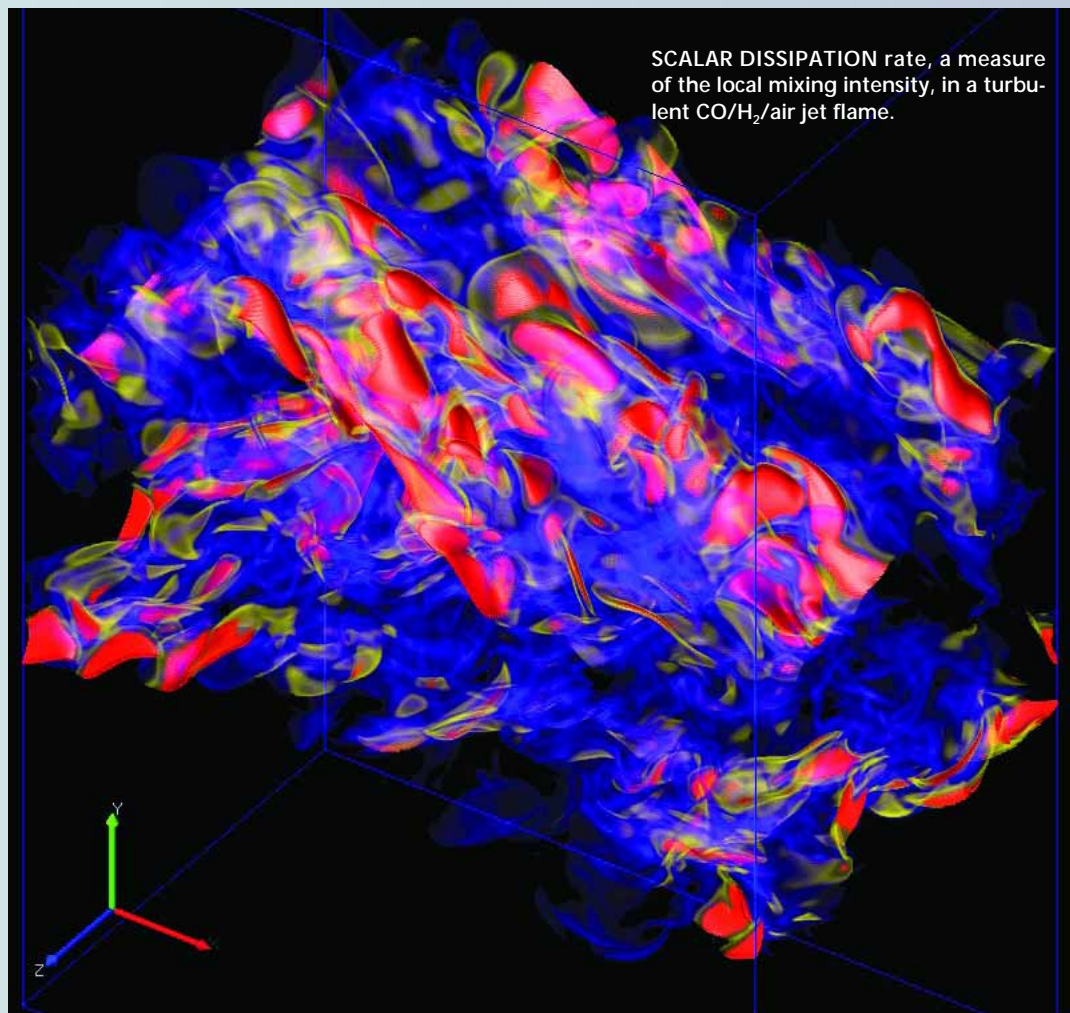
ENOLS make cover of *Science*.

Sandia has developed **new modeling and simulation capabilities** for application to advanced armor systems being developed at the Army Research Laboratory (ARL). Magneto-hydrodynamics capabilities developed for Z-pinch modeling, improved equations of state and electrical conductivity models developed from quantum molecular dynamics simulations, and new ceramics models employing statistical variability to eliminate numerical dependencies, have been integrated in the ALEGRA-MHD code. Analysts at ARL are now using ALEGRA-MHD simulations to help guide experimental work on improving the resistance of new armor concepts to various penetration threats. (1400, 1600, 6100)

We installed and tested a robotic projectile download workcell to **disassemble 155mm ADAM Improved Conventional Munition projectiles** in the state-of-the-art Munitions Cryofracture Demilitarization Facility at the McAlester Army Ammunition Plant in McAlester, Oklahoma. The workcell removes people from the potentially fatal hazards that occur annually in a worldwide industry. The Defense Ammunition Center used Sandia technologies developed under the DOE/DoD Advanced Munitions MOU Program.



LIGHT OUTPUT from a blue InGaN LED with (a) and without (b) a photonic lattice on the surface. The radiation patterns match the symmetry of the lattices.

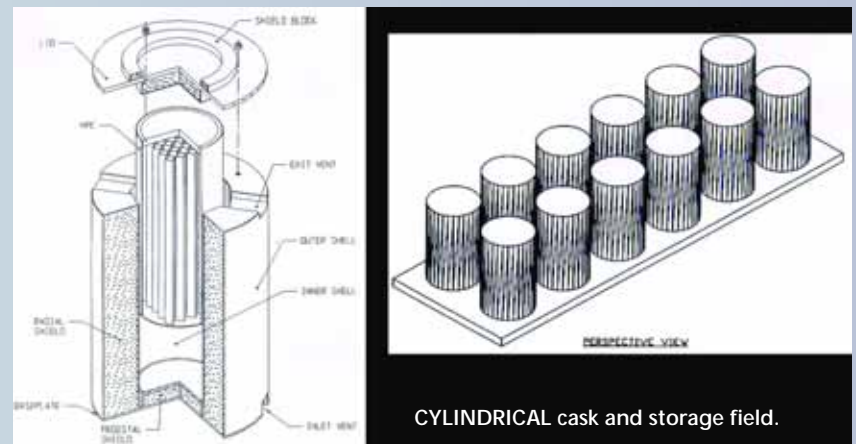


Sandia has developed a **new family of flexible flight computers** called IMPACCT that addresses a national need for economical computer solutions for high-consequence aerospace applications. IMPACCT embodies a flexible design concept combining Sandia custom subassemblies with commercial computer modules. Aerospace Systems Development Center 5400-sponsored graduate research at Kansas State University has produced student-inspired versions of IMPACCT that will be demonstrated on upcoming Missile Defense programs in FY06. Two KSU students last year earned IMPACCT-related MS degrees and now are helping sustain development and application efforts as members of Sandia's technical staff. (5400)

Sandia researchers **invented and tested new desalination and arsenic-removal technologies** while also helping New Mexico communities develop new sources of arsenic-free drinking water. Desalination efforts at Sandia involved researchers from several organizations who explored biomimetic separation of salts from water by cellular processes, freeze distillation, and advanced membrane synthesis. Research also explored the possibility of recovering drinking water from petroleum extraction wastes. In conjunction with the research, pilot-testing, technology commercialization, and out-

reach efforts are identifying paths for lowering arsenic levels in drinking water nationwide. (6100, 6200, 8300, 8700, 1000)

The nuclear power industry is turning to dry-cask spent-fuel storage systems to augment on-site spent fuel pools. Casks are typically tall, vertical, free-standing cylinders that might slide or tip



CYLINDRICAL cask and storage field.

during a strong earthquake. In work for the NRC, Sandia developed a comprehensive finite element **methodology for evaluating cask response to seismic ground motion**, including an integrated model of the soil, concrete pad, and the cask. The NRC will use the analysis results in licensing reviews to ensure system safety. (6800, 5400)

Sandia has developed an extensive array of analytical tools and experimental facilities to assess physical protection system performance. Center 6400, working closely with a nuclear utility, demonstrated the applicability of this security technology base to the development of options for **improved protection of nuclear power plants against terrorist attacks**. The utility participants are enthusiastic about using Sandia technology. The tools and techniques enable them to perform cost/benefit analyses for security upgrade options, support training of security personnel, provide a cheap and safe alternative to supplement force-on-force exercises, and evaluate the effectiveness of tactical response options.

Center 6800 leads an international effort involving DOE, France's atomic energy organization, and General Atomics to **develop the sulfur-iodine thermochemical cycle** for emission-free hydrogen production using high-temperature heat and water. In FY05, Sandia performed experiments to demonstrate high-temperature sulfuric acid decomposition, one of the three primary reactions in the sulfur-iodine cycle. The experiments demonstrated the process chemistry and materials technology that will provide the basis for an integrated international experiment at Sandia in FY2007. (6800)

From the beginning, Sandia developers of the Army's Explosive Destruction System (EDS) for chemical warfare munitions suspected that it could also destroy biological agents such as anthrax. Sure enough, under LDRD funding, **researchers confirmed EDS's effectiveness against bio agents**. Three treatment approaches were investigated: steam autoclave, gas fumigation, and liquid decontamination. Each resulted in complete neutralization of anthrax simulant bacterial spores. First delivered to the Army in 1998, EDS is a transportable system that has neutralized recovered chemical munitions in more than 225 operations in six states and England. (8200, 8700, 5100)

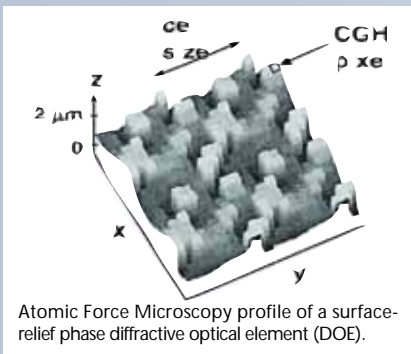
A Sandia team, teaming with researchers from UNM and Lumileds, a leading light-emitting diode (LED) manufacturer, have **demonstrated significant (1.6x) improvements in the light output** from visible LEDs using photonic lattices (see images at left). Advanced device modeling and design, nanolithography, and novel process development enabled the demonstration of these photonic crystal LEDs using InGaN materials. (1100, 1700)

Nonproliferation

The 23rd Defense Support Program satellite (DSP-23) was shipped from Northrop Grumman Space Technologies in Los Angeles to Cape Canaveral in Florida last May. DSP-23 is the last DSP satellite and the last of a long string of radiation detection (RADEC) and Advanced RADEC payloads that are and have been key to the nation's capability to detect both endoatmospheric and exoatmospheric nuclear detonation events. The DSP RADEC program has been a long-standing model example of collaboration between LANL and Sandia in service to the nation.

Sandia's most complex satellite system to date completed its Critical Design Review milestone, clearing the way for fabrication with system-level deliveries slated for early this year. The system is a technology-driven system-level development program that provides a Sandia-unique solution to critical national needs. Sandia's system engineering combined with key technologies enable this state-of-the-art system capability. Key technologies include large-format focal plane arrays, reprogrammable integrated circuits in radiation environments, precision pointing and control, high-throughput, low-latency, ground-based data processing, and supporting mission analysis. (5300, 5500, 5700)

Photonics Microsystems Technologies Dept. 1713 has delivered **diffractive optical elements (DOEs)**, as next-generation flight components, advancing spectral remote sensing capabilities in the Nonproliferation and Assessment SMU. These surface-relief phase DOEs direct more than 80 percent of the transmitted light into the dispersed order while allowing a small, broadband, zero-order beam for alignment. This represents a 4x increase in transmitted light over previous approaches. Completion of the DOEs challenged Sandia's lithographic fabrication and numerical modeling resources. We continue fundamental diffractive optics research that is relevant and responsive to all Sandia customers. (1700, 5700)



Atomic Force Microscopy profile of a surface-relief phase diffractive optical element (DOE).

We have developed a **technique to better solve registration issues associated with challenging image-pairs**. Few of the current image registration approaches include a measure of the statistical confidence associated with a solution. Such a measure is essential for many autonomous applications involving dubious registration solutions. The new approach employs the application of a well-established statistical procedure to select a "best" solution among a number of edge-detected candidates. The approach has been validated through an extensive simulation study, and has performed successfully in many applications to challenging real-world scenarios. (5500)

Sandia's biosecurity team made **great strides in promoting biosecurity**, which aims to stop bioterrorism before it starts by securing dangerous bio agents. Through international conferences and workshops, the team provided international scientific, policy, and law enforcement communities a thorough technical introduction to biosecurity. The conferences have led to laboratory biosecurity becoming a legislative and technical priority issue in many Asian countries, which have sought Sandia assistance in



ATTENDEES AT A SANDIA-SPONSORED conference on biosecurity issues in Malaysia. Sandia conducted similar workshops in Thailand and Singapore.

A Defense Support Program (DSP) satellite is shown on orbit in this Air Force illustration.



developing biosecurity systems. The team conducted workshops in Singapore, Malaysia, and Thailand, and visited labs in Indonesia, India, Japan, the Philippines, and Pakistan. (6900)

We have developed a training course that provides an **introduction to cryptography** through four half-day sessions. The Crypto Course topics include an overview, history, and details of both symmetric key and public key cryptography, covering various aspects of these technologies such as encryption and decryption algorithms, digital signatures, authentication, hash functions, side channel attacks, and key exchange methodology. Those wishing only a high-level overview (managers and project leaders) can sign up for just the first half-day session. (5600)

Researchers in Signal Processing and Research Dept. 5937 have designed a **next-generation real-time synthetic aperture radar (SAR) image formation and exploitation processor**. Built around a low-cost, ruggedized, fully scalable architecture, this revolutionary system is slated to fly this year on a General Atomics aircraft in a first-ever demonstration of strip-mapping coherent change detection (CCD). That is, the processor is designed to keep up with the demands of forming high-resolution images and performing CCD processing in a continuous fashion at aircraft velocities. (5900)

Sandia has delivered the second of the **next-generation Global Burst Detector payload** for integration with the second Block IIF Global Positioning System spacecraft at the Boeing Satellite Systems facility in El Segundo, Calif. The detector system encompasses a suite of sensors that perform the nuclear event monitoring mission of the US Nuclear Detonation Detection System. The sensors are designed and produced by Sandia and Los Alamos National Laboratory, with Sandia responsible for overall system engineering and integration.

Sandia led a multi-institutional R&D proposal team in process control system security funded by the **Institute for Information Infrastructure Protection (I3P)**. The unique aspect of this project is that the team includes 11 institutions working on a single project focused on securing the information infrastructure of the gas and oil sector. Team participants included researchers and engineers from Dartmouth College, the universities of Virginia, and Illinois, Pacific Northwest National Laboratory, SRI, University of Tulsa, MITRE, I3P, MIT,

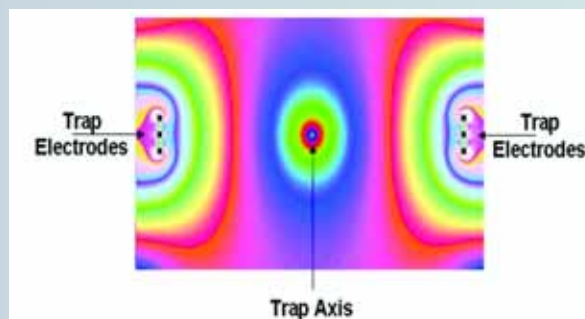
NYU, and Sandia. (5600)

The next-generation Integrated Correlation and Display System (ICADS), a \$190 million project, continues to defy the fate of similar DoD projects plagued by cost overruns and schedule slips. ICADS, part of the US Nuclear Detonation Detection System, processes data from sensors aboard Global Positioning System and Defense Support Program satellites. ICADS consists of a million lines of code and hardware located at seven facilities, and was handed over for system verification testing right on schedule. This milestone is the initial step of a year-long AF operational test process. (5700, 5500, 2600)

Sandia's Information Design Assurance Red Team (IDART), part of the Information Operations Center (5600), assisted in **Microsoft's process to**

improve system integrity, privacy, and data security for its Next Generation Secure Computing Base. An existing red teaming course was modified to include IDART's software red teaming methodology and then delivered to Microsoft. The project extended Sandia's capability in the areas of software assurance, trusted software, and information operations. This was Sandia's first major technology partnership agreement with the global software leader. (5600)

REDTEAM2005 was a resounding success as the first cross-governmental red team conference with attendance of 250 representatives from 60 government and military organizations. Hosted by the Information Operations Red Team & Assessments program, part of the Information Operations Center (5600), it was supported as a cross-Sandia effort. Themes for the event were Information Operations — supporting needs in DoD; and Homeland Security — supporting DHS and NORTHCOM. REDTEAM2006 will be held in May. (5600, 4100, 5900, 12300, 15200)



AXIAL VIEW of pseudopotentials calculated for a three-electrode-level Paul trap designed to confine a linear array of ions for quantum computing experiments. Ions are confined at the center by micro-fabricated electrodes on either side.

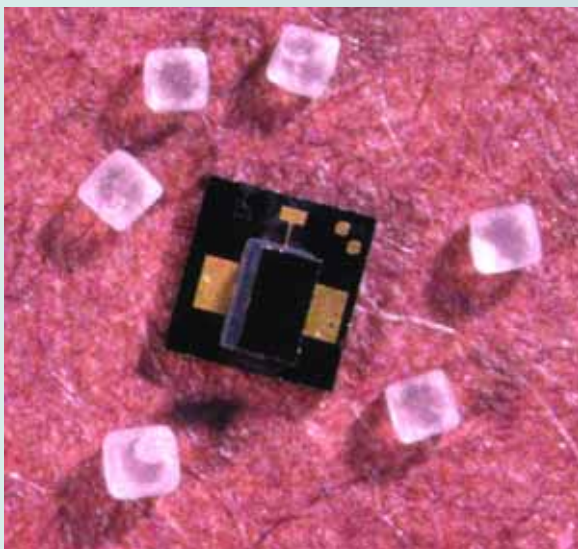
and algorithm-oriented LDRDs, an ARDA-funded project to develop micro-fabricated ion traps, and two DARPA projects. (1100, 1400, 1700, 4300, 5600, 5900)

The **"International Conference to Engage Iraq's Science and Technology Community in Developing its Country"** took place in Amman, Jordan, last September. Of the 175 participants, more than 80 Iraqi vice-ministers, scientists, engineers, and university administrators participated. Thirty grant proposals focusing on environment, water, agriculture, health, materials science, and business were presented to the international funding community. Representatives from several sponsoring organizations spoke with the Iraqis about funding requirements. Proposals when matched with funding partners will re-engage Iraqi scientists with their global colleagues while reconstructing Iraq.

Sandia researchers, **working with Israeli and Jordanian officials**, extensively tested a personnel explosives detection portal at the Allenby/King Hussein border crossing. Test data for the commercially available system based on Sandia technology have been shared between the two countries and the system has been certified for operational use. Use of the portal has cut the time of entry into the West Bank from three hours to one hour and has significantly reduced the number of pat-down searches that made border crossings difficult and time-consuming.

Electronics

Maintaining the desired internal atmosphere for hermetic devices is essential for long-term component reliability. There's a catch, though: **verifying hermeticity becomes much more difficult, but no less important**, as package size decreases. New MEMS packages (about the size of a grain of salt) have an internal volume of only nanoliters. Methods and hardware were developed that enabled successful sampling and quantitative analyses of the internal gas atmosphere of nanoliter packages. The technique is a radical jump from previous methods for common electronic packages having many orders of magnitude more volume (hundreds of microliters). (1800)



SALT CUBES AND MEMS — 30-nanoliter MEMS package surrounded by table salt crystals.

The **Ion Photon Emission Microscope, or IPEM, earned a 2005 R&D 100 Award**. The IPEM technique is based on determining by projection optical microscopy the position an individual ion enters the surface of the sample. This position is correlated with the ion-induced signal generated in the device under test, such as a malfunction in an integrated circuit. The IPEM will be useful for terrestrial

radiation effects mapping by commercial integrated circuit manufacturers and for radiation-hard IC testing at cyclotron labs. (1100)

Two nuclear micropower approaches have shown the potential to **safely deliver milliwatts of electricity** for decades. A robust 4.4-cm³ thermoelectric device (a cubic centimeter is about the size of a sugar cube) demonstrated 0.34 milliwatts electric in tests, with promise of approximately one milliwatt. A thermophotovoltaic device, meanwhile, demonstrated 1.3 mW electric from a tiny, 900K radioactive pellet, with an ultimate potential of >10 milliwatts/cm³. These devices point to 10-to-1,000-times improvements over commercial battery energy densities and could be invaluable in weapons and unattended sensor applications. (1700, 1800, 2500, ORNL)

The Terahertz Detector Team **achieved dramatic performance improvements in a unique detector** of terahertz-frequency electromagnetic radiation. The detector, with important potential applications in chem/bio and concealed weapons/materials identification, uses charge-density oscillations, called plasmons, rather than electron current in a specialized transistor. Plasmons greatly increase transistor speed and yield the advantage of all-electronic frequency tunability. This device has the unique property of generating spectroscopic information with no moving parts. (1100, 1700)

The world's **smallest fine-resolution synthetic aperture radar** flew for the first time last May, making high-resolution real-time images at kilometer ranges. It was a dramatic debut for MiniSAR, a 25-pound instrument package that can be used for all-weather, 24/7 intelligence, surveillance, and reconnaissance (ISR) on near-model-airplane-sized UAVs. Potential customers in the military and industry have expressed interest in not only applying the current technology to ISR applications, but also to commercialize MiniSAR. (5300)

Friendly fire is a tragic and difficult-to-completely-avoid reality in combat. Now, Sandia researchers are doing something to minimize it. Labs researchers **demonstrated the Athena Radar-Responsive Tag** during Exercise "Urgent Quest" in the UK. During the exercise last summer, Athena



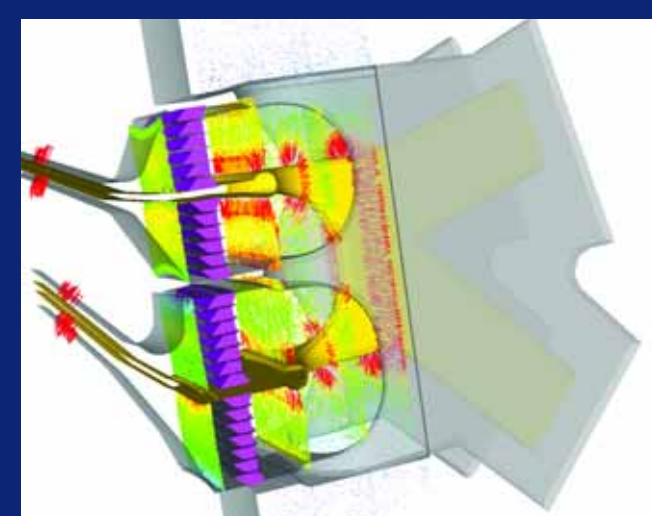
FOILING FRIENDLY FIRE — Lars Wells (5354, right) and Dave Erlandson (General Atomics) installing Athena tag on M3 Bradley during Exercise Urgent Quest in the UK.

tags were placed on military vehicles. The tags can be "seen" by aircraft radar, which recognize them as belonging to friendly forces. During the demonstration, aircraft on bombing runs used their radar systems to ensure there were no friendly troops in their sights. If a tagged vehicle was present, the pilot was alerted, avoiding a potential friendly fire incident.

With their virtually 1-dimensional geometry, **semiconducting nanowires represent a new class of materials** with unique electronic and optical properties that could have applications ranging from visual displays to sensors for chemical and biological agents. The focus of intense research around the world, the systematic characterization and assembly of nanowires into electrical devices and the realization of electro-optical circuits remains a formidable challenge. Sandia researchers have developed a simple platform that streamlines the integration and testing of a large number of nanowires, providing both electrical and optical characteristics with statistically meaningful results. (8700, 1100, 8200)

Pulsed Power

Supernova remnants are radiative shocks that exhibit a large amount of structure and may play a role in star formation. In experiments with the University of Texas using the Z-Beamlet laser, we modeled the growth of such structures by **tracking the evolution of perturbations** induced on the surface of nearly spherical blast waves. A unique feature of our experiments is the ability to induce perturbations of different wavelengths using wire arrays. The measured perturbation decay rates are in substantial agreement with a theory proposed by Vishniac in the 1980s. (1600)

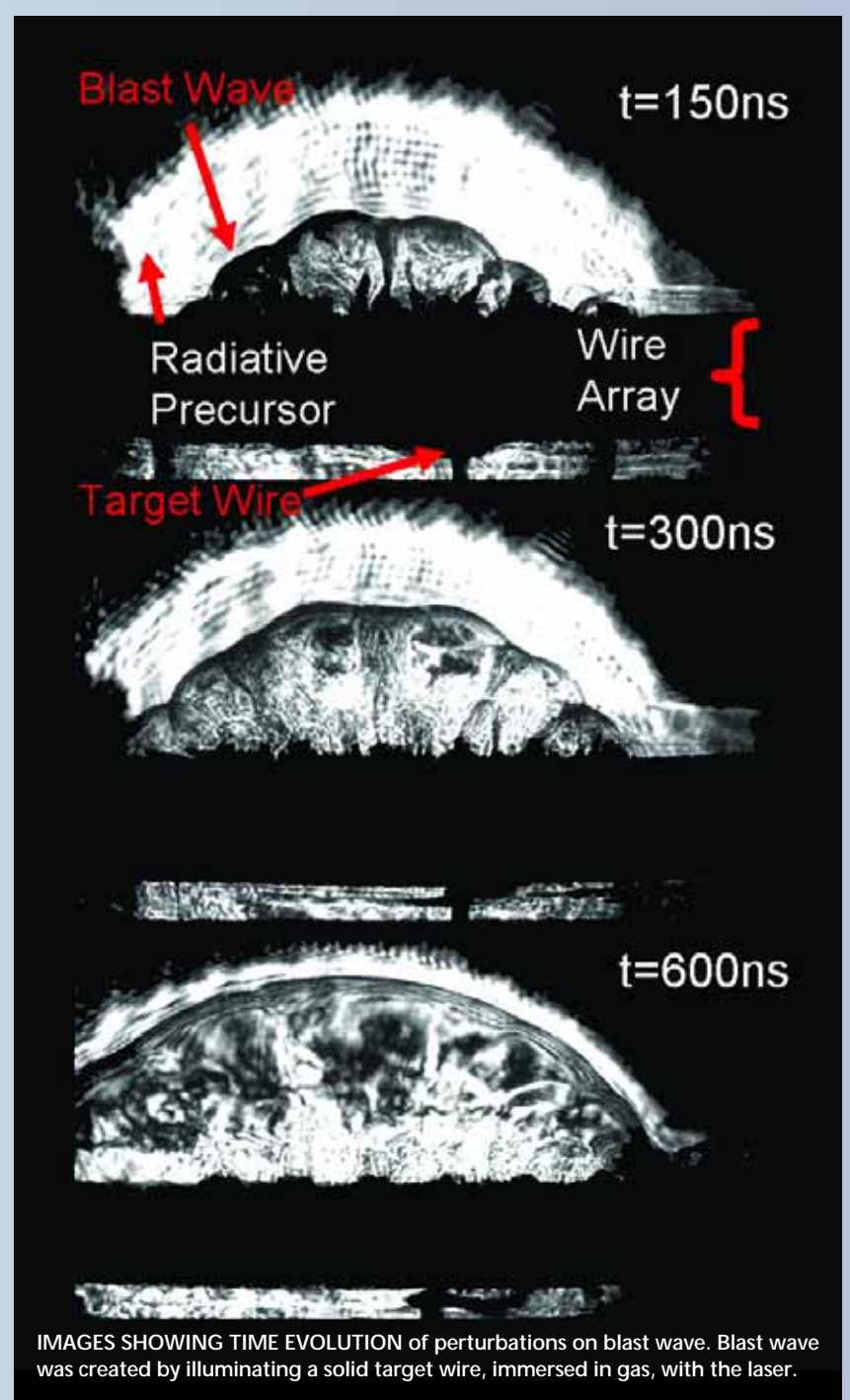


ELECTRIC FIELDS from a 3-D Emphasis/Nevada electromagnetics computational simulation of the ZR machine design. The vectors' colors represent the electric field magnitudes, where blue are lowest and red are highest magnitudes, and the vectors' directions represent the electric field directions.

Our 3D electromagnetics modeling code, **Emphasis/Nevada**, was used to model the detailed, time-dependent performance of the complex water convolute component in the ZR accelerator. Emphasis/Nevada simulates full electromagnetics behavior using a cutting-edge, finite-element formulation. Using standard analysis techniques, we also constructed an electrical circuit model of the convolute for the ZR system model. The 3D modeling identified a problem with the water convolute that we corrected in the final design, thereby improving the performance of ZR by more than a million amperes.

Following its successful deployment of flash X-ray radiography on the Armando sub-crit experiment at the Nevada Test Site, the Advanced Radiographic Technologies Program has met a corporate level 2 milestone with the **completed construction of the Radiographic Integrated Test Stand (RITS)**. The RITS-6 accelerator is designed to deliver 11 MV, 125 kA, 60-ns pulses for flash X-ray radiography source development. Future experiments to be conducted in collaboration with the UK's Atomic Weapons Establishment will attempt to obtain world-record X-ray intensities from a pulse-power-driven architecture.

Wire array z-pinch driven at up to 20 MA on the Z accelerator are the world's most powerful and energetic laboratory source of soft X-rays. Recent progress in meeting the radiation symmetry requirements for inertial confinement fusion (ICF) has now been complemented by experiments that shaped the soft X-ray radiation-drive time history. **Nested wire arrays were shown to meet the pulse shape requirements** for high-gain inertial fusion at yields of 290-900 MJ, compatible with future applications of low-cost z-pinch technology to stockpile stewardship and fusion energy applications. (1600)



IMAGES SHOWING TIME EVOLUTION of perturbations on blast wave. Blast wave was created by illuminating a solid target wire, immersed in gas, with the laser.

Technology partnerships

The 13-year old Sandia-Goodyear CRADA partnership reached a major milestone in winning an R&D 100 Award for the innovative use of computational modeling and simulation in developing Goodyear's new Assurance TripleTred™ line of tires. Finite element analysis was used to simulate traction, wear, durability, and other characteristics, and allowed Goodyear to produce a commercial product from concept to market in less than a year. This is a major step along the way in Goodyear's use of computational simulation throughout its product development processes. It is a clear indication that similar gains can be made at Sandia. Sandia and Goodyear have five active projects under the umbrella CRADA, with four new projects under development. (1500, 1400, 6600, 10100)

Under a cooperative research and development agreement with Boeing, Sandia's EMU computer code is helping to analyze the structural design of Boeing's new 787 commercial jet. The code models patterns of damage and cracking in complex materials. Boeing has identified EMU as offering unique advantages for understanding the formation and effects of impact damage in composite materials such as those being used in the 787 wings and fuselage. EMU is based on the peridynamic mathematical theory, which originated at Sandia. Boeing and Sandia researchers are jointly developing the composite model. (1400, Boeing)

Through a Shared Vision partnership Sandia and Lockheed Martin Systems Integration are pursuing a new-generation display technology for military and commercial applications. The technology is based on a revolutionary concept developed by UniPixel Displays, Inc. We have developed and delivered patterned aerogel thin films, a Sandia-patented technology, to serve as the ultralow refractive index cladding layer. Lockheed Martin believes the technology could lead to reestablishing a US manufacturing capability for thin, lightweight, low-power, low-cost displays to meet military performance requirements and rugged environmental conditions. (2400, 1800)

General Motors and Sandia announced a partnership to develop and test tanks capable of storing hydrogen in the form of the complex metal hydride sodium alanate. The goal is to develop a pre-prototype solid-state hydrogen storage tank that will store more hydrogen onboard a fuel cell vehicle than current conventional hydrogen storage methods. Researchers hope to create a tank design adaptable to future improvements in metal

hydride materials. Sandia is at the midpoint of the four-year, \$10 million program. (8700, 1800)

The Sandia Science & Technology Park won the US Department of Commerce Economic Development Administration's "Excellence in Technology-Led Economic Development" award for 2005. The award recognizes the tech park's commitment to sound, research-based, market-driven development in helping grow the local economy. Battelle, Sandia MESA TOP II, and the Sandia Synergy Center joined the Park this year. Groundbreakings were held for Poly-Flow Engineering, Sandia's Computer Science Research Institute, and a major expansion for TSP. To date, 20 companies employing more than 1,100 people are located in the Park, and investment exceeds \$178 million. (10100)



RESEARCHER HAL MORGAN, a long-time collaborator with CRADA partner Goodyear, shows off the TripleTred™ tire, a home-run product for Goodyear. (Photo by Randy Montoya)

Sandia and six other New Mexico research institutions signed the Inter-Institutional Agreement, a contract that allows bundling of patents to promote economic development. This groundbreaking agreement provides rapid response and flexibility so that when commercialization opportunities arise, these institutions can quickly capitalize on each opportunity rather than spending time negotiating contracts. The agreement was negotiated by a multi-organization team, including Sandia licensing executive Paul Smith. Signing the agreement were Sandia, Los Alamos National Laboratory, Science and Technology Corporation at the University of New Mexico, New Mexico State University, New Mexico Tech, The MIND Institute, and the National Center for Genome Resources. (10100)

Sandia's University Alliance initiative is a special licensing program that allows US educational institutions to leverage Sandia's MEMS capabilities. As part of the agreement, the school receives MEMS teaching materials, SUMMIT™ design and visualization software, training, and MEMS parts for test and evaluation. During FY05, the program gained 10 licenses, and has four licenses pending. University Alliance is a joint effort to facilitate MEMS education cosponsored by the Microsystems Science & Technology and Corporate Business Development and Partnerships centers. The program was honored as an industry "Best Practice" at the national 2005 MEMS Educational Workshop. (1700, 10100)

Integrated enabling services

More than 60 teachers from elementary, middle, and high school participated in a summer program as part of a ground-breaking collaboration among UNM, Sandia, and APS on inquiry-based science teaching. Six courses were offered in various content areas with graduate credit provided for all participants, enabling many of them to meet specific "No Child Left Behind" requirements. Five local educators attended a workshop on inquiry-based science teaching with the Golden Apple Foundation in preparation for bringing it to Albuquerque in 2006.

Significant improvements were implemented in 2005 to streamline the annual Student Internship Program Mass Sign-Out process. This process enabled more than 520 students to separate from Sandia and the summer internship program by visiting just one location. Internship program staff worked with Records Management, Treasury/Travel, and the Badge Office to provide a greatly simplified sign-out process, eliminating the need for the intern to physically visit each location. The process has led to significant time savings and reduced effort to the service providers involved.

The process of promoting employees from non-exempt to exempt positions was reengineered during a Kaizen Event. This was done to improve the way Sandia evaluates and promotes its non-exempt employees to exempt staff, while providing line organizations with ownership of this function. The appropriate checks and balances were added to ensure administration of a fair and unbiased Fair Labor Standards Act-compliant process.

The Sandia Corporate Mentor Program celebrated its 10th year in 2005. The program, which launched in 1995 with 68 participants, had 936 participants in 2005, demonstrating that mentoring continues to be a powerful and effective development tool. Last summer the program was recognized for two best practices in mentoring among Lockheed Martin enterprises. Two SAND reports have been published about the model program, which earned a Gold President's Quality Award in 2003.

Enhancements have been made to the "get people" system to make it easier for job applicants to apply online. The education screens were reduced from seven to one, and the system now uses terms commonly used by industry job search sites. Feedback from applicants show that they agree the system is easier to use. The speed, functionality, and interface for managers were greatly enhanced, too. These are just a few of the efforts that are helping the Labs hire the best possible candidates.

Security

Restart of the Sandia Pulsed Reactor was approved by DOE last September and the Safeguards & Security Center played a significant role in the approval. Pro Force readiness was validated, the Perimeter Intrusion Detection and Assessment System was successfully tested, and the Site Safeguards and Security Plan was approved. Upgrades supporting the Design Basis Threat were completed, and a complex force-on-force exercise was conducted with no injuries or other ES&H or security incidents.

The Security System Replacement Project is a multi-year, multimillion-dollar initiative launched two years ago to replace Sandia's existing alarm and access control systems. The on-going project is modernizing security while increasing capacity, improving alarm station interface, and reducing maintenance and repair costs. During the past year, Technical Security Systems Dept. 4214 completed the system-selection process, received the first shipment of system components, completed design for the retrofit of the first set of vaults, and successfully tested the network to determine optimum system configuration for potential applications across the DOE complex. (4200)

Every day, hackers attempt to breach Sandia's computer systems, making rapid patching of desktops essential to cyber security. Using automated methods, Sandia's Computing Support Services (CSS) deployed 37 sets of security updates, totaling more than 537,000 individual computer patches, on the Sandia Restricted Network. The time to get patches ready for installation declined from seven days to two. The time required to

reach at least 50 percent of Labs computers was reduced from two weeks to one, and will decline further with new methods CSS has developed. (4300, 4500)

The Assurance Program's Resolution of Findings process successfully closed 65 external findings during FY 2005 through a rigorous validation process conducted by NNSA's Sandia Site Office. The team effort, which included Security managers and staff from all Sandia programs and sites, ensured that the findings were addressed through formal corrective action plans. The effort resulted in an internal verification assessment process, further ensuring that actions to address the problem were completed, adequately documented, effective, and sustainable. Through this quality process, repeat problems have been virtually eliminated.

Implementation of new Security Incident Management Program procedures and changes to a corporate process requirement — Security Concerns Reporting Process — led to substantial improvements in the awareness and attitude of both managers and staff regarding security incidents. The 60 percent reduction in serious incidents during FY05 indicates awareness and attitude play a significant role in overall culture change, a long-term initiative in the Safeguards and Security Program.

Using pharmaceutical molecular descriptors — signature atom neighborhoods and topological indices — researcher Jean-Loup Faulon reverse-engineered the molecular structures of 800 drug compounds, proving that molecular descriptors were a secure representation for patentable chemicals as proposed by the National Institutes of Health for its planned PubChem database.

Employee and Labor Relations Dept. 3011, along with several management partners across the Labs, signed collective bargaining agreements with the Metal Trades Council, Office and Professional Employees International Union, and the Security Police Association. Through the agreements, management and more than 1,000 union-represented employees will continue to work together to achieve mission critical goals.

The annual Student Internship Symposium and Career Fair last August provided real-world experience for the more than 225 interns who made presentations on their research activities. The symposium is the culminating event of the Student Internship Program, bringing together interns, technical staff, mentors, management, and representatives from industry and academia. This high-energy event included more than 800 attendees who participated

in numerous activities including a graduate opportunities panel where Labs President Tom Hunter spoke.

Our writers, editors, designers, videographers, and printers played a significant role in bringing recognition to Sandia, its programs, and its people in 2005. Our products communicated the Labs' important work and brought home to Sandia some 100 awards, including high honors in PRSA Cumbre, Society of Technical Communication, Lockheed Martin's Communication Excellence, and Aurora Film and Video competitions. The Labs' in-house print shop, with its state-of-the-art digital printing capabilities, contributed by printing many of the winning materials, from publications and posters to brochures and displays. Members from all the Center's organizations worked

(Continued on next page)

Integrated enabling services

(Continued from preceding page)

closely with White House communications staff to make the August 2005 visit by President Bush a notable communications success. (3600)

Recreating a "Learning Organization," a major Sandia initiative begun by the Strategic Education Committee, chaired by Executive VP John Stichman, got off to a solid start with the allocation of 32 developmental hours for all Sandia employees. The intent is to help Sandia employees augment their education relative to Sandia's core mission areas. The funding covers time to attend a wide variety of educational experiences that fall outside an employee's normal work assignment, but within the Sandia mission space.

Health and benefit programs enable Sandia to attract and retain an exceptional workforce. HBE provides accessible workplace preventive, behavioral, medical services, and competitive benefits, **deploying short and long-term cost containment strategies** in an era challenged by escalating health care costs. The Disease Risk Management Clinic (DRMC) provides health services for employees with diabetes, hypertension, hyperlipidemia, and obesity. In October 2004, DRMC had 717 participants, increasing to 1,426 participants as of September 2005. The Benefits Department provided new benefit plans that promote employee consumerism.

Center 3800 was responsible for planning and implementing all necessary changes for successful transition to the new Labs structure in June 2005, while ensuring thorough, clear communication. A cross-organization team and functional area leads assured **an efficient and effective transition**. Various information systems, policies, and procedures were affected by the change. The use of change management techniques improved the communication flow and minimized the impact to line organizations. Project management tools were successfully used to plan, track, communicate, and complete actions on time and according to executive expectations.

The Sandia Wi-Fi Project Team led three limited-area pilot deployments, making Sandia **the first facility in the nuclear weapons complex** to deploy production wireless networks in a limited area. The team also deployed wireless networks in 13 buildings outside the tech areas at Sandia's Albuquerque and Livermore sites. The wi-fi team is providing significant leadership within the complex by sharing experiences and results with the other complex facilities; the experience gained at Sandia may demonstrate that new technologies such as wi-fi can be used throughout the complex. (4300, 8900)

The Technical Library **initiated a change in the MARC standard for library cataloging** in the US to the Library of Congress. This change includes historical security classification change information in the MARC standard. The Library of Congress accepted this change for immediate use; it was published in the October 2005 MARC 21 Edition. The change is also reflected in the Library of Congress MARC documentation.

The Portability pilot introduces **ready network access for mobile devices** in select offices, laboratories, and meeting rooms around the Sandia/California site. Individuals employed at any Sandia site can — without requesting spe-

cial support — plug in their properly registered, portable computing devices to designated ports to access desired SRN resources. We developed software, policy, and procedures to support a satisfactory user experience, while adhering to fundamental security principles. (8900, 4300)

The Training and Development Team in Human Resources Dept. 8522 partnered with an advisory team of senior managers to **address the expected high rate of attrition of senior managers and directors** and the potential loss of their collective knowledge. Working with an external consultant, the team developed experiential learning modules to accelerate the development of future leaders. Topics include: self-awareness and feedback; interpersonal communications; coaching; difficult conversations; transition management, ambiguity, and risk; decision-making and delegation; global vision, strategic thinking, and strategic planning. (8500)

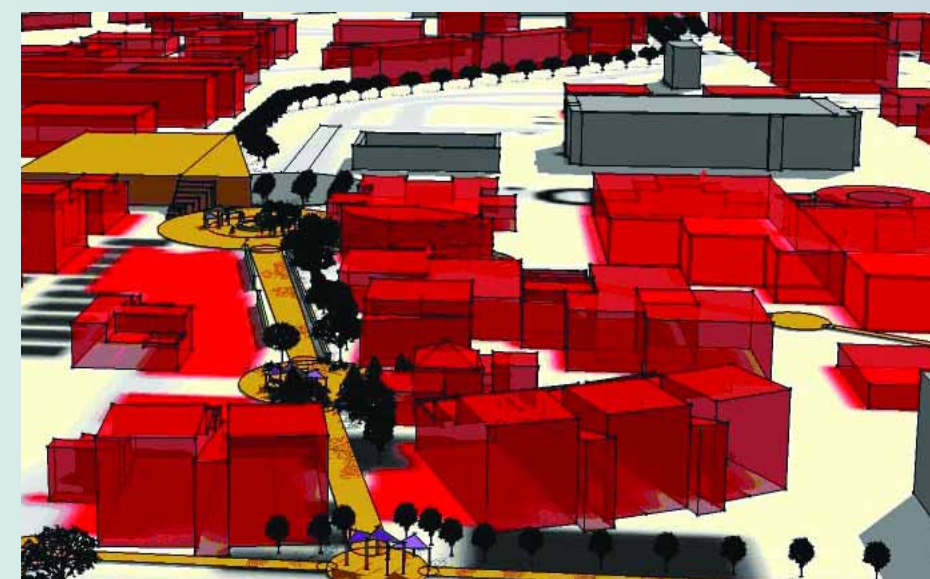
Sandia Procurement Center 10200 spent two years establishing its ISO 9001:2000 system. The ISO system provides the organizations with a **framework to focus on major processes and customer service**, thereby increasing their value to Sandia and continually improving their perfor-



IN A KEY STEP advancing "operational excellence," Sandia deployed the Integrated Laboratory Management System at the Lab level and within all the strategic management units. Documented management systems that implement the five functions of the Corporate Work Process were developed and deployed. Positive impacts on performance are expected through the systematic anticipation and resolution of problems, as well as providing assurance of effective performance and risk management to our customers and stakeholders.

formance. In June 2005 an outside auditor visited Procurement and conducted a six-day audit of the ISO system. The auditor was impressed, and 10200 became the first procurement group in the DOE/NNSA complex to earn ISO 9001:2000 certification.

In support of DOE's I-MANAGE financial implementation project, Sandia **redeveloped its standard accounting and reporting system** — or STARS — application to satisfy all DOE requirements including sending specified data elements on a monthly basis and rewriting the financial reporting system to enable monthly reporting in DOE formatted data. This includes the cross-walk between the old (alphanumeric) and the new (numeric) Budget and Reporting numbering scheme. The changes positioned Sandia to support the new DOE budgeting system (due out in October). (10700, 10500, 4500)



FACILITIES COMPLETED a discussion draft of the Long-Range Development Plan for the Albuquerque campus. The document is Sandia's first comprehensive vision to guide campus development through the mid-21st century and create the "Lab of the Future." To meet short-term space needs, Sandia has awarded two contracts to lease more than 180,000 square feet of space offsite. Almost 1,000 people will be relocated, freeing up space onsite that can be brought into the Limited Areas to help meet the critical classified space crunch facing many mission customers today. (10800, 10200)

Sandia's **construction program had another banner year** in FY2005, adding 120,000 square feet of space to support new mission work. Projects under design or construction



CONSTRUCTION OF BLDG. 929 (above) was completed and the building was occupied by the Biological and Microfluidic Science group at the California site last February. The 22,974 sq. ft. building provides office and reconfigurable space for some 70 researchers and staff, three conference spaces, two multi-use light assembly labs, and a central break room. The facility was Sandia/California's first Institutional General Plant Project and was designed, constructed, and ready for occupancy in 12 months at a total construction and equipment cost of \$4.7 million.

include the Microsystems and Engineering Sciences Applications Complex (MESA), the Center for Integrated Nanotechnologies Core Facility (CINT), and the Test Capabilities Revitalization project. The program continues to receive award recognitions for being the first laboratory in the DOE complex to have a certified Earned Value Management System in place to measure performance, improve efficiency, and reduce costs on large construction projects. (10800, 10200)

Sandia's Energy Management Program continues to **ensure that utility systems are reliable and efficient**, while conserving resources as much as possible. The program strives to integrate and institutionalize energy efficiency into planning, design, construction, and operations, with excellent results. Last year, electrical reliability was 99.993 percent, exceeding the industry standard of 99.982 percent. The program has also exceeded DOE's 2010 goal of improving energy use in office buildings by 35 percent (relative to 1985 levels). Sandia has already reduced energy use in these buildings by 39 percent. (10800)

Custodial Services Dept. 10848 continues to provide good customer service to the line at minimal cost. The group was nominated for seven team awards and two individual awards at last summer's fourth annual Operating System 1 Users Group Symposium. **The team took home three trophies** from the ceremony: Best Program, Best Audit, and Best Cleaning Industry Safety Program. The group received the Green Certified Award and has gone more than 15 months without a single lost work day due to an on-the-job injury. (10800)

Supplier Profile Management (SPM) was implemented with the 11i10 Oracle upgrade. This enhancement implementation to the iSupplier portal product was an intensive effort that required representation and participation from Procurement, Accounts Payable and Supplier Profile management. **SPM enables the supplier to securely (electronically) register** with Sandia through our external web page. The benefits include more accurate address and contact information, greater source selection capability based on classification and product/service definitions, and enhanced reporting capability.

A corporate-wide need was identified to develop a method of tracking Sandia business travelers. In February 2005, Treasury and Travel Services Dept. 10507 developed a **system to track travelers in case of emergency**, replacing various home-grown systems. Enterprise Information Systems Development and Support (4524) created the Travel Information System, a one-stop solution allowing individual departments, as well as several support organizations, to identify travelers in need during emergency situations. (10500, 4500)

Thanks to cooperation throughout the laboratories, corporate tax employees (10500) with the assistance of the Oracle NMGR programmer (4500) **gathered information for additional deductions for New Mexico Gross Receipts Tax**. The corporate tax team filed for this \$3.5 million refund. This refund was applied against our current year corporate tax liability of \$62.5 million, which lowered our overall tax liability to approximately \$59 million. The external corporate tax expense is recovered through internal tax loads. This effort resulted in winning an employee recognition award for the team.

Some 47,000 benefits plan documents (or nearly 1.6 million pages that would have been delivered in paper) were delivered electronically. In FY05 alone, this saved about 190 hours in the Sandia mail room, \$50,000 in paper and printing, and these savings do not include the environmental impact of eliminating 1.6 million pages of paper from the environment. We would like to believe there is a grove of trees somewhere because of these efforts.

MAKING HYDROGEN using the power of the sun — Sandia researcher Rich Diver works at a solar furnace, the energy source that will drive his simple two-step thermochemical process for splitting water into its constituent hydrogen and oxygen atoms. The process will use a device of Rich's own invention; he calls it the Counter Rotating Ring Receiver Reactor Recuperator — or CR5. (Photo by Randy Montoya)

