

# ACCOMPLISHMENTS

## 2005

Sandia engineer Bianca Keeler examines this eye-safe laser configuration in which MEMS-based light-wave interference enables naked-eye detection of motion in the 10 nanometer range. Bianca, along with Greg Bogart, John Sullivan, Tom Friedman, and Joel Wendt, were part of a research team headed by Dustin Carr.

*Sandia National Laboratories*





Photos this page by Randy Montoya

## To all Sandians:

Welcome once again to Sandia's compilation of significant contributions made over the course of the last year. If there is a dominant theme, it is the ever expanding diversity of important national contributions in many technical fields and to address many urgent national needs.

- From the imaging of biological membranes and understanding fundamental life processes, to the development of bacteria microsensors that can literally diagnose a patient's disease within minutes.

- From a joint project with the Environmental Protection Agency to protect the nation's water supplies from chemical or biological attack, to an in-depth analysis done for the Department of Energy on the possible hazards posed by liquid natural gas fires which could result from terrorist attacks on LNG ship transports.



C. PAUL ROBINSON

- From development of a new wind turbine built from newly developed materials, to carrying out flights of highly instrumented aircraft to study the role of clouds in determining Arctic climates.

- From leading a government and industry forum to create and adopt future standards for software reliability, to the creation of a new manufacturing process using ultra-short laser pulses (approx 10-15 sec) for precision machining of a wide-variety of materials.

These achievements and the many more described in this report attest to the fact that Sandia is fulfilling its national security missions — including a continuing role to maintain the safety, reliability, and effectiveness of the US nuclear deterrent forces — against a wider set of threats than ever before.

I believe as you read this report you will agree with me that:

(1) our leading-edge science, engineering, and technology developments are helping to achieve a higher level of security for our nation and the world, and,

(2) this work, in so many fields and against such a diverse menu of challenges, is making Sandia a much more interesting institution.

C. Paul Robinson  
President and Director

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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](mailto: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

Last May, the Armando SubCritical Experiment was performed at the Nevada Test Site, **investigating possible differences** in the impulse response of cast and wrought plutonium. The Pulsed Power Sciences Center led a multi-institutional team to develop and deploy a state-of-the-art flash radiographic capability: the twin-axis Cygnus accelerators provide four Roentgens a meter from a 1-mm-diameter X-ray source at 2.2 million volts, about a factor of 50 greater performance than previously available at the NTS. **The accelerators performed perfectly**, and the resulting radiographic data obtained on Armando are excellent. The dynamic experiment was conducted within a portable blast containment vessel, so this unique diagnostic infrastructure may be reused repeatedly as needed by the NNSA. (1600)

New tenants of the Joint Computational Engineering Laboratory (below) began moving in last March. Ulti-



mately, 175 personnel relocated to JCEL. Boasting the largest switching and routing capability for the Sandia customer network, JCEL was also the first to use the new High Performance Computing network architecture, including 10-gigabyte trunks and dedicated HPC distribution infrastructure. **JCEL houses a vast unclassified server room** containing the 407-node Linux computer cluster and several other large computer resources supported by Engineering and Sciences High Performance Computing team. (9100, 9200, 9300, 9900, 2900)

The construction contract for the MESA Weapons Integration Facility (WIF) has been placed, and construction has commenced. The overall project is approximately 50 percent complete and **project performance is on schedule and under budget**. The MicroFab and MicroLab facilities are on schedule to complete construction in FY05 and begin operations in FY06. The MESA Institute is Sandia's microsystems interface to the US academic community. It has established **collaborations with more than 30 targeted universities**, with 50+ students coming to Sandia yearly, creating a pipeline for top new hires. (1900)

The second-generation (PA2) Permafrost digital



A MEMS COMPONENT, fabricated with the LIGA process from a newly developed high-strength electroformed nickel alloy, was developed and extensively characterized for possible use in the stockpile. **The Hurricane Spring component** has flexures approximately 130 microns thick and 1.3 mm tall, controlled to a dimensional pre-

cision of only a few microns across its ~10 mm width. If chosen as baseline, this LIGA component will be **one of the first MEMS systems deployed in the stockpile**. The associated process technology has been transferred and demonstrated at the Kansas City Plant, where it will be manufactured. (2600, 8700, Kansas City Plant)

weapon controller for the W76-1 has been designed, fabricated, and tested. Sandia's Microelectronics Development Laboratory fabricates PA2 in its CMOS7 radiation-hardened technology. Additional functionality in the newer version adds **44 percent more logic gates** while retaining a very demanding low leakage current requirement. The added complexity and demanding specs were countered by applying lessons learned and technology improvements to **achieve unprecedented MDL yield** on a chip of this complexity (1700, 2300, 1100)

The development of novel silicone gel materials and processing methods for high-voltage devices **solved a high-risk weapon refurbishment issue**. This technology allows a dramatic reduction in the size and weight of a weapon component, while assuring the high reliability required for weapon performance over a broad temperature range. Because of its exceptional mechanical, adhesive, and electrical stability, this gel encapsulant has been chosen as a baseline material for future weapon electrical designs. (1800, 14100, and 1700)

We designed seven SE3331 data-acquisition systems, which have been used to record the interface data between the aircraft and nuclear weapon for certification of nuclear weapon systems. The SE331, installed in B61 and B83 Compatibility Test Units, is **an event-driven data-acquisition system** that records the electrical events of voltage, current, time, and noise, and stores this information in non-volatile memory. It has **been used successfully** on the B-2A and B-52H aircraft to verify compatibility with the B61, B83, and W80 weapon systems. (2900)

We successfully completed a series of high-fidelity B83 JTA surveillance experiments at the Aerial Cable Facility. The experiments required close coordination and extensive planning among 9100, 2900, the NWSMU office, Security, ES&H, Facilities, NNSA, BWXT/PX, and the Sandia Site Office. **These experiments were the first hi-fi experiments** authorized by SSO to be conducted at Sandia/New Mexico. Rigorous test planning included integration with the line item construction process, a facility safety assessment, and detailed supporting safety calculations using CTH. (9100, 2900)

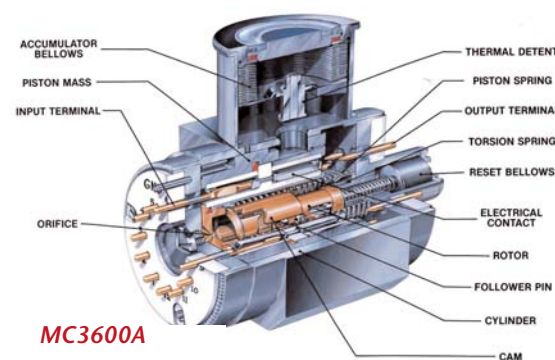
**The Milestone Reporting Tool** is a complex-wide, web-based application that tracks Nuclear Weapons Complex-wide issues. It was developed for NNSA to aid the integration, planning, and assessment of the scope of nuclear weapons program work. Since using this system, **NNSA has reduced the time it takes to conduct quarterly reviews** from two days to four hours. Recent enhancements enable NNSA to conduct this review via

videoconference, resulting in annual savings of at least \$400,000. (5400)

THE W76-1/Mk4A DESIGN DEFINITION **continued to mature** with successful reentry body system and Arming, Fuzing, and Firing (AF&F) system Baseline Design Reviews. The Preliminary Weapon Development Report was completed, and the DoD Preliminary Design Review And Acceptance Group **independently validated** that the system design and qualification are on track to meet the military's requirements. **Four reentry bodies**, including the first fully functional AF&F and new Joint Test Assembly, **were assembled and delivered** to the Navy for flight testing in early FY05. (2100, 1700, 1800, 2300, 2500, 2600, 2900, 8200, 9100, 12300)



Photometrics and Data Acquisition test capabilities facility in Area 3 houses 26 staff, providing the Nuclear Weapons Complex with **state-of-the-art photometric and data-acquisition capabilities** to support weapons qualification and development, investigations, and model validation. Additionally, the facility provides a venue to develop and deploy advanced quantitative photometric capabilities for measurements ranging from lab microscale to field macro-scale applications. (9100, 10800)



MC3600A

The MC3600A (shown at left), a nuclear safety-critical component for the W87, **successfully attained First Production Unit status** in June 2004. The MC3600A is an inertial switch that closes and latches 10 electrical contacts after experiencing two discrete acceleration-time events. During its first production run in FY04, nine MC3600A units were certified and accepted by NNSA for use in the W87 system. Center 2600 is the design agent for the MC3600A and Honeywell FM&T Kansas City Plant is the production agent. (2600, KCP)

Sandia has developed a **unique metrology course** designed for managers who work in research and development activities. The course consists of examples of lessons learned across NNSA and emphasizes critical thinking applied to measurements, as well as discipline and innovation. It provides tools to **help managers determine the appropriate level of formality** to use in the collection or analysis of data. The course has been presented to more than 200 staff and managers at Sandia, Oak Ridge, Lawrence Livermore, and NNSA. (2500, 3500, 2300).

Size requirements for the MC4300 neutron tube have led to **new concepts for target resistors**. Integration of the target resistor into the neutron tube target insulator with a Low Temperature Co-fired Ceramic, or LTCC, design has the potential to enhance reliability, eliminating the need for a hermetic electrical feedthrough, and reduce part count and assembly complexity compared to conventional or thick film resistors. The concept has been **demonstrated in prototype**, and the technology is being qualified as a viable option for the MC4300 baseline design. (2500, 14100, 14400, 1800, 2900, 6200, 6700, FM&T)

Eight product testers were **built from scratch within a design-build-deliver cycle of only six months**. Significant efficiencies were realized through the use of common hardware and software, and each includes real-time data acquisition and process control. Three of the testers located at supplier sites have the ability to securely transmit test data to Sandia. (2500)

The **Sandia Weapon Intern Program** graduated its sixth class in September 2003 and started the Class of 2004. The program aims to promote career development. (Continued on next page)



## Nuclear weapons

(Continued from preceding page)

ment at Sandia and to achieve **complex-wide excellence in weapon engineering** through education. Among the participants are 12 Sandians and four NNSA, two Air Force, one DTRA, and three Kansas City Plant personnel. The one-year **curriculum continues to evolve** to meet the changing needs of the nuclear weapons complex. This year included increased emphasis in Modeling and Simulation and Weapons Effects education. (2900, 9700, DoD, NNSA)

The stockpile evaluation program executed the first high-fidelity system level surveillance tests under post-9/11 heightened security measures. FY04 accomplishments included a **successful B61 flight test at the Tonopah Test Range** and completion of all preparatory measures for FY05 B83 testing at both Tonopah Test Range and the Sandia Aerial Cable Facility. Implementing these tests required a tremendous amount of coordination and perseverance by several organizations at Sandia as well as Lawrence Livermore National Laboratory, Pantex, and NNSA. (1900, 2800, 2900, 4100, 4200, 8200, 9100, 9700)

Two W80 captive carry flight tests were successfully completed in FY04. In the first test, temperatures were measured on a mock warhead in a cruise missile mounted on the wing pylon of a B-52. The second test was a series of multiple flights to measure vibration and acoustic environments in each of the warhead's three deployment configurations. The information will be used to establish or update W80 environmental requirements. Center 8200 designed and built the data processing and recording equipment, and coordinated the flight tests.



On June 30, 2004, the Electronic Systems Center (2300) and Honeywell Federal Manufacturing & Technologies delivered the **first fully functional MC4655 Warhead Interface Module** for the W80-3 Life Extension Program. To fit increased functionality into less than half the previous volume, the WIM team worked with Microsystems Center 1700 and developed the largest mixed signal (digital and analog) application-specific integrated circuit for a nuclear weapon. The WIM will be the **first weapon subsystem to use a MEMS system for environmental sensing**. (2300, 1700, FM&T)

The **first fully functional Crypto Coded Switch (CCS)** prototypes were built at Honeywell/FM&T, environmentally tested at Sandia/New Mexico, and delivered on-time to support the W80-3 Stockpile Life Extension Program. At the core of CCS is the Sandia Secure Processor, a Sandia-designed Application Specific Integrated Circuit featuring a novel implementation of a Java-based microprocessor. CCS **significantly improves the Permissive Action Link system** by supporting end-to-end encryption, higher code/key security, enhanced commands, and a designed-for-manufacture packaging concept. (2100, 1700, 12300, 14100, H/FM&T)

A ribbon-cutting ceremony was held last fall to celebrate the completion of Sandia's new **Weapons Evaluation Test Laboratory** located at the Pantex plant in Amarillo. The \$22 million state-of-the-art facility replaced the 39-year-old laboratory, constructed when some of the early weapons were first built. It will house more than **\$90 million worth of testing equipment** that will conduct systems-level, non-nuclear tests on nuclear weapons and components. WETL is the only US facility that performs

these types of tests. (1800, 2500, 2900 and 10800)

We developed and deployed a **major enhancement to the Classified Image Management System** that copies all of the unclassified images stored on the Unclassified Image Management System to the CIMS nightly. This enables users of the CIMS to work exclusively in the classified environment, which significantly improves the usefulness of the classified environment. The Image Management System is one of our most heavily used engineering information systems (an average of 35,000 documents are downloaded every month by engineers throughout the Nuclear Weapons Complex). (2900, 9300, 9500)

The latest version of the **Nuclear Weapons Information Environment Portal** was deployed in September. The NWIE Portal provides the common user interface to the Engineering Information Systems. Engineering information is now presented in an organized fashion based on the weapon system. Access to the information is based on common need-to-know control mechanisms. The NWIE portal **pulls together the multi-year investment** that has been made in the development, deployment, and operation of Sandia's classified Engineering Information Systems. (2900, 9500)

Interactive Electronic Procedures (IEP) is a BWXT Pantex (PX) initiative to replace the classified paper procedures currently in use. Since Sandia and the nuclear design labs have procedure concurrence responsibility for PX, this posed both **connectivity and platform compatibility issues** for the complex. The Qualification Engineering Release was recently released for the on-site qualification of the IEPs at the Pantex Plant. This **concluded a multi-year effort** by Sandia and nuclear laboratory personnel. (2100)

Center 12300 quality engineers **provided Quality Assurance support** to the W76-1 Life Extension Program product-realization teams. Major qualification milestones of the W76-1 Arming, Fuzing, and Firing System components and testers have been met, qualification documents released, and reviews completed. This project is an excellent example of the **successful implementation of the Technical Business Practices** and teaming that is taking place among Sandia, the production plants, and commercial suppliers. (12300)

The 12300/2100 Virtual Assessment Facility came online in FY04 to surety assessments for new and enduring stockpile systems. The **facility provides a 3-D stereo environment** for running virtual assessments of weapon system design, functionality, and performance in both normal and abnormal environments. The facility will assist in integrating the **Design through Analysis Realization Team program (DART)** and Sandia-developed simulation codes into weapons programs assessment/assurance activities in a classified environment. (12300, 2100)

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The identification of component-aging effects, the resulting impact to system performance, and the prediction of weapon lifetimes is of increasing importance to the monitoring of the stockpile. **Model Based Performance Analysis** is providing a predictive capability by using modeling and simulation of weapon electrical systems to act as a **bridge between aging effects and system performance**. In FY04, circuit models were developed for the MC2901 and SA2142 (B61 Life Extension Program), MC3971-B83 Firing Set and MC3719-W87 Firing Set (Component Surveillance Program). (12300, 8200)



TONOPAH TEST RANGE force-on-force exercise earned new certification.

In FY04 **Tonopah Test Range** became the first site in the DOE complex to meet the physical security requirements required by the new NNSA Design Basis Threat (DBT). TTR, with the help of Center 4200, completed a new Vulnerability Assessment, was certified for new high-powered weapon systems, and conducted a force-on-force exercise. That exercise resulted in the site being **certified to test high-fidelity test units**. TTR completed two high-fidelity tests in FY04 ending a sus-

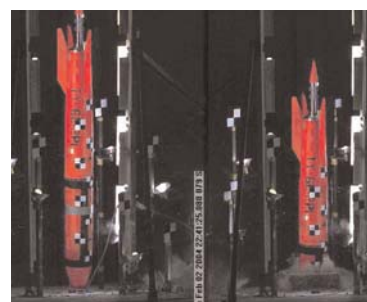
pension on these test activities that had lasted many months. (2900)

To ensure **continuing safety** of nuclear weapons systems, the materials of their nuclear safety components must maintain the characteristics upon which their safety function depends. Materials specialists and nuclear safety engineers studied the W78's nuclear safety critical components. **Thousands of materials and material combinations were reviewed**. No potential materials issues were identified. For each component, several observations and suggestions were made to enhance component surveillance. The classified report joins those from W76, W80, and W87 studies. (12300, 1800)

Tests and analyses were conducted to **evaluate the effects of lightning on several unique facilities**, including critical assembly areas at the Pantex Plant, the Weapons Engineering Tritium Facility at Los Alamos, and maintenance and storage facilities at Air Force bases. The work encompassed a wide range of activities, which included performing a **cost/benefit analysis of competing lightning protection approaches**, measuring the transfer impedances of reinforced-concrete structures, and bounding the energies delivered to load impedances representing electrically sensitive components due to indirect field coupling. (12300, 1600)

An **external review panel** continued to advise Sandia executive management on the effectiveness of the independent assessment activities of the Weapon Surety Assessment Center. The panel consists of knowledgeable executives with diverse backgrounds and experience in nuclear weapons enterprises and other high-consequence operations. The panel provides an **in-depth review of Sandia processes** to conduct independent assessments of the Weapons Program in twice-yearly reviews. The panel's suggestions are tracked and

(Continued on next page)



THE TECHNICAL BASIS used to characterize the capability and reliability of **our nation's only nuclear earth penetrator** improved with the development of the B61-11 Type 6C Joint Test Assembly. The new configuration allows for **cable pull-down testing at Sandia's Aerial Cable Facility**. Worst-case impact conditions, predicted using aerodynamic trajectory modeling and penetration simulations, can be achieved using full-scale testing. The first B61-11 Type 6C surveillance test is scheduled for 2005. (2100, 2900, 9100)



A 4,800-POUND PENETRATOR prototype was accelerated on a sled-track, then launched and successfully impacted into a megalithic, 25-foot-diameter target at a velocity of thousands of feet per second. The test significantly advanced our ability to study such designs under well-controlled



and meaningful deceleration environments. Specialty on-board instruments captured the extreme accelerations and stresses experienced by the penetrator components, thus enabling comparisons with advanced analytical models. (8200, 2100, 9100, 15400, 8700, 2600, 12600, 14100)





A new development Joint Test Assembly for the W78 Mark 12A Reentry Vehicle was successfully launched from Vandenberg Air Force Base in September 2004. This new Joint Test Assembly, designated as JTA6, contained an advanced, modular telemetry system that transmitted data indicating satisfactory weapon system functionality and vehicle motion performance. The JTA6 is representative of a new family of JTAs that will provide improved insight and early warning of aging and performance-related phenomena in nuclear weapons. (2100, 2900, 8200)

Photo by Brian Webb

## Nuclear weapons

(Continued from preceding page)

responded to by the Weapons Systems Division and the Surety Assessment Center in coordination with the office of the Executive Vice President. (12100, 12300)

The final report of the Joint Nuclear Surety Study initiated by the Air Force to improve the security of nuclear weapons throughout their lifecycle was reviewed by the major commands for potential implementation. The Tri-lab study team (Sandia, Los Alamos, and Lawrence Livermore labs) developed an Integrated Security Architecture including weapon surety upgrades that could be implemented without factory retrofit. A formal

Phase 6.2/6.2A Study, requested by US Air Force Space Command, has been approved by the Nuclear Weapon Council Safety and Standing Committee. (12300, 2100, 4100, 8200)

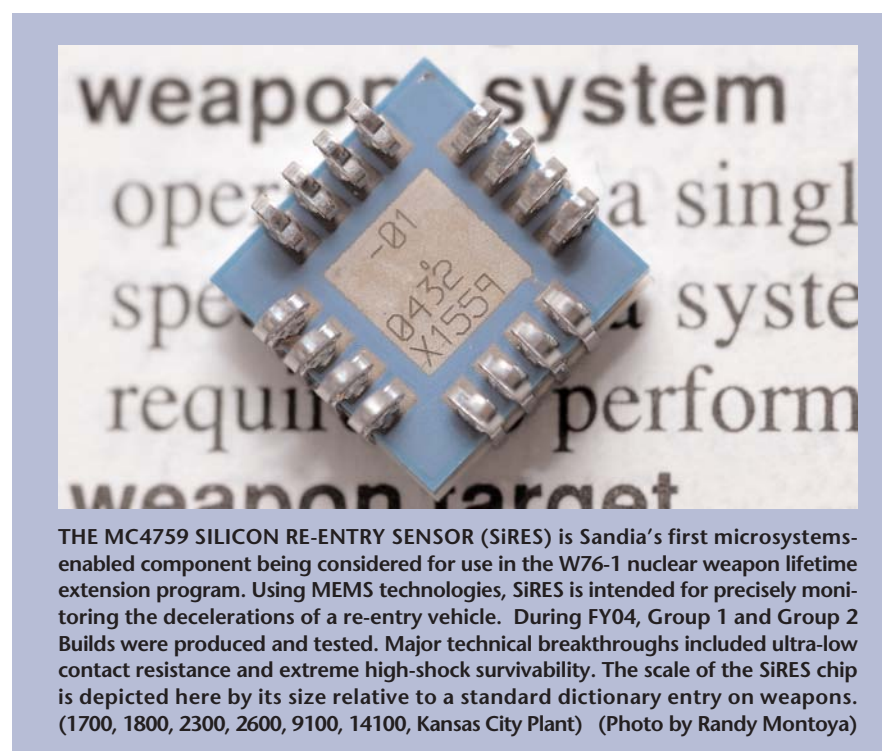
We conducted various experiments with fuel-air explosives (FAE) to be used for security applications. The major problems encountered were control of the fuel-air ratio and mixing of constituents. A test series was performed to develop a FAE scaling law which allows for future development of prototype components. (12300, 2100, 2500)

In response to the increasing threat environment, a cross-disciplinary team developed a concept, known as SAFE, to provide an integrated physical security/use control architecture to provide enhanced security for nuclear assets. Critical technologies to support implementation of the concept were identified and may be developed in the coming years. (12300, 2100, 8200, 4100, 9700)

Development of a unified general-purpose constitutive model for geologic materials was completed. This effort, originated in the late 1990s, experienced accelerated development over the last several years. Key applications include projectile penetration, analysis of hard and deeply buried targets, and reservoir mechanics. The SANDIA GEOMODEL represents a major advancement in the ability to model the complex constitutive response of nonlinear rock-like materials. (6100, 9100, 9200)

Two milestones were completed that increase confidence in the ability of several computer codes to make predictions to help qualify new weapon components. The codes, developed by the Advanced Simulation and Computing program, simulate radiation transport and electromagnetics. They model the electrical and mechanical response of components in hostile X-ray environments. A validation process was followed to compare predictions to experimental data. These codes are currently used to support qualification of the new arming, fuzing, and firing component for the W76-1 and the new neutron generator for the W78. (6700, 1600)

Construction and occupancy of the Distributed Information Systems Laboratory at Sandia/California were completed in 2004. DISL provides Sandia's



THE MC4759 SILICON RE-ENTRY SENSOR (SiRES) is Sandia's first microsystems-enabled component being considered for use in the W76-1 nuclear weapon lifetime extension program. Using MEMS technologies, SiRES is intended for precisely monitoring the decelerations of a re-entry vehicle. During FY04, Group 1 and Group 2 Builds were produced and tested. Major technical breakthroughs included ultra-low contact resistance and extreme high-shock survivability. The scale of the SiRES chip is depicted here by its size relative to a standard dictionary entry on weapons. (1700, 1800, 2300, 2600, 9100, 14100, Kansas City Plant) (Photo by Randy Montoya)

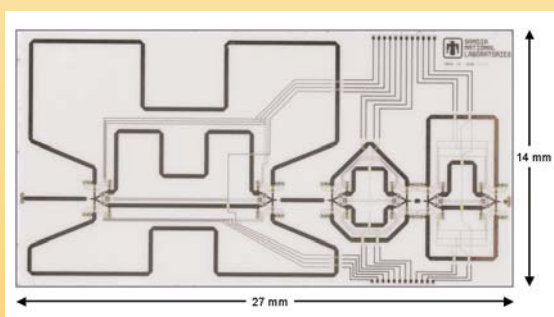
Simulation Enabled Product Realization (SEPR) program office and laboratory space to invent the future of distributed computing through computer sciences research and development. DISL will also help stimulate the transformation in engineering through prototyping of new technologies by weapons engineering workgroups located in classified spaces in DISL. (8500, 8900)

The W87 Life Extension Program rebuild of the stockpile was completed at the Pantex plant in September, achieving a major milestone for NNSA, and finishing a production effort that started in 1999. Activities in the last year consisted of resolving warhead production issues at Pantex, and solving numerous problems at the Kansas City Plant to keep shipment of components in line with the Pantex production schedule. Most notably in 2004, Sandia processed a number of body sections/heat shields with Mark Quality processes to assure that there were enough parts to finish the last warheads.

The Monitoring Technologies group completed a study of the X-ray shielding efficiencies of high-purity tungsten in neutron generator surveillance applications. Results show that box shields of reasonable mass will greatly reduce X-ray-related errors and will improve monitor accuracy by an order of magnitude. This has tremendous implications for production and stockpile surveillance of neutron generators. Monitors incorporating X-ray shield boxes will allow, for the first time, accurate comparisons of production/shelf-life and stockpile surveillance measurements. (2500)

## Electronics

Sandia designed, built, and delivered 6-bit time-delay circuits (below) for wideband electronically steerable array antennas. Enabled by radio-frequency MEMS systems, this advance offers significant noise figure improvement for radar sensors and communication systems, including MESA SAR. Present activities focus on packaged circuit reliability in relevant operational environments. (1700, 5700)



We have made breakthroughs in the performance of light-emitting diodes with wavelengths less than 300nm, achieving optical powers of 2.25mW at 297nm and 1.3mW at 276nm. This has enabled significant gains in the capability of non-line-of-sight communication systems and bio-agent detectors. Additionally, LEDs with emission as short as 237nm, the shortest wavelength reported for this type of device, have been demonstrated. Deep-UV LEDs may replace lamp-based systems in a number of other applications, including water purification, decontamination, and thin film curing. (1100)



## Homeland Security

FLORIDA

Bahama Is.

**H**urricane Frances was heading for Florida, expected to hit land in two days. Sandia got the call to answer difficult, crucial questions before Frances struck. What infrastructures would be damaged? What were the predicted economic costs? Sandia, along with Los Alamos and Argonne

national labs, is developing extensive modeling and analysis capabilities to provide comprehensive answers to critical infrastructure issues. DOE and DHS have regularly called upon these advanced capabilities to address terrorism, new threats, and emerging issues. (6200)

The Hound trace explosives detection system was **broadly fielded last year**. The New Mexico National Guard used the Hound in a warfighting and civil support demonstration for the National Guard Adjutants General from more than 24 states. The South Texas Specialized Crimes and Narcotics Task Force credited the Hound with the **quick identification** of a major methamphetamine shipment after a routine traffic stop revealed concealed powder and liquid. The Task Force said the **Hound saved lives**. Commercialization efforts continue. (4100)

As part of our mission to support our NNSA Nuclear Incident Response Program and the Department of Homeland Security, we **delivered Turbo-FRMAC**, a software tool that allows first responders and consequence managers to **quickly and accurately assess actions required during a radiological event** (nuclear detonation, nuclear power plant accident, dispersal of radiological materials, etc.). The software distills three volumes and more than 500 pages of guidance into a useful set of input panels that are user friendly and intuitive to use. The software provides crisis and consequence managers estimates of the near- and long-term radiological effects to the surrounding population, as well as guidance on dealing with supporting infrastructure such as drinking water, food streams, and personal protection guidance for the public. (4100)

The DHS-IP funded NISAC Western Gulf Coast Infrastructure Interdependency Analysis Project **evaluated potential effects of infrastructure disruptions** and propagation of impacts to other regions and infrastructures by analyzing disruptions caused by increased homeland security levels, loss of physical capacity in water transportation system, loss of refining capacity, loss of crude oil pipeline capacity, loss of refined petroleum product pipeline capacity, regional electric power outage, and regional telecommunications outage. This achievement included close working relationships with the **US Coast Guard, oil industry, and Port Authorities**. (6200)

We developed a suite of components comprising a miniaturized “front end” necessary for biodetector systems. Samples from an aerosol collector have been autonomously prepared, processed, and **delivered into a microChemLab biodetector**. Microseparator/microimpingers provide aerodynamic particle-focusing,



DAVE HANNUM demonstrates the drug-sniffing capabilities of the Hound handheld sniffing device. (Photo by Randy Montoya)

inertial size-separation, and direct-impingement into liquid microsamples. Components developed for post-collection sample preparation include particle concentrators based on dielectrophoresis, microlysers to solubilize proteins, solid-phase extraction and size-exclusion cartridges, miniaturized pumps, valves, and specialized power supplies. Initial results for a breadboard system indicate **successful processing of *Bacillus subtilis* spores**. (8100, 8300, 8700, 9100)

We conducted analyses, staffed deployments and provided follow-up assessments for “Orange Alert” activities including the **Republican National Convention** and New Year’s events to support enhanced radiological and nuclear defensive deployments. The RNC activity **proved that a well-designed concept of operations is required** to ensure a successful deployment.

Most radiation alarms result from naturally occurring radioactive material, such as ceramics and fertilizer, that can overwhelm the secondary screening capacity. Using Sandia’s **Sensor for Measurement and Analysis of Radiation Transients (SMART)**, spectroscopic detectors, and automatic isotope identification algorithms, nearly all naturally occurring radiation sources can be identified non-invasively. (4100, 5900, 6300, 8100, 12300)

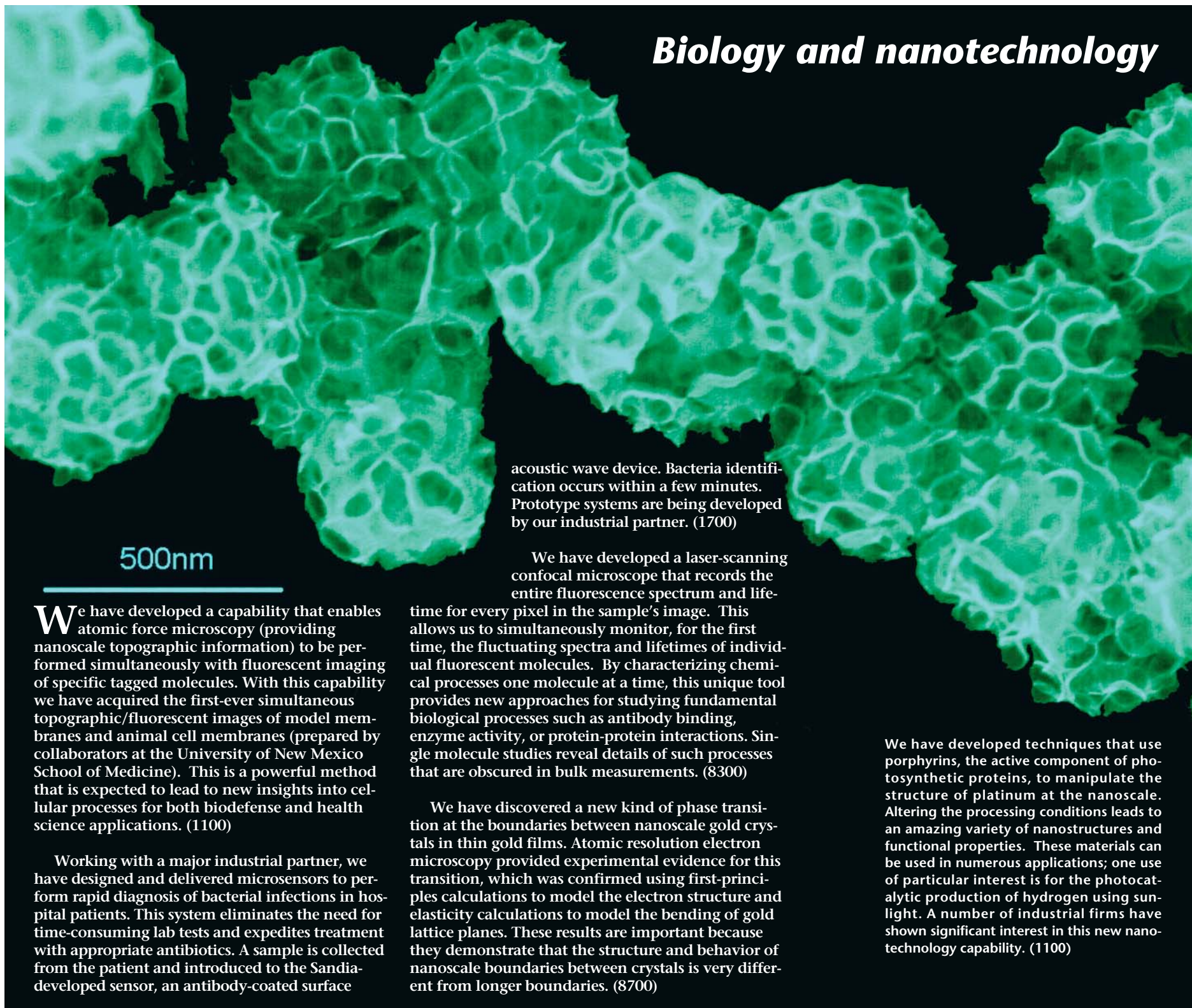
While Livermore, Calif., residents and visitors enjoyed Fourth of July barbecues, music, and other activities, Sandia researchers and members of the Livermore Police Department **tested a complex system of sensors** and other advanced technologies designed to keep revelers safe from terrorist attacks. The Sensor Management Architecture, developed by the Center for Homeland Security Systems & Development (8100), linked chemical and radiological/nuclear sensors, surveillance cameras, and real-time communications to form a **rapidly deployable warning and incident characterization tool** for first responders. (8100)

A guideline document intended to **improve the preparedness of airports** against chemical and biological threats has been published by the **DHS PROACT** airport chem/bio facility protection program. The guide targets near-term facility enhancements and response strategies to prevent or mitigate attacks. This document was developed by Sandia and Lawrence Berkeley labs, combining general chem/bio facility defense expertise with detailed analyses of facility experiments and exercises conducted in collaboration with San Francisco International Airport. **Dissemination to airports nationwide** is being coordinated through the Transportation Security Administration. (8100)

Sandia and EPA are **teaming to protect the nation’s water supply** from chem/bio attacks. DHS-funded work addresses indoor (e.g. courthouses, airports) and outdoor urban air environments. These projects provide guidance for early-warning systems and response plans. Sandia helps sites prepare by assessing risk and computing optimal sensor locations. Real-time physics-based algorithms use sensor data to compute optimal strategies for **protecting people and decontaminating facilities**. EPA enthusiastically writes, “This is an excellent opportunity to leverage the analytical and computational skills at Sandia. . . .” (9200, 6100)



## Biology and nanotechnology



500nm

We have developed a capability that enables atomic force microscopy (providing nanoscale topographic information) to be performed simultaneously with fluorescent imaging of specific tagged molecules. With this capability we have acquired the first-ever simultaneous topographic/fluorescent images of model membranes and animal cell membranes (prepared by collaborators at the University of New Mexico School of Medicine). This is a powerful method that is expected to lead to new insights into cellular processes for both biodefense and health science applications. (1100)

Working with a major industrial partner, we have designed and delivered microsensors to perform rapid diagnosis of bacterial infections in hospital patients. This system eliminates the need for time-consuming lab tests and expedites treatment with appropriate antibiotics. A sample is collected from the patient and introduced to the Sandia-developed sensor, an antibody-coated surface

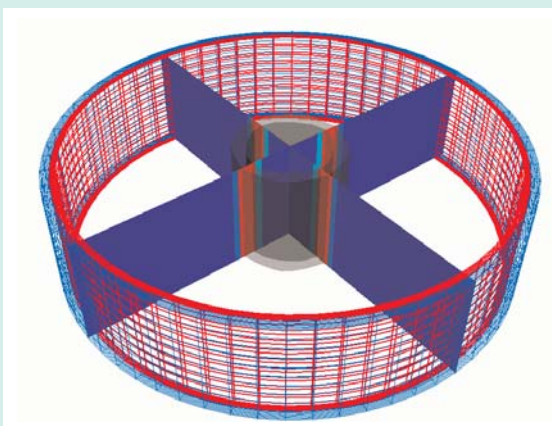
acoustic wave device. Bacteria identification occurs within a few minutes. Prototype systems are being developed by our industrial partner. (1700)

We have developed a laser-scanning confocal microscope that records the entire fluorescence spectrum and lifetime for every pixel in the sample's image. This allows us to simultaneously monitor, for the first time, the fluctuating spectra and lifetimes of individual fluorescent molecules. By characterizing chemical processes one molecule at a time, this unique tool provides new approaches for studying fundamental biological processes such as antibody binding, enzyme activity, or protein-protein interactions. Single molecule studies reveal details of such processes that are obscured in bulk measurements. (8300)

We have discovered a new kind of phase transition at the boundaries between nanoscale gold crystals in thin gold films. Atomic resolution electron microscopy provided experimental evidence for this transition, which was confirmed using first-principles calculations to model the electron structure and elasticity calculations to model the bending of gold lattice planes. These results are important because they demonstrate that the structure and behavior of nanoscale boundaries between crystals is very different from longer boundaries. (8700)

We have developed techniques that use porphyrins, the active component of photosynthetic proteins, to manipulate the structure of platinum at the nanoscale. Altering the processing conditions leads to an amazing variety of nanostructures and functional properties. These materials can be used in numerous applications; one of particular interest is for the photocatalytic production of hydrogen using sunlight. A number of industrial firms have shown significant interest in this new nanotechnology capability. (1100)

## Engineering Science



The W80-3 Abnormal Environment Verification and Validation Level 2 Milestone was completed through the efforts of Centers 8700, 9100, and 8900. The team demonstrated a hierarchical approach to code verification and model validation through analysis and testing at increasing levels of geometric complexity and physical phenomena. The project focused on assessing capabilities (with quantified uncertainty) to predict W80-3 response to abnormal mechanical and thermal environments. The results support the W80-3 qualification activities.

We used a new thermal-electrical-mechanical coupled-physics analysis code to describe the 3-D motion of a microsystems thermal actuator. The

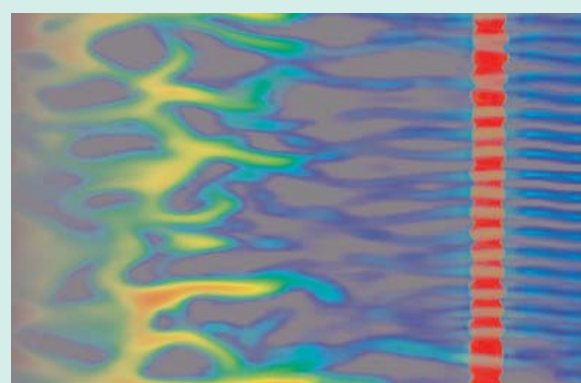
actuator could be used in mechanical non-volatile memory devices. This new analysis capability was developed by coupling thermal, electrical, and mechanical analysis programs within the **Sierra framework**. This analysis capability can run on the world's fastest parallel computers, and will accelerate microsystems development rates. This project included analysts and code development teams in 9100 and microsystems designers in 1700.

The **Analyst Homepage** is an online resource for modeling and simulation analysis. It presents a wealth of information about codes, tools, servers, and other topics of interest to analysts. Because of the sheer volume of information and the uncharted nature of the project, it took tremendous effort on the part of the developers and the project owners,

including user research, information architecture, interface design, coding, and maintenance. The site has received more than 25,000 hits per month since its deployment. (9500)

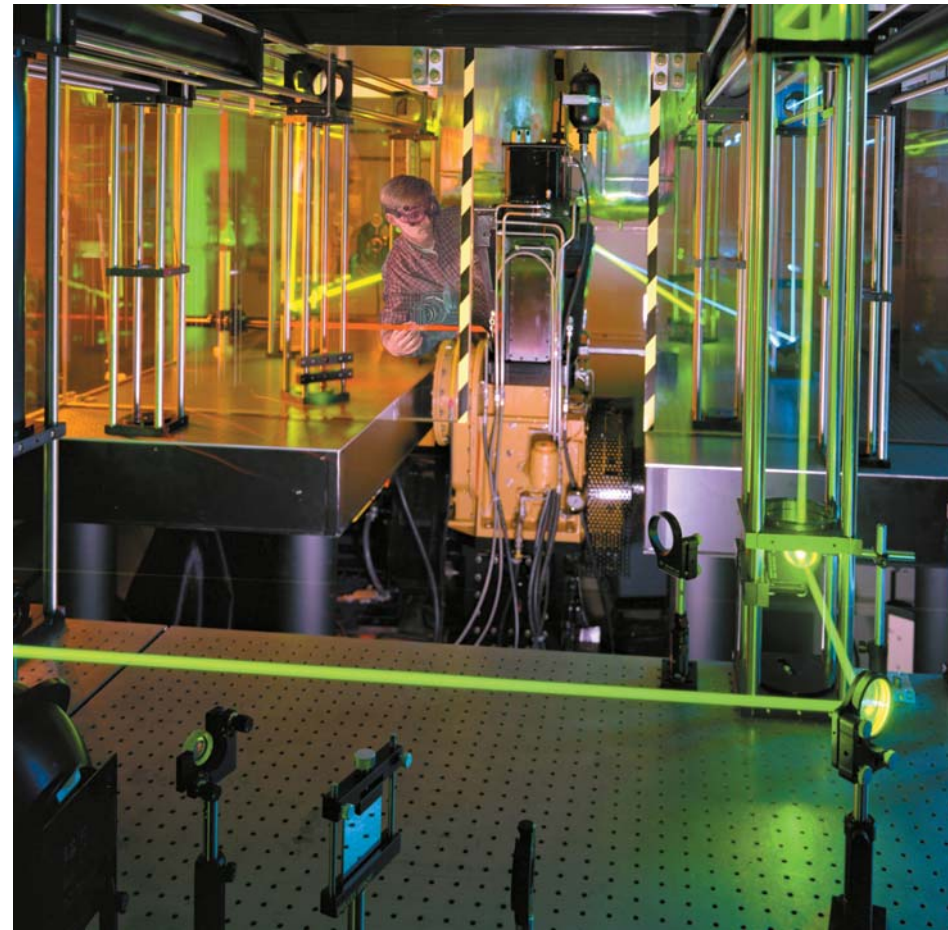
**DART, the Design Through Analysis Realization Team**, has set its sights on improving scientific and engineering analysis times by an order of magnitude. Corporate ownership and careful management has produced a progressive technical roadmap and aggressive changes within a portfolio of 14 projects. Strategic integration has been accomplished via XML metadata files. **Critical process knowledge and information** has been captured via a comprehensive analyst homepage. A common user support structure has been adopted to enhance usability and supportability of the codes. (9200)

SANDIA'S RECORD-SETTING visualization algorithms were deployed in 2004 through the open-source visualization tool **ParaView**. Sandia collaborated with external partner Kitware Inc. to deploy the Data Analysis and Visualization Dept.'s high-end visualization algorithms, including the world's fastest parallel rendering algorithm. These algorithms scale from the desktop to leading-edge visualization clusters and high-resolution display walls. ParaView was recently used to display and explore the results of the largest finite element simulation data set at Sandia (greater than 70 million finite elements). **ParaView is downloaded by more than 70 people around the world each day.** (9200)





## Energy and infrastructure assurance



The Atmospheric Radiation Measurement-Unmanned Aerospace Vehicle program conducted 14 scientific flights over the DOE sites at the North Slope of Alaska as part of a three-week multi-agency Mixed-Phase Arctic Cloud Experiment. The complex payload, flown on Scaled Composites' Proteus aircraft, was controlled from a distance of 2,400 miles using a low-cost satellite link. More than 60 hours of flight data were collected to investigate arctic water/ice clouds. The data will help researchers to better understand their microphysical properties and role in the atmospheric energy budget. (8200)

Oxygen-containing compounds added to fuel are called oxygenates. The potential for oxygenates to limit soot emissions from diesel engines has been known for some time. What hasn't been known is whether (or why) some oxygenates are more effective than others. Research (in collaboration with Lawrence Livermore National Laboratory) has significantly advanced the understanding of oxygenated fuel combustion, conclusively demonstrating how molecular structure can play an important role in determining the soot-reduction potential of an oxygenate. (8300)

Sandia was selected last March to lead one of three new DOE Centers of Excellence for Hydrogen. The \$25 million Metal Hydride Center of Excellence includes eight universities, three companies, and five other national laboratories. It focuses on developing new solid-state reversible hydrogen storage materials that will meet or exceed the DOE FreedomCAR goals in 2010 and 2015. (8700, 8300, 8200, 1800, 6200)

We have developed, in collaboration with American Superconductor Corp., a new superconducting wire. The new method deposits epitaxial films of superconducting ceramics on a flexible nickel-based tape by dip-coating of solution precursors, and enables high deposition speeds of 120 meters/hour. This method holds promise for low-cost production of superconducting wire for stabilizing power transmission, increasing efficiency of transformers, producing lightweight generators, and improving the sensitivity



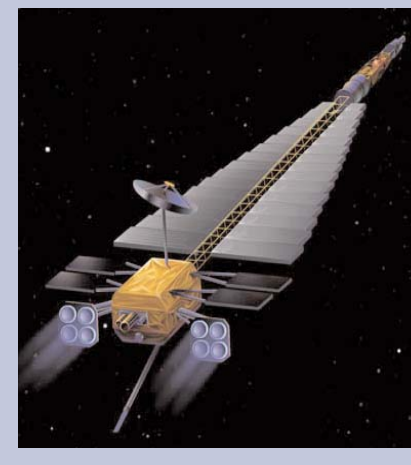
of commercial Magnetic Resonance Imaging machines. (1800, 1100)

Sandia's Center for SCADA Security was established to address security challenges facing the National Critical Infrastructure. Supervisory Control and Data Acquisition, or SCADA, systems manage electric power, oil and gas, water, and other critical infrastructure. The Center provides R&D, standards development, vulnerability assessments, and outreach to government and industry at its facility. CSS is part of DOE's National SCADA Test Bed program, the Department of Homeland Security Control System Security and Test Center. It leads \$16 million in SCADA security research through the Department of Homeland Security and the Institute for Information Infrastructure Protection. (5600, 6200)

We have developed wind turbine blades that use carbon/glass hybrid materials to reduce weight and shed loads caused by turbulence through aeroelastic twist-bend coupling. The first sub-



Center 6800 led a Sandia team to provide nuclear reactor and aeroshell design expertise to NASA and its industrial aerospace teams for a proposed Jupiter Icy Moons Orbiter (JIMO) mission (see NASA illustrations, left and right). This mission will use a nuclear reactor to power electric thrusters, enabling a fuel-efficient flight to Jupiter. Moving forward, Sandia will be part of the team that will design, develop, and test the JIMO orbiter for the 2016 launch. (6700, 6800, 9100)



scale prototypes have been built and will be tested this year. The novel concepts were designed using the Sandia-developed NuMAD tool for blade analysis. Early results are promising, and three blade manufacturers have been selected for a \$7 million, three-year, cost-shared collaboration to take these concepts to full-scale commercial application. (6200)

We developed a software tool that enables rigorous definition of drilling fluid pressure requirements and robust well designs for deepwater subsalt settings. The software interpolates across 580 non-linear finite element analyses in stress-temperature space to constrain borehole closure and casing loading for circular and elliptical boreholes. Using experience from WIPP, the Strategic Petroleum Reserve, and data for deepwater salts, strong, medium, and weak salts are modeled. The software was released to eight oil companies and has been applied to several new field developments in the Gulf of Mexico. (6100)

An initiative of the presidents of Sandia and the Kurchatov Institute in Russia to bolster nuclear energy development and deployment resulted in a joint report signed by seven US national laboratories and nine Russian counterpart bodies. The report was agreed on at a US-Russian Lab Directors Forum, held last summer in Vienna. The summary, signed by all 16 research chiefs, asserts: "The time has come to develop a comprehensive and realistic plan to ensure the



LIQUEFIED NATURAL GAS (LNG) is being transported by ship to the United States to meet increasing energy needs. Multiple government agencies requested that Sandia assess the hazard posed by very large (100s of meters in diameter) LNG fires from potential terrorist attacks. Evaluations of wide variations in predictions from previous studies (including comparisons to nuclear detonations), guidance on best methods for analysis, and key sources of uncertainty were analyzed. New, unique experiments are being assembled at Sandia to obtain critical data. Likely causes of a fire and explosion at an Algerian LNG facility were also identified. (9100, 6200, 4100, 2500)

## Energy and infrastructure assurance

development and deployment of nuclear energy. It must preserve access to nuclear energy

sources for all countries of the world, and in parallel, reduce the risks of nuclear arms proliferation, nuclear terrorism, and hazardous impacts on environment and population health."

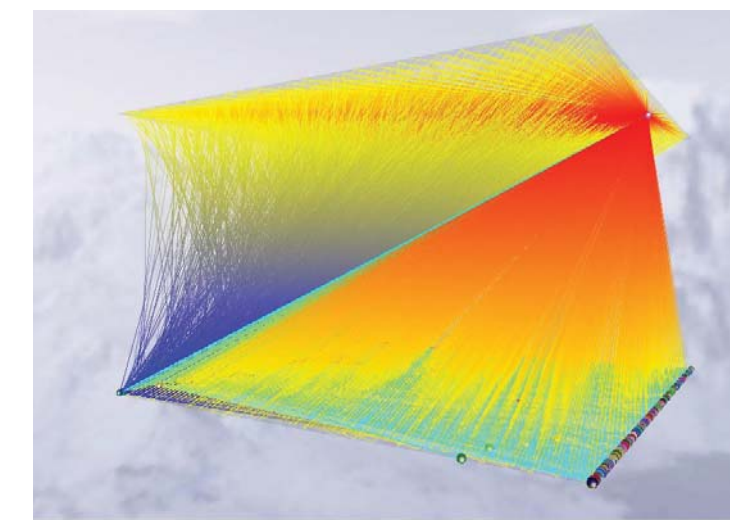
The Transportation and Materials Management Program completed a structural and thermal impact analysis of an F-16 crash for the Nuclear Regulatory Commission. The analysis assessed the consequences of an F-16 crashing into a cask at a spent nuclear fuel dry storage facility. This work was critical because the NRC rejected the initial recommendation that the probability of an accident was too low to consider credible. This work included expert witness testimony and is critical to the future licensing of storage facilities. This work produced a novel approach to modeling bolts and a novel application of the Smooth Particle Hydrodynamic code. (6100, 9100)

Sandia's Carlsbad Programs Group, home of the nation's top experts on WIPP-related science issues, last year applied its expertise to another thorny waste disposal issue. It completed a Performance Assessment analysis that was instrumental in gaining the required EPA approval to dispose of 20,000 cubic meters of super-compacted waste produced by the Advanced Mixed Waste Treatment Facility at the Idaho National Engineering and Environmental Laboratory. (6800)



Sandia engineers, in cooperation with an international cadre of industry partners and the Nuclear Regulatory Commission, completed and documented a three-year effort to define the state-of-the-art in fire probabilistic risk assessment for the nuclear energy industry. Sandia has been the lead laboratory for regulatory fire safety research for three decades. The work is a watershed in cooperative research between nuclear regulators and industry, and enables implementation of an essential goal for the NRC: risk-informed regulation for fire protection at nuclear power plants. (6800)

As part of our geothermal research programs, we have developed high-temperature electronics and instrumentation. After 7,950 hours at 193°C, a Sandia-developed high-temperature, high-pressure well-logging tool using a Silicon-On-Insulator chip set is setting new records for long-term well monitoring. The Sandia-designed 250°C chip (manufactured by Honeywell) is the heart of a long-life data-acquisition system capable of monitoring geothermal wells, advanced fighter aircraft, or even future Venus explorers. (6200)

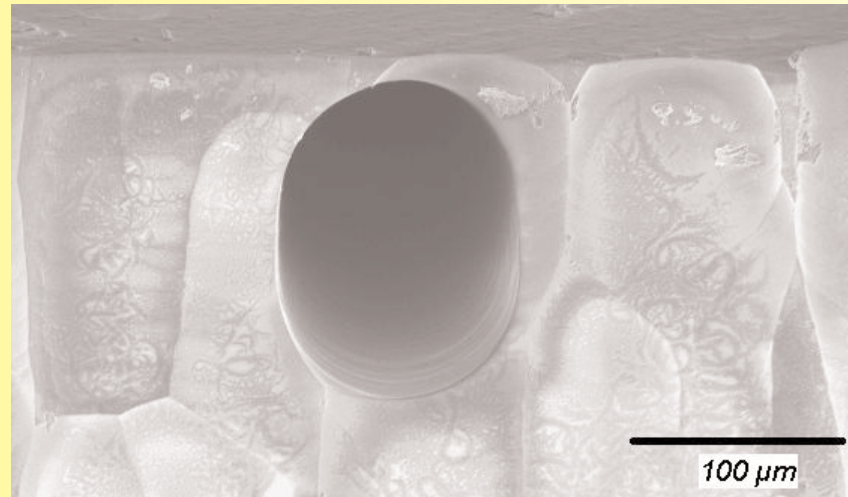


## Manufacturing

The Neutron Generator Production Center uses Lean/6 Sigma (LSS) methods in its continuous improvement program. Use of the LSS Vertical Value Stream process allowed the Quality Front End Work-In-Process team to better organize, prioritize, and manage its project plan. It resulted in project completion four months ahead of schedule and improved quality of the Oracle Manufacturing Application interface and work-in-process tracking system that was implemented for production floor personnel use. Oracle production floor transaction entry efficiency was improved by 75 percent. The team presented its improvements at the 2004 Association for Manufacturing Excellence Conference in Cincinnati. (14400)

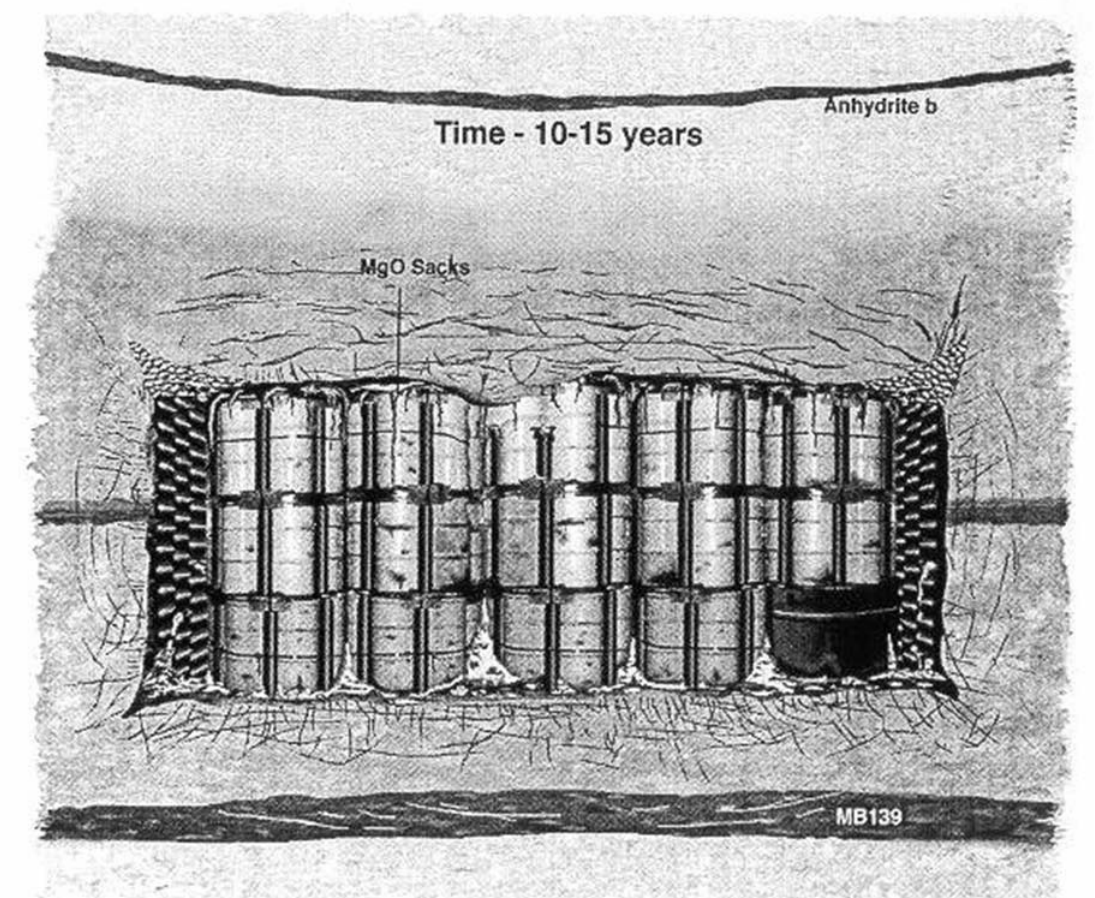
The Ceramics and Glass Processing Department and the Quality Engineering and Assurance Department collaborated to improve and perform Sandia product acceptance. As a result of the work, the NNSA Sandia Site Office discontinued its Quality Assurance Inspection Procedure on two WR nuclear weapon active ceramic components. A zero defect rate of inspected parts and a robust Sandia product acceptance process have established a high Sandia Site Office confidence level with active ceramics product submittals.

The US Bureau of Apprenticeship and the New Mexico State Apprenticeship Council have officially certified 14100's Advanced Manufacturing Trades Training Program as an apprenticeship program. The National Defense Industrial



A NEW MANUFACTURING TECHNOLOGY based on ultrashort pulse laser processing has been developed to directly micromachine energetic materials and films, create embedded microfluidic channels, and fabricate low-loss 3-D optical waveguides and integrated optics in bulk glass. This enabling technology minimizes the thermal damage during machining of metals and permits the creation of novel photonic devices and structures and the fabrication of integrated microsensing systems. (14100, 1700, 1800, 15000)

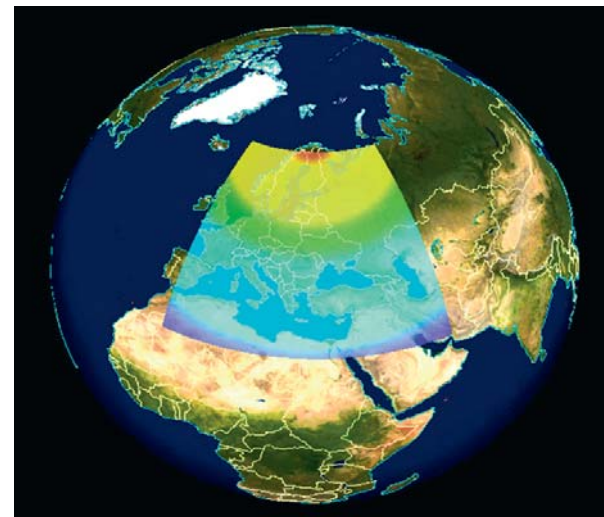
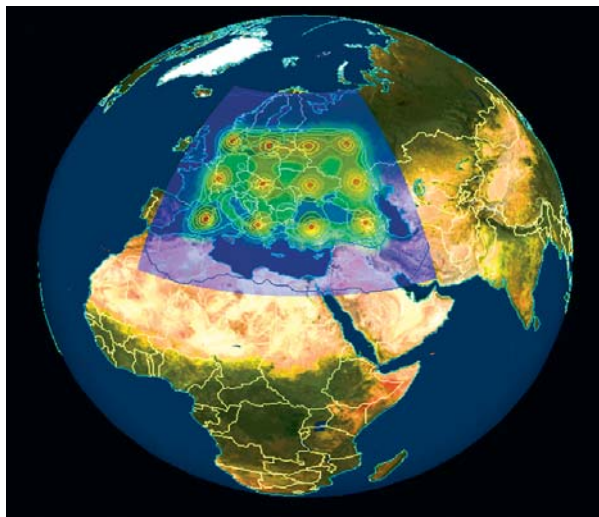
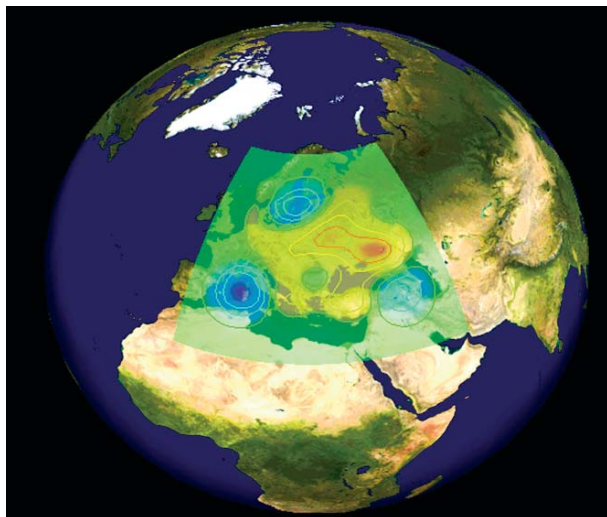
Association recently recognized AMTTP for "Defense Manufacturing Excellence." AMTTP recruits students attending New Mexico technical institutions. Students successfully demonstrate technical capabilities in national technical competitions. Representatives of the Labs and Albuquerque TVI designed the AMTTP using skills standards from the National Coalition for Advanced Manufacturing. (14100)







## Nonproliferation and assessments



Sandia delivered the Ground-Based Nuclear Explosion Monitoring Knowledge Base Version 6 to the Air Force (images above). The Knowledge Base was a collaboration among Sandia, Los Alamos, Lawrence Livermore, and Pacific Northwest labs, where Sandia acts as both a contributor and as system integrator. The Knowledge Base is **critical in improving the ability of the US to detect, locate, and identify clandestine nuclear tests** by providing **detailed knowledge of the earth's structure**, signal propagation characteristics, and analysis tools. There are now 99 unique products in the Knowledge Base. (5700, 5500)

Sandia has transitioned a new sensor microsystem from concept to spaceflight-quality fabrication in only three years. These microsystems are based on custom sensor read-out and signal processing Integrated Circuits (ICs) designed and built at Sandia. **Two hundred fifty-six of these ICs** are assembled onto two-sided multichip modules and integrated into a multi-layer assembly with a photodiode array. We are fabricating these highly integrated sensor microsystems for the **next generation of Global Positioning System satellites**, and two flight-quality sensors are complete. (5700, 1700, 1800, 14100)



For applications requiring both data encryption and authentication, **we have developed new algorithms** that use information from the internal state of a standard cipher to provide data authentication at little more than the computational cost of encryption alone. Their "Cipher-State Mode of the Advanced Encryption Standard" is a National Institute of Standards and Technology (NIST) candidate mode of operation for an authenticated encryption standard. **This same algorithm was recently integrated into a commercial software product** to support Sandia's Cyber Security of Utility Operations project. (5600)

At the conclusion of a 6-year, \$15 million effort, **we delivered a suite of advanced radiological debris collection and analysis systems** to harvest gas and particulate samples. The work is part of an Air Force mission to conduct international nuclear test ban treaty monitoring. The Advanced Atmospheric Research Equipment provides significant enhancements in computer control and data management, real-time radiation monitoring, and crew safety radiation monitoring. Last summer the equipment was installed on an Air Force WC-135 (Boeing 707) aircraft and **successfully flight-tested**. (5500, 5900)

The AURA (Advanced UV Remote-sensing Applications) airborne lidar, a technology developed to perform **standoff detection of WMD proliferation "markers,"** underwent extensive flight test evaluations. The system was installed on a Proteus aircraft and completed 50 hours of flight testing over a period of 11 days. Airborne collections were successfully performed to validate design performance estimates and better understand the limits of this technology for operational applications. (1100, 2300, 5700, 6100, 8100, 8300)

Sandia's **Center for Cyber Defenders** (CCD) program uses highly qualified students interested in becoming cyber security professionals to address cyber security challenges facing the nation. **Students work on research projects and develop security technologies** relevant to Sandia's mission: network visualization, supervisory control and data acquisition (SCADA) security simulation, sensor network security, computer network mapping, and wireless network security analysis. So far, the program **has recruited 52 students from 22 universities** across the country. Thirteen CCD alumni are now Sandians. (5600)

The Radiological Threat Reduction (RTR) Program at Sandia **secured 24 sites** with high-risk radiological sources. In Lithuania, five hospitals and one waste repository site received security upgrades and a search for orphan sources was conducted at 39 locations. Sandia is working with the Russian Federation Navy to dispose of Radioisotopic Thermo-electronic Generators (RTGs), replacing them with alternative energy systems. Also, in preparation for the **2004 Olympics in Athens**, the team secured 18 sites and **trained Greek officials** on safeguarding radiological materials. (6900)

The Sandia-developed Special Sensor F, or SSF, was launched on an Air Force weather satellite in late 2003. During 2004, Sandia completed early-orbit testing and extensive calibration of SSF, and declared it **ready for operational use**. The sensor **provides laser-threat warning for its host satellite**; it is the first of its class — it not only detects laser illumination, but it also characterizes the laser energy (both wavelength and incident energy) and provides location of origin. (5700)

The Dynamic Explosive Test Site hosts training, research, development, test and evaluation for nuclear emergency responders, the special operations community, and other federal agencies. Explosive testing supports units in the field (gauntlet test). Lifelike replicas of improvised explosive, nuclear, or radiological devices set in realistic training venues (e.g. the *Rubik Maru*) provide challenges for responders' tools, tactics, and procedures. Lessons learned during training guide development of new tools and techniques, which are immediately put to use around the world. (5900)

The **Megaports team** successfully developed and installed an integrated information technology and communications system for use by Dutch Customs in the



IN OCTOBER, the twenty-third Defense Support Program satellite (DSP-23) **passed its final inspection** prior to being shipped to its launch site. This launch will be the last for a DSP satellite, which has been a major element of the US Nuclear Detonation Detection Systems for **more than 30 years** and a major activity in the Monitoring Systems and Technology Center. (5700)



REALISTIC TRAINING VENUES, like the *Rubik Maru* platform at the Dynamic Explosive Test Site (above), enable responders to exercise and hone the skills and tactics they need to deal with real-world terror threats.

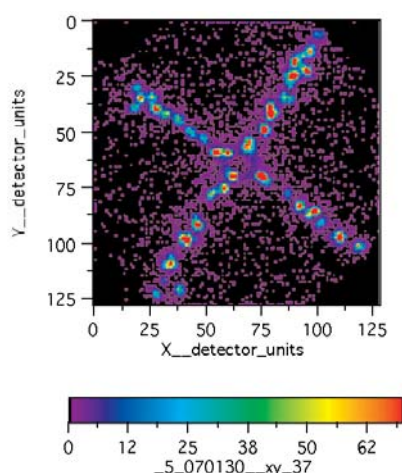
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## Materials, chemistry, and physics

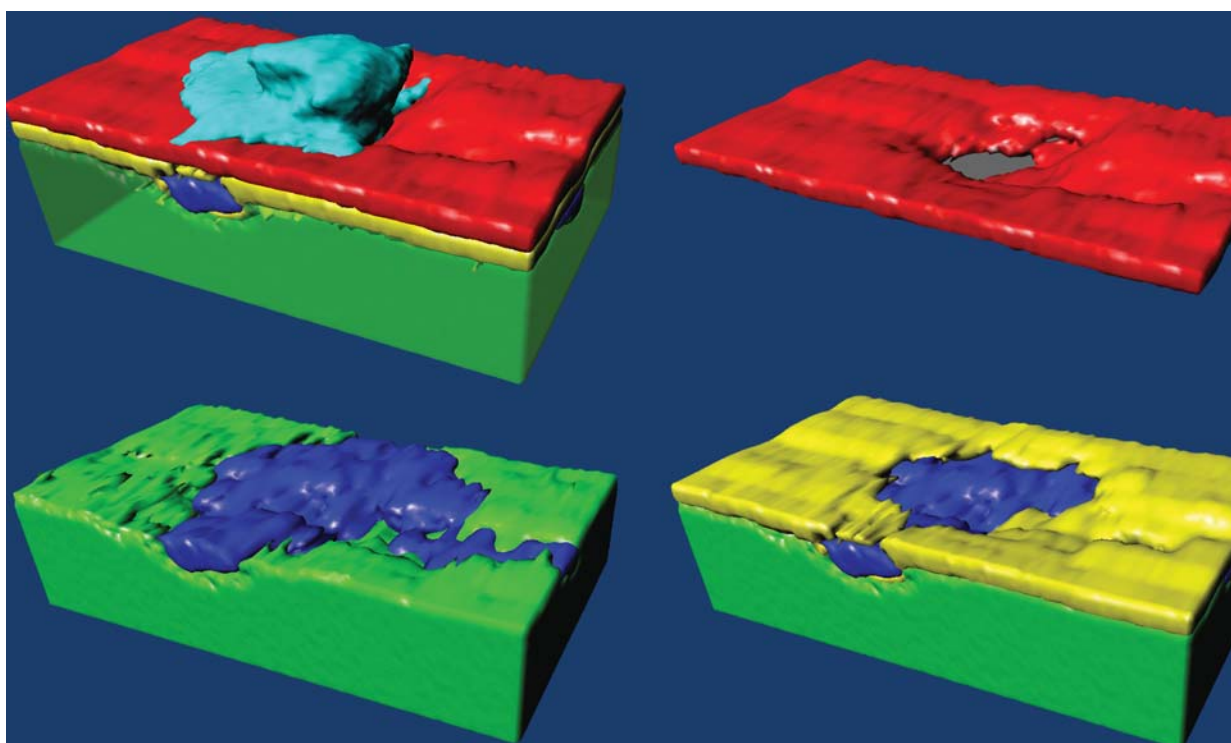
We have developed a simple and robust general sensor platform for chemical and biological detection based on self-assembled nanoporous materials. This sensing device is easy to fabricate and can be integrated with Sandia's advanced microsystems. The specific and selective binding of biomolecules is translated into electronic signals without requiring the complicated labeling steps used in the preparation of most other electrochemical sensors. This ultra-sensitive sensor enables the detection of protein and sequence specific DNA at the femtomole ( $10^{-15}$  mole) level. (1800)

Metal hydrides are used to store hydrogen and its isotopes in neutron generator targets. The presence of tritium in hydride systems results in a time-dependent change of the target material due to the radioactive decay of tritium to helium-3, resulting in a potential negative impact. The behavior of radiogenically produced helium-3 in metal tritide films has been an active



area of interest for more than thirty years but remains a poorly understood phenomenon. Recent experiments using several neutron scattering techniques have been applied to this problem resulting in first-time observations of helium ordering within an erbium tritide matrix. Studies are under way to determine the underlying reasons for these observations. (14400)

We have developed a revolutionary new method for comprehensive 3-D chemical analysis that requires no a priori knowledge of the chemistry. This method provides detailed characterization of critical materials, such as aging stockpile materials. The X-ray spectral images, analyzed with Sandia's patented and award-winning Automated eXpert Spectral Image Analysis software, reveal rich detail not previously available. This information has been essential for resolving materials problems, such as identifying causes of component corrosion and ways of mitigating future problems. (1800)



COMPREHENSIVE 3D chemical analysis of localized corrosion on a gold- and nickel-plated copper substrate. The gold layer is red, copper substrate is green, unexpected silicon oxide contaminant is blue, copper sulfide corrosion product is cyan (light blue), and nickel layer is yellow. The silicon oxide caused a hole in the nickel and gold layers which resulted in corrosion after atmospheric exposure.

## Environmental remediation

The disassembly/sanitization process for material that was exhumed during remediation of the Classified Waste Landfill was completed last September. The activity started in February 2000, with no disposal path available for mixed classified components and no other facility available to perform this work. Therefore, the material was sorted and disassembled on-site, involving combinations of cutting, shredding, and melting. Approximately 30,000 classified items were excavated. A few items could not be disassembled because of ES&H concerns and were managed as classified low-level waste. Approximately 90 percent of the



original volume of materials was recycled. (6100, 6300)

Facilities, Procurement, and Pollution Prevention (P2) staff implemented comprehensive recycling and green purchasing programs for construction. Major projects recycle over 80 percent of construction waste, and 99 percent of their purchases meet the EPA's recycled content requirements. Sandia received a White House Closing the Circle and NNSA P2 award for green purchasing. For construction recycling, Sandia received an NNSA P2 Award, the EPA Waste Wise Program Champion Award for the Federal Government, and the New Mexico Recycling Coalition "Federal Facility Recycling Program of the Year" award. (6300)

## Nonproliferation

(Continued from preceding page)

leading international Port of Rotterdam, one of the busiest container terminals in the world, to deter, detect, and interdict illicit trafficking in special nuclear materials. System design, installation, and operation included radiation portal monitors, video cameras, and special scan trigger sensors. The system is widely recognized and praised for outstanding performance and attracts port representatives from around the world. (6900)

The Enhanced Radiometer (ENRAD) was launched from Cape Canaveral on June 23, 2004, on board the GPS Mission IIR-12 satellite. ENRAD is a demonstration of the next generation of optical sensors which will be included on future GPS satellites. These sensors will provide significantly enhanced optical sensor performance for worldwide nuclear treaty monitoring. During the early-orbit test period a series of tests were performed to verify functionality and set operating modes and the sensor was tested with ground-based optical pulses. (5700, 5500, 1700, 14100)



ENRAD launch at Cape Canaveral.

Focusing on local infrastructure rebuilding, international R&D, and business development, an initial survey was made to contact and engage members of the Iraq science and technology community. Proposals were requested from Iraqi scientists, and two projects were funded in the high-priority areas of water and public health. Current efforts include working with Iraqi scientists to develop detailed project proposals that can be submitted to international funding organizations. This program has strong Iraqi participation and the participation of scientists from other Arab countries. (6900)

## Advanced concepts group

The Advanced Concepts Group has developed a process — called "fests" — for large group brainstorming. Fests are particularly effective in bringing together diverse groups to address open-ended questions requiring new approaches. Two successful Fests were held in FY04 dealing with international approaches for countering terrorism: PACFest involving Singapore, Australia, Guam, Fiji, and Palau in the Pacific region; and NorthAm Fest involving Canada, Mexico, and the US. (16000)

The ACG developed a strategic architecture for understanding and anticipating terrorist threats to enable a full range of actions for countering terrorism. An ACG-funded LDRD for "The Hypothesizer" has created a prototypical, AI-based tool that generates terrorist scenarios. Those scenarios, in turn, provide the data this architecture needs for a better understanding of the full range of hypothetical terrorist actions. This has led to a fledgling program in the Information Systems Center (5500) in Knowledge, Discovery, and Dissemination with the intelligence community. (16000)



Artwork by Ken Miller

An understanding of terrorist motivation and intent will greatly improve our ability to anticipate terrorist targets and methods, disrupt their operations, and narrow the field for homeland defense. The ACG developed a program for this purpose, including the establishment of Knownet, a network of terrorism experts now available to the homeland security and intelligence communities. ACG concepts have been adopted by the DHS and incorporated into a new Center 5900 program for that agency. (16000)



## Military technology and applications

Sandia designed, produced, and tested shoulder-length gauntlets to help protect the arms and lives of military personnel in combat. The gauntlets, forearm and upper arm protective inserts as seen at right, made of Kevlar layers with carbon-composite, protect soldiers riding atop military vehicles from Improvised Explosive Devices (IEDs). Army representatives are collecting statements from troops who have worn the gauntlets. Among the comments: "They really like the gauntlets and think they are a great item;" "impressed with the gauntlets;" and "looking forward to receiving many more gauntlets." (6900, 15300)

Exoskeletons for soldiers require advanced sensing of their environment, including ground reaction forces and terrain sensing. To solve this problem, a Sandia team (15200, 1700, 14100, and 9100) produced a custom MEMS-based pressure sensor array and integrated it into an exoskeletal boot sole. The team advanced the state-of-the-art in microsystems deployment by packaging a delicate MEMS device to withstand the abusive environment encountered by the bottom of a soldier's boot. (15200)



The US military needs a rapid-response, precision-strike conventional weapon capable of holding hardened and deeply buried targets at

risk. The Tactical Missile System Penetrator project is an Advanced Concept Technology Demonstration to design, develop and demonstrate such a weapon system. The US Navy Strategic Systems Programs Office is sponsoring Sandia's work in this conventional warhead payload effort. The project is in the flight demonstration phase. An FY05 project deliverable will be six combat-capable residual assets. (1800, 2300, 2500, 2600, 2900, 3100, 9100, 10200, 12300, 14100, 15400)

The Intelligent Systems Controls Department (15234) has recently developed a Wheeled Hopping Vehicle (photo at right) for DARPA's Advanced Technology Office. This man-packable robot vehicle uses a combustible cylinder to jump over 8-foot-tall obstacles. This capability allows a small vehicle to negotiate rough terrain previously considered impossible. Applications for this robot vehicle include searching caves and deeply buried facilities. (15200)



The Targets Program delivered two target payloads to support Missile Defense Agency launches in early FY05. These launches test the effectiveness of our nation's missile defense system. Five additional target payloads reached various stages of completion in FY04, all of which will support flight tests in FY05. The newest of these payloads, designed by Sandia in FY04, involves highly advanced development work, including Wireless LAN technology. This advanced development work aligns with our pro-

gram's future objectives as well as the Labs' vision. (15400)

The Penetration Science and Technology Department and the Structural Mechanical Engineering Department designed and successfully demonstrated a new, two-piece penetrator with a jointed-nose that provides the following advantages: Precision deep-cavity machining of high-strength steel alloys; uniform heat-treatment; expanded assembly options; forward fuze placement; nose-shape; nose-material optimization; and reduced production costs. The elements of these designs have been used across the Lab, and are being embraced by DoD laboratories and contractors.

We are developing the technology for an eye-safe, robust, low-cost, lightweight, 3-D structured lighting sensor for use in broad daylight outdoor applications. Structured lighting requires image processing to isolate or segment a laser signal from background clutter in a camera image, which is difficult to accomplish under bright outdoor conditions and with highly absorptive surfaces. Applications include precision mapping, autonomous navigation, dexterous manipulation, surveillance and reconnaissance, part inspection, geometric modeling, laser-based 3-D volumetric imaging, simultaneous localization and mapping (SLAM), aiding first responders, and supporting soldiers with helmet-mounted LADAR for 3-D mapping in urban-environment scenarios. (15200)

Sandia staff are helping the US Navy create next-generation aircraft carrier operations by conducting analyses leading to improved performance, reduced manpower, and reduced costs. After successful completion of a four-month evaluation of current Navy air wing operations, structure, and preliminary improvement alternatives in FY04, a strategic partnership has been formed through at least FY07 to develop a "system of systems" analysis capability providing greater quantitative understanding of the aircraft carrier system to improve decision-making regarding organizational structure and resource allocation. (6800, 6200, 15200)

The Micro Analytical Systems Department is completing work for the Defense Emergency Response Fund to address mass-manufacturing and other critical issues for MicroChemLab. DoD had significant reproducibility problems with production of other chemical sensor packages. We have overcome many of these

issues and have developed apparatus to reproducibly deposit polymer films and sol gels for our chemical analysis system components. In addition, we have established commercial manufacturers for each of the critical components for MicroChemLab. (1700)

Significant new electromagnetic launch capability has been achieved this year as a result of new launch programs supported by DoD and Lockheed Martin. A program has been initiated by the Defense Advanced Projects Agency to analyze and demonstrate EM launch



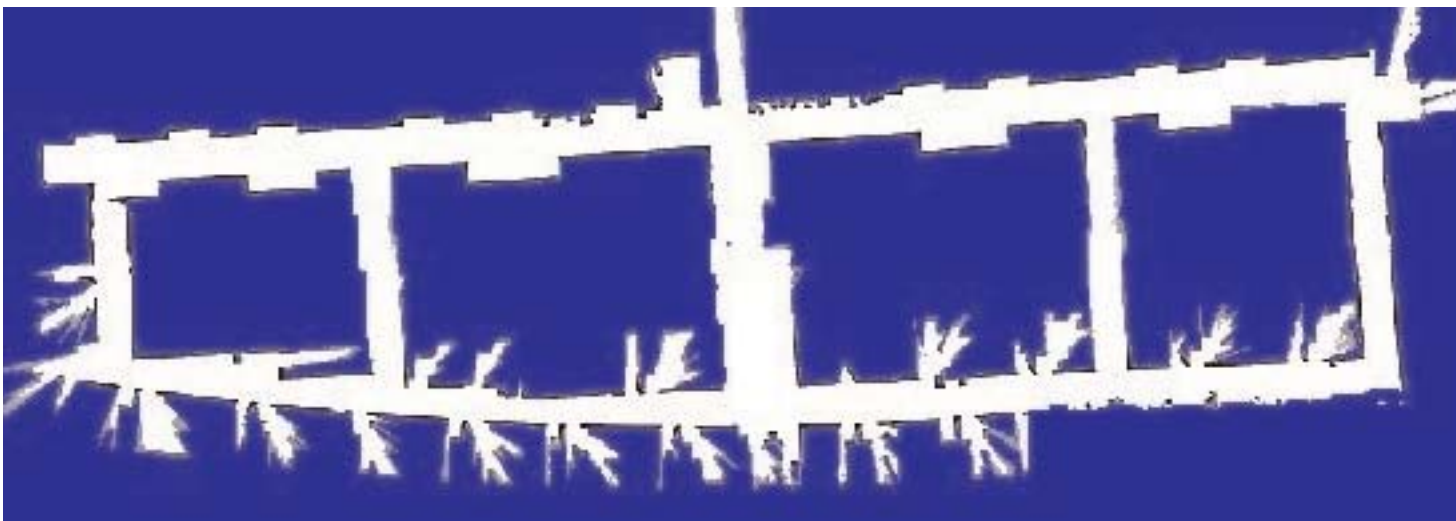
MEMBERS of the New Mexico Army National Guard demonstrate how Sandia-developed Kevlar gauntlets would be deployed in the field. (Photo by Randy Montoya)

capability for mortar-class artillery. The goal of this program is demonstration of full-scale launchers (both railgun and coilgun variants) at muzzle velocity of 420 m/s for 120 mm mortar projectiles, with kinetic energy of 1.6 MJ. The EM Mortar team is composed of the following organizations: Sandia (lead), Institute for Advanced Technology (IAT) at the University of Texas; The Army Research and Development Command, Picatinny Arsenal; the National High Magnetic Field Laboratory at Florida State University and Los Alamos National Laboratory; and TPL, Inc. (15300)

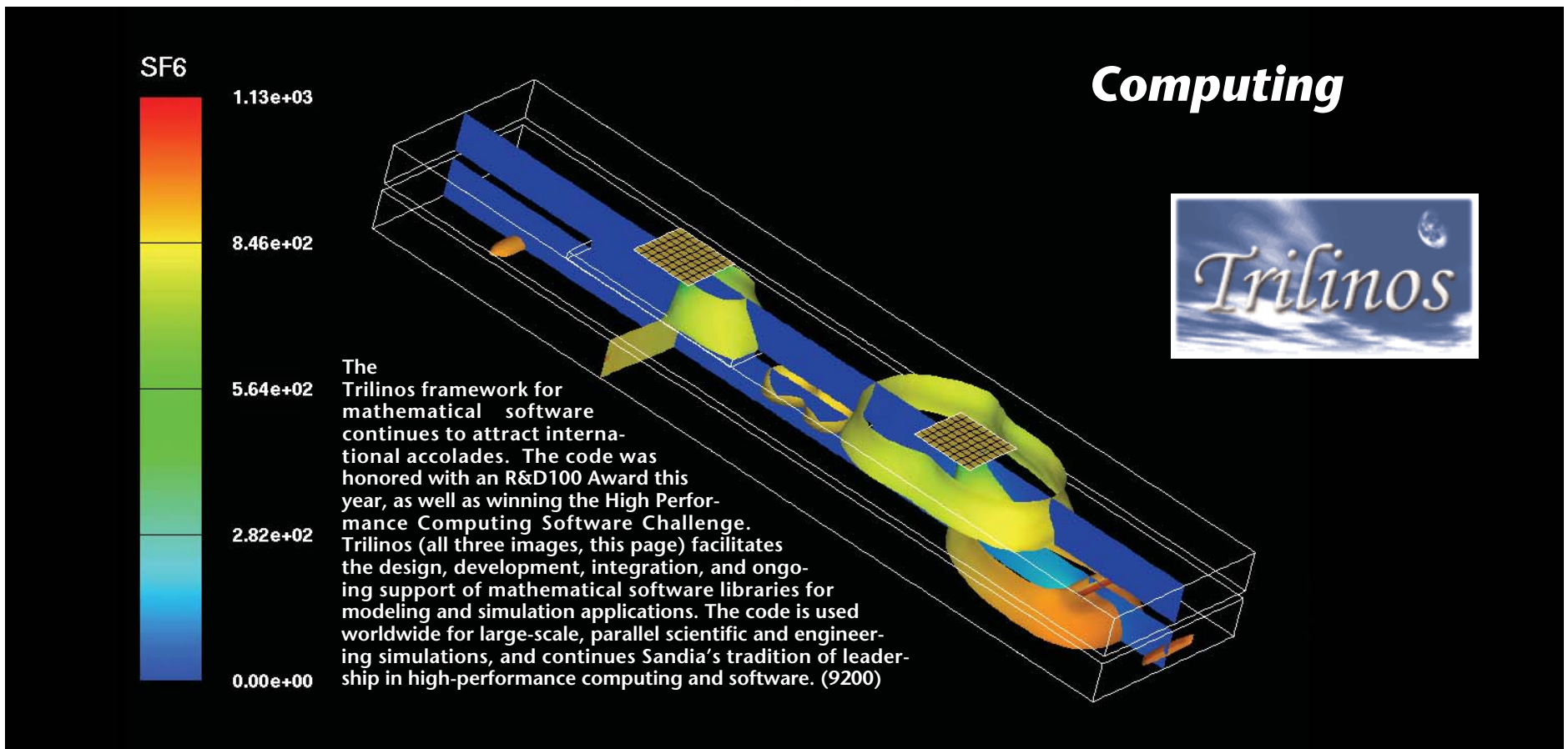
A full-size EM launcher for vertical launch missile systems has been demonstrated at Sandia through a Shared Vision program with Lockheed Martin Marine Systems and Sensors Division in Baltimore. Our missile launcher demonstration test-stand has been assembled and tested with full mass (1430 pounds) and velocity of 10 m/s, the velocity predicted for the five-stage launcher. The payload is launched to a height of more than 20 feet, as predicted from launcher simulation. This revolutionary launch capability is being presented to the Navy Sea Systems Command and Office of Naval Research in a series of briefings and demonstration launches. (15300)



JOHN JOJOLA (15335) prepares the electromagnetic missile launcher for a test flight. (Photo by Randy Montoya)



AS PART OF the Enhanced Perception LDRD, we're developing robotic vehicles capable of autonomously generating maps. The map at left was generated from a laser scanner mounted on a mobile robot. The robot uses these maps to plan its own paths. The robot continuously correlates its scanned data to the map to localize itself as it navigates. Data from upward-looking sensors are stitched together to generate 3-D maps. 3-D maps provide enhanced situational awareness to the operator.



Sandia chaired the Society of Automotive Engineers' Software Committee that published six software reliability and supportability standards and guides that subsequently were adopted by national security organizations including the US Army and NATO, and industries including Boeing and Lockheed Martin. The lessons learned from major software-intensive programs such as the Eurofighter were incorporated. These publications provide a comprehensive approach to addressing the concepts, strategy, processes, and implementation of a software supportability program and software reliability program within a systems context. (12300)

A Presidential Early Career Award for Scientists and Engineers was presented to **Tammy Kolda** (8900), in September 2004. The award is "the nation's highest honor for professionals at the outset of their research careers," according to the White House Office of Science and Technology Policy. Tammy was nominated by Sandia and DOE's Office of Science for her innovative research in algorithms and software for optimization, parallel computing, and nonlinear solvers. Tammy is the third Sandian to receive the award since its inception in 1996. (8900)

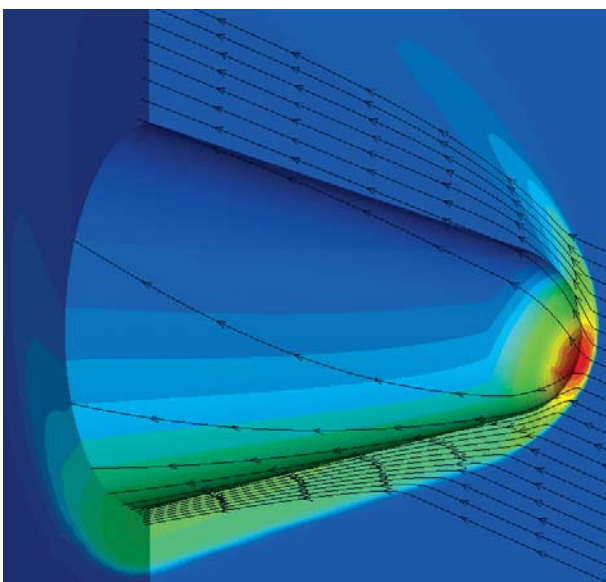
Strategic Web Infrastructure Framework & Technologies (SWIFT) used portal technology with Sandia's existing infrastructure to improve the content, presentation, and usability of Techweb, Sandia's internal website. Techweb gives Sandians better access to the information they need. Portal technology allows SWIFT to build flexibility into information delivery, avoid user information overload by allowing users to customize their Techweb site, distribute maintenance of corporate information, offer a single point of access to multiple data resources around the labs, and facilitate online communities of interest. Many groups contributed, including Corporate Communications, CEDT, Infrastructure, IES, Oracle Financials, PeopleSoft HRIS, Sandia/California, and the Technical Library.

**Sandia Anywhere** collects into one place (<http://anywhere.sandia.gov>) the established methods for remote access to resources on Sandia's internal network, and adds a new production capability — "Remote Desktop." After authentication through SecurID, Remote Desktop allows a user (from any Internet-connected computer) to establish a secure desktop connection to the Restricted Network. Users can also connect to their own desktop computers to access data or run programs as if they were sitting in their office. (9300, 9600)

Three buildings were completed in FY04 that provide modern office, laboratory, and computer room

space to support high-performance computing programs. These buildings included the **Joint Computational Engineering Laboratory** in Albuquerque and the **Distributed Information and Simulation Laboratory** in California. Construction of the **SuperComputing Annex** to house the Red Storm supercomputer was also completed. (9900)

On July 13, 2004, Sandia placed a \$9.8 million contract with Hewlett-Packard to purchase three production-capacity computing clusters for the Nuclear



Weapons program. These clusters, built on processors based on Intel's Extended Memory 64-bit Technology (EM64T) and Myrinet 2000 interconnect, provide Sandia with 16 teraops of computing resources. Delivery was speedy: Spirit, the New Mexico restricted network cluster, was in production, as planned, by November 16. Justice, the New Mexico classified network cluster, and Lassen, the California classified network cluster, were released to users the following month. (9300)

Sandia was a major participant in the NNSA **Integrated Cyber Security Initiative**, which designed and purchased the security infrastructure for a classified NNSA Enterprise Secure Network. This network will enhance the ability of sites to securely and conveniently share data across the NNSA in a web environment. Requirements were gathered from all labs and plants and consolidated into an NNSA-wide competitive procurement handled through Kansas City. The

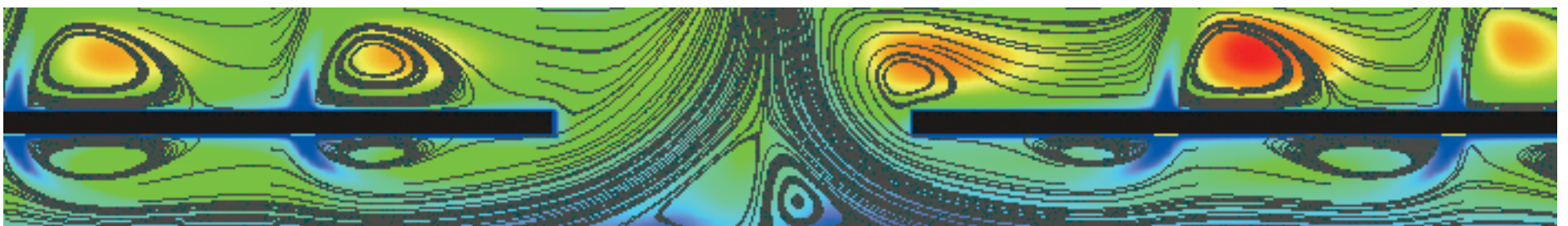
purchased hardware and software will be deployed in FY05-06. (9300, 9500)

The Information Management policies were updated to improve usability and to identify and initiate development of needed requirements arising from new technology and new drivers. The redevelopment included a self-assessment of existing policy, added sections on new capabilities and processes, updated terminology and definitions, and improved search capabilities. A topical structure, with an associated application, was created to make it easier for users to find the requirements. The Corporate Process Requirement pages were reduced by 30 percent, and the number of policy documents dramatically reduced. (9600, 9300, 9500, 8900, 4200, 10700)

The e-mail team in Center 9300, with support from Center 9600, completed the migration of all (13,000-plus) Sandia electronic mailboxes to Microsoft Exchange 2003 with increased mailbox size. Macintosh users now have access to their mailboxes with a full-featured client (Entourage), giving them such capabilities as shared calendaring with co-workers. In addition, the new Exchange servers give BlackBerry wireless users remote connectivity to their Sandia e-mail. (9300, 9600)

The **Enterprise Data Warehouse** has grown to include 13 data sources used by customers across the Labs. Oracle Manufacturing, Stockpile Unsatisfactory Reports, legacy databases from Pinellas for neutron generator components, underground test data, the NNSA Weapon Information System, the Product Test System, neutron generator components, the weapon Record Of Assembly, and Engineering Bill of Materials are examples of warehoused information available to the weapons program. In addition, the warehouse effort supports Oracle Financials, satellite data, facility data, and corporate HR data. (9500)

Three computer programs mark major progress by 9200 staff developing agile microsystems design tools and high-fidelity process simulators. Two codes provide a breakthrough, automated design loop for MEMS (made using standard microelectronics masking and deposition techniques). The unique program FAETHM generates a mask set from a 3-D part design. SummitView, given a mask set, now renders a 3-D part 100 times faster than previously. CHISELS, a 3-D massively parallel code, accurately models key microsystem fabrication processes such as plasma-enhanced chemical vapor deposition and deep reactive ion etching. (9200)

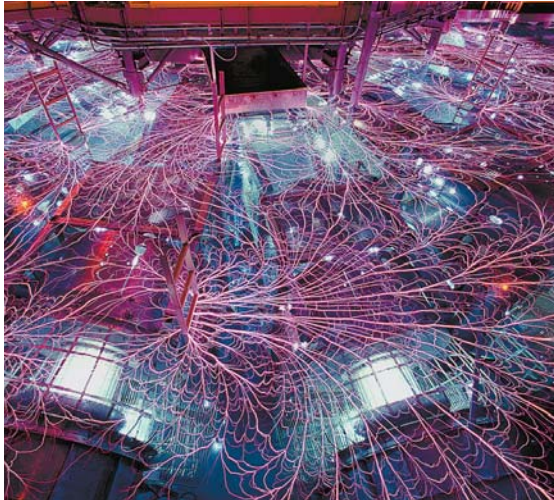




## Pulsed power

Z-pinch implosions on the Sandia Z machine have been **photographed for the first time using bent-crystal radiography diagnostics**. The crystals screen out most of the ~1 million joules of X-rays produced by the pinch implosion, allowing high-resolution radiographs to be made using <1 joules of X-rays from Sandia's Z-Beamlet laser. The photos provide **quantitative information** about the initial formation and implosion of the z-pinch plasmas that will help researchers optimize future designs and improve X-ray yields. (1600)

**Quantum molecular dynamics simulations** based on density functional theory have been used to generate an accurate wide-range electrical conductivity model and manifestly consistent equation-of-state for stainless steel in the difficult warm dense matter regime. Optical conductivities are calculated for sampled atomic configurations. These new QMD-based physics models permit **unprecedented high-fidelity simulations** of high energy density physics experiments with advanced modeling codes, such as ALEGRA. (1600)



In the field of complex radiation-hydrodynamics, "rad-hydro," **the Z accelerator has recently extended its application** to yet another area of high energy density physics and inertial confinement fusion. Specifically, in conjunction with the Z-Beamlet laser as the radiography diagnostic, Z has generated indirectly driven "jets"

that, in addition to being of interest to basic science, may provide **critical experimental data for benchmarking** certain weapons science rad-hydro codes. The project is a close collaboration among Los Alamos, AWE UK, Lawrence Livermore, and Sandia. (1600)

A Z-Pinch Inertial Fusion Energy (IFE) program was initiated by Congress to **extend the single-shot z-pinch fusion target results on Z to a repetitive-shot z-pinch fusion power plant concept** for the economical production of electricity. Initial results on recyclable transmission lines, repetitive linear transformer drivers, thick-liquid wall shock mitigation, proof-of-principle experiment planning, IFE high-yield targets, and z-pinch IFE power plant technologies support development of long-range Z-Pinch IFE program. (1600)

Experiments on Z produced a **world-record peak velocity** of 34 km/s for a magnetically accelerated aluminum flyer plate, which is a factor of four larger than is possible by conventional gas gun techniques. Shots were designed using the ALEGRA-HEDP magnetohydrodynamics code combined with circuit simulations to accelerate the 0.085 cm thick flyer without shock formation, which destroys it. Velocity measurements proved **the flyer was accelerated without shock formation**, which enabled accurate, state-of-the-art, equation-of-state data to be obtained for quartz and sapphire. (1600)

## IES: Integrated Enabling Services

A Supplier Showcase sponsored by Sandia and the City of Albuquerque was held last year. **Sixty-five suppliers** in the areas of homeland security, optics, and biotechnology met with buyers and technical personnel from around the state and the region. Following on the success of the 2004 event, the **2005 Showcase** will focus on homeland security, manufacturing, and vital resources such as water and environmental quality. (10200)

The Sandia Project Management Portal **consolidates project management resources** into a central location and provides information on PM events and requirements. The **Project Management Users Group** will serve as a community of practice for PM at the Labs. It also provides the opportunity for the Sandia PM community to provide feedback into future PM efforts, including the newly established Project Management Resource Office. Phase 2 of the PM Portal will include a PM repository, collaboration zone, and resource feedback methods. (10500)

In FY04, Sandia received a **\$2 million New Mexico gross receipts tax refund** for FY2000. We will be filing refunds for approximately \$7 million for 2001-2003. These deductions reduce our liability going forward and bring our effective tax rate from an average of 3.2 percent to 2.86 percent. This translates to an additional savings of \$4.6 million for 2003 and \$9 million for 2004. As a side note, **Sandia is the largest payer** of gross receipts taxes in the state of New Mexico, with more than \$60 million paid in FY2004. (10500)

The upgrade to the latest version of the Oracle applications (Finance, Manufacturing, and Procurement) positions Sandia to provide new capability for more agile and effective business operations in meeting the daily business needs of the Labs. The upgrade will enable

better planning for future business needs. Business Intelligence (real-time access to information) provides for **more effective business decisions**. Enhanced project management capabilities will increase customer satisfaction, productivity, and allow for easier cost, schedule, and performance monitoring. Self-service applications provide ease-of-use for common business functions.

The Supplier Community Advisory Council, an organization of local business community members, business development organizations, and Sandians, recommended establishment of the **C. Paul Robinson Awards**. These awards acknowledge Sandia's project and program procurement managers and teams who excel in using regional suppliers or who **demonstrate excellence in community development** through procurement opportunities. Dr. Robinson presented these awards at the 1st Annual C. Paul Robinson Awards Ceremony held in February 2004, in conjunction with the Supplier Showcase. (10200)

Sandia's **construction program set a record pace** in FY2004, with a budget of more than \$230 million. Among the projects under design or construction were the Microsystems and Engineering Sciences Applications (MESA) Complex, the Weapons Evaluation Test Laboratory (WETL), the Joint Computational Engineering Laboratory (JCEL), the Center for Integrated Nanotechnologies (CINT) Core Facility, the Exterior Communications Infrastructure Modernization (ECIM) project, Phase 1 of the Test Capabilities Revitalization (TCR) project, the Heating System Modernization (HSM) project, and several smaller new buildings and renovations around the site.

Sandia became the **first and only laboratory** in the DOE Complex to have a **certified Earned Value Management System**. EVMS is a tool for measuring performance on construction projects. Bruce Carnes, NNSA Associate Deputy Secretary, formally certified Sandia's EVMS in a letter stating, "The Department of Energy . . . congratulates Sandia Corporation Lockheed Martin



SANDIA'S Decontamination and Demolition program (see photo at left) demolished almost 100,000 square feet of space in FY04. The removal of the 75,300-square-foot Bldg. 805 constituted the lion's share of this work and is the largest structure the program has removed to date at the Sandia/New Mexico site. This proactive D&D effort is helping Sandia to comply with the new congressional mandate to offset all new square footage by the removal of an equivalent amount of space.

## Security

The Nuclear Safeguards and Security Center has completed testing and evaluation of new perimeter vehicle barriers that can **defeat threat vehicle energies** of up to 65,000 lbs at 50 mph. Sandia worked with two commercial firms, Kontek and RSA Protective Technologies, to develop the designs. The RSA barrier, tested at the Texas Transportation Institute, stopped the threat vehicle within two feet. Computer models of barrier designs also were developed for validation. These new vehicle perimeter barriers provide Federal agencies with options to enhance site security and **already are being installed at two DOE sites** and several NRC facilities. (4100)

We recently completed the installation of the first exterior **Remotely Operated Weapon System (ROWS)** application. The weapon platforms (photo below) are installed at a DoD site and safety and operational reviews are



nearly completed. This technology **provides near-immediate small arms response** to potential security threats and has potential to significantly improve security response effectiveness. Other applications for weapon platforms are planned at both another DoD site and a DOE facility in FY05. (4100, 5600)

The **2003 Security Standdown** resulted in many well-received security initiatives. The Standdown involved every member of the workforce and was planned by a multi-organizational team. Approximately 11,500 individuals received at least 16 hours of security and awareness training. All divisions prepared a consolidated Standdown report containing recommendations and comments. Data from those reports were analyzed using data-mining software, resulting in a corporate report containing recommendations. As a result, **we implemented a Security Awareness Campaign**, Security Help Desk, and the Security Education, Awareness, and Lessons Learned (SEALL) team. (4200)

Over the past several years, various internal and external audits identified a number of concerns related to security. Beginning in 2003 and continuing in 2004, these problems within Sandia's Safeguards & Security (S&S) Program received **significant senior management attention** resulting in substantial improvement in the S&S Program. NNSA Performance **Evaluation Review Ratings** for Sandia/New Mexico **improved dramatically** in 2004, with the highest rating of satisfactory for 4 of 5 topical rating areas, marginal for one area, and several areas of excellence specifically identified. (4200)

During the Security Standdown of November 2003, internal customers voiced a **loud and clear message** that they wanted to do the right thing when it came to security but that the information presented via the CPR format was too difficult to locate and understand. Security and technical communications personnel in Center 8500 teamed with line organizations to produce a web-based product with search capabilities. This product offers **easy-to-find answers to the most complex questions** associated with security requirements.

on its acceptance. **You have achieved a significant milestone** by demonstrating a performance measurement system that provides valid data and is effective in managing project performance."

**IES funded two additional Institutional General Plant Projects** and vacated 11,000 sq. ft. of Area 1 space for mission organizations. IES also began operating the institutional cluster computer and 35 terabytes of disk space funded in FY03 and invested in a second cluster for FY05. A new internal homepage, an accelerated clearance process, and cost estimating tools were introduced. The **IES expanded the disease management program**, resulting in decreased health care costs and sickness absence, reduced the cost of small facilities projects by 50-70 percent, and streamlined the WFO process.

The Materials Management Workshop is an annual meeting of the Materials Management Association to exchange ideas, address common supply chain problems, and improve materials management in the DOE/NNSA complex. The 2004 event was sponsored by Sandia Logistics' Material Movement. Thirty-six members from 13  
(Continued on next page)



Photo by Randy Montoya

COMMUNITY INVOLVEMENT continued to have a very positive impact. We distributed more than \$2 million in corporate contributions to our communities. Our employees and retirees **donated more than \$20,000 to Shoes for Kids**, which enabled us to fit school children from 20 elementary schools. More than 170 Sandia volunteers participated in 10 projects for Make a Difference Day. More than 275 volunteers last summer completed our fifth Habitat for Humanity House (photo of Habitat family below).

Overall, our volunteers donated almost 90,000 hours to community projects. In addition to the corporate contributions, **Sandia employees pledged more than \$2.5 million** for the 2004 Employee Contribution Plan/United Way/Livermore Employees Assistance Program Campaign. Funds donated by Sandians supported community efforts such as *Cuidando Los Niños* in Albuquerque, which provides care for homeless children. In the photo at left, *Cuidando* volunteer "granny" Beulah Haynes comforts a child.



## IES: Integrated Enabling Services

(Continued from preceding page)

DOE facilities attended. **Accomplishments** included a quality educational forum, an 80 percent increase in membership, online registration, national website, developing legacy practices, showcasing Logistics best practices, and partnering with DOE/NNSA, the business community, and nonprofit organizations. **This event won a 2004 PQA Gold Award.** (10200)

**Indirect Financial Management** developed out-year information to assist the line in forecasting, estimating, and preparing proposals that extend several years out. This Forward Pricing Information consists of forward pricing rates and standard labor rates. Having this information available to our line customers helps eliminate some of the speculation involved when preparing budgets and proposals for out years. An added benefit is that it **helped to increase the line's understanding** of the Labs' rate structure. (10500)

**More than 23 new technical courses** were implemented to support the Strategic Education Plan initiative. This Plan — and new course offerings — aim to bring a renewed commitment to continuous education at the Labs. Program categories include engineering, bioscience, material science, energy surety, and computer science/software engineering. Data show that **program participants are applying knowledge and skills** gained from the training directly to their work and that the Technical Education Program is on target in meeting core and critical needs of the Labs. (3500)

Employee and Labor Relations, in partnership with Corporate Education, Training, and Development, has **implemented a Tier Career Path Development Program**. This program created a curriculum and learning opportunities that strive to enhance the existing skills of Tier employees and help develop new skills. It will also help ease the consistent labor shortage and prepare more qualified internal bidders for available Tier positions. Other represented employees have found the program resources beneficial. The Tier Career Path Development Program is **open to all represented employees** and received a Turquoise PQA in 2004.

The **Integrated Safety Management System Software program** is the cornerstone of ES&H management at Sandia. Rewritten during 2004 to become web-based, ISMS Software incorporates requirements from DOE, federal law, and subject matter expertise into simple-to-use programs that establish safety envelopes and environmental requirements for all operations. Reporting capabilities allow users to **retrieve information in PDF reports or Excel spreadsheets**. Creation, editing, review, and approval activi-

ties are simplified, saving up to two-thirds of the time needed to train users and produce safety and environmental documentation. (9500, 6300).

Sandia's **Secure IP Videoconference team** was awarded the National Nuclear Security Administration (NNSA) Defense Programs Award of Excellence for deploying a Nuclear Weapons Complex (NWC) secure videoconference capability. The team led six NNSA organizations in deployment and certification of a cross-organization secure communications resource. The secure IP-based videoconference capability is now **routinely used throughout the nuclear weapons complex** with the capacity to support 24 locations connected simultaneously. The capability is designed to support full digital collaboration capability, including data sharing, visualization, and model manipulation.

A cross-functional team **implemented best practices** in developing an integrated and comprehensive method of orienting Sandia/California new hires. A system approach ensured the program was embraced by all stakeholders and that the design incorporated a holistic foundation. **Quality metrics were imbedded** to drive for continuous process improvement. The program received an ERA award and was also cited by Corporate Internal Auditing as an observed area of excellence, being described as "professionally developed, thorough, comprehensive, and effectively delivered." (8500)

The Ninth Annual **Student Internship Symposium**, held last August at the Albuquerque Convention Center, brought together approximately 800 attendees, including **475 Sandia student interns**, with 225 interns participating with oral and poster presentations. More than 30 exhibitors represented 20 different organizations ranging from fellowships, colleges and universities, and Lockheed Martin recruiters. (3500)

Sandia's **Disease Risk Management Clinic** has demonstrated that many of the complications of diabetes can be prevented through education, treatment with diet modification, exercise, and new pharmacological approaches. The clinic is **currently helping some 800 employees** and has expanded to include the management of high blood pressure and cholesterol. For self-insured employers, the focus on **providing optimal care** to those individuals with chronic disease has been shown to be an **effective cost-containment strategy**. (3300)

Sandia signed an MOU with the **Inter-Tribal Economic Alliance (ITEA)** and Intertribal Information Technology Company (IITC) to **develop and deploy** technologies related to microsystems, aging aircraft, and

manufacturing. ITEA and IITC are owned by a strategic consortium of sovereign tribes, Alaska native corporations, and native Hawaiian organizations for business development in Native American communities. (12100)

In FY04 Contract Audit, Procurement, and Oracle Project departments implemented Phase I of the Integrated Contract Audit System. The system **integrates audit data** with supplier, purchase, and invoice data into one information system. It allows timely resolution of audit findings, and provides one-stop shopping of contract audit information for Contract Audit, Procurement, Accounts Payable, Travel and Treasury, and line personnel. The system **allows tracking of auditable contracts** from identification to final closeout, and to final payment or collection activities. (12800)

The **Management Advisory Services Team** became more firmly established during FY04. A small team provides special studies of pressing management issues for senior management. For the first time since its inception in FY02, the team has a backlog of study requests. Additionally, the team initiated an information service to **alert management of developing issues** from outside Sandia that might prove applicable here. This "environmental scan" will provide an additional mechanism of 'early warning' to Sandia executives. (12800)

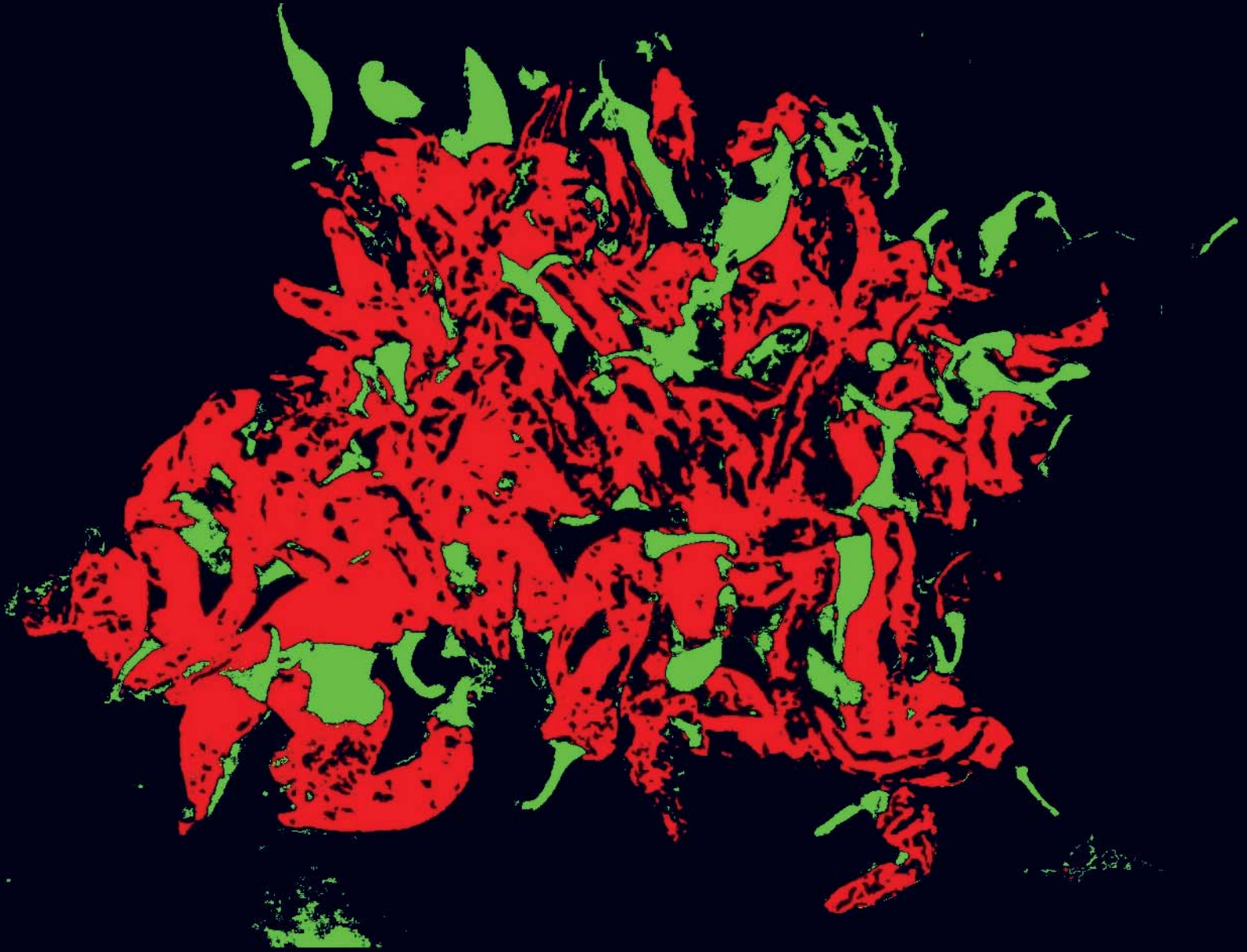
Senior managers from across the company performed an **in-depth review** of the *Columbia* space shuttle accident to understand lessons learned for Sandia's high-risk operations. The resulting briefing directed managers to consider issues associated with **understanding and managing risks**, ensuring adequate and deep technical understanding, decision-making with particular emphasis on communications, and key elements of safety culture. All managers in the company were briefed and urged to reflect the lessons learned in their daily operations. (12300, 2100, 4100, 8200, 9100, 9700, 12100, 15400, 16000)

Video streaming proved to be a key communication tool on the SRN. The fiscal year **began with an average of 8,000 video streams** viewed per month. **By the end of the year we averaged just under 14,000 streams** per month. In November 2003 a significant amount of content was required as part of the Security Standdown. Many presentations were available to view via streaming. **We had 175,000 video streams** accessed during the month of November, clearly demonstrating the viability of streaming. (12600)

ES&H Performance Assurance developed an **Injury and Illness Predictive Model** which will help Sandia **decrease the number of employee injuries**. This tool uses a customized approach to identify characteristics that can forecast the risk of injuries within an organization, so interventions can be **applied precisely where needed**. To date, Lockheed Martin and Liberty Mutual have expressed interest in this methodology. (6300)



# TECH PARTNERSHIPS



The **Sandia Chile Meter** is an intelligent image-based system for automatically measuring the amounts of chile and trash in chile processing operations. It is being used to optimize the configuration and effectiveness of a mechanical chile cleaner in an effort to improve automation in the state's \$200 million/year industry. Intelligent Systems and Robotics Center 15200 has been working on the automation problem with the **New Mexico Chile Task Force**, an industry and university consortium, through Sandia's **New Mexico Small Business Assistance program**. (15200, 1300)

The **Navy Wolf-Pack** (MTA+Tech Partnership Business Development Team) successfully initiated a new Navy relationship that cascaded through four Navy Program Offices (including Carriers, Deepwater Ships, Coast Guard, and Naval Air) and produced four memoranda of understanding. The relationship affords the opportunity to **work with 11 defense contractor industry partners** to provide pathways for Sandia systems solutions for the war fighter. Initial funding has reached DOE, and Phase One tasks have been accomplished. (1300, 15000)

The **Sandia Science & Technology Park** continues to foster economic development in New Mexico. It attracted four new tenants in FY04: Ktech, Sunwest CAD, Heel, and Sandia's Controller and Pension Plan Management Center. The Park now **boasts 19 companies employing almost 1,100 people**. An economic impact analysis in 2004 found that the average salary for each job in the Park was \$55,000 and also determined that the Park created an additional 3,200 indirect jobs. Public and private **investment in the Park exceeds \$161 million**. (14000)

Sandia's Military & Technologies Application business unit has **established a new strategic partnership**

with Rockwell Collins. On Oct. 1, 2004, DOE approved a five-year umbrella CRADA **with Rockwell Collins**. On Oct. 5, 2004, Rockwell accepted Sandia's first project and task. The project will **conduct and document a capability study** to identify how Sandia's expertise in the area of high-density interconnect substrates, thermal management, and RF power transistors can be applied to support Rockwell Collins' development of a miniaturized data link. This effort will support the Air Force Research Laboratory Weapon Data Link Architecture Program.

Sandia and Waters Corporation successfully concluded a three-year CRADA to develop an **electrokinetically pumped high-pressure liquid chromatography system**. Biomolecule separations were demonstrated with a prototype microfluidic gradient system. The work resulted in **record-setting microfluidic performances** in high-pressure electrokinetic pumps exceeding 55,000 psi, nanoliter flow sensors, ultra high pressure microfluidic valves, and high-pressure plastic microchip materials fabrication processes. **Nine patent applications were filed**. These technologies are being commercialized by Waters and incorporated in Sandia Chem/Bio Detection programs, DHS BioBriefcase, and DoD  $\mu$ ChemBioLab. (8100, 8300, 8700, and 8500)

**Eleven bellwether emergency responders** from across the nation met for two days with Sandians and representatives of Smiths Detection last summer. Developers of the uChemLab Chem/bio detector **met face-to-face in no-holds-barred discussions** with people whose lives might depend on the performance of our system. In broader discussions, we shared the possibilities of a range of Sandia technologies and confronted realities of real-world conditions and situations. We learned from each other and began enduring personal relationships. (8300, 8100, others)



THE SANDIA CHILE METER uses imaging technology to scan red chiles (photo below) to produce digital, analyzable images (top of page) to help optimize the efficiency of a mechanical chile cleaner (photo immediately above). Sandia's involvement in the project was made possible through tax credits granted by the New Mexico Small Business Assistance Program.

