

2001 Labs Accomplishments

To all Sandians:

In Donald Stokes' book *Pasteur's Quadrant*, it was suggested that the best model for advancing science and technology



may well be to seek new "understandings" while also seeking new "uses" for science and technology. It is a model we at Sandia greatly respect.

This year, the challenge of marrying use with understanding appears to have been well met. This report chronicles

many accomplishments, large and small, by technical teams, support staff, and individual researchers. I believe you will agree with me that Sandians have made many important advancements.

Great significance, new possibilities

Some of the achievements are already of great significance, like the innovations that have kept America's nuclear weapons safe and reliable. Others opened up new possibilities to create new strengths for the future, including advances in short-pulse lasers; in ultra-high magnetic pressures; in nanotechnology; in miniaturized sensors and circuitry; in missile defense targets and advanced satellites; in new energy conversion technology; and in supercomputing, information systems, and cybersecurity.

The greatest privilege

The opportunity the nation affords us to participate in the creation of new knowledge, as we also help to solve important national problems, makes working in the Laboratories perhaps one of the greatest privileges any citizen can have.

C. Paul Robinson

Labs Director and President



LIGHTING THE WAY — Keven Krenz (8420) briefly doffs his face mask for a photo at the chamber of the extreme ultraviolet lithography device where workers align light used to pattern circuits in this potential next-generation approach

to microchip manufacturing. Sandia is making the EUVL tool as part of the largest-ever funds-in DOE CRADA (\$250M over 5 yrs). See the EUVL entry below.

(Photo by Randy Montoya)

Sandia LabNews

Special Section

January 26, 2001



Partnerships

Extreme Ultraviolet Lithography (EUVL) extends current lithography capability to the sub-100 nanometer feature size, allowing fabrication of microprocessors with 100 times the speed and 1,000 times the memory of today's integrated circuits. Sandia activities in EUVL include precision engineering, modeling and simulation, and process development activities. Once complete, the EUVL tool will be capable of printing features as small as 70 nm. This program is the largest-ever funds-in DOE CRADA (\$250M over 5 yrs). (8400, 8700, 2300, 2200) *Bill Replogle, wcreplo@sandia.gov*

The Southwest as a Region of Innovation Conference 2000 brought together representatives from Arizona, Colorado, New Mexico, and Utah to work toward creation of a southwestern Microsystems Industry Cluster. The Albuquerque conference attracted 338 attendees who discussed how to form this cluster and focused on using the microsystems expertise, facilities, and resources present in the Southwest. A regional Leadership Team was formed and is working toward this cluster creation. The new Microsystems and Engineering Sciences Applications facility is

envisioned as the cluster cornerstone facility. (14000, 1000, 1300, 1700, 1900, 12100, 12600) *Jackie Kerby Moore, jskerby@sandia.gov*

Sandia and ten industry partners have signed the **Cold Spray Consortium** cooperative research and development agreement, under which the Labs will develop and commercialize Cold Spray technology over three years. In this process, metal or composite powders, accelerated to high velocities in a compressed gas jet, bond to a target surface by a process similar to explosive welding, but on a micro-scale. Depositing metals/composites in the solid state opens exciting new design and manufacturing possibilities. (1800, 9100, 1300) *Mark Smith, msmith@sandia.gov*

Sandia researchers, in partnership with the UNM Cancer Center, were instrumental in obtaining a \$1 million grant for UNM Health Sciences from the Keck Foundation to support development of **new tools for research in functional genomics**. By combining optical imaging devices developed as part of our satellite program, chemometrics data analysis routines developed for materials characterization, and data mining/visualization software (VxInsight™),

(Continued on next page)

A note to readers

Toward the beginning of each calendar year the *Lab News* sums up Sandia National Laboratories' principal achievements during the previous fiscal year. This issue of Labs Accomplishments continues that tradition.

All Sandia divisions were invited to submit achievements; submissions selected by the VPs' offices are presented on the following pages. The work was accomplished mostly during the fiscal year that ended Sept. 30, 2000. Key Sandia organizations contributing to each accomplishment are in parentheses at the end of each entry. Also — new this year — a key contact name and e-mail address for each submission are included.

You'll note that the work is presented here by category. We find this organizational approach to be 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 under the category "Nuclear weapons," for example, could very appropriately have been listed under "Microelectronics" or "Computing."



Partnerships

they proposed, and were funded to develop, a next-generation gene chip micro-array scanner. (1800, 9200, 5700) *David Haaland, dmhaala@sandia.gov*

The New Mexico Legislature passed legislation that allows Sandia to earn a tax credit of up to \$1.8 million in return for assisting small businesses in the state. Through its New Mexico Small Business Assistance Program, Sandia is using Labs expertise and capabilities to **help small businesses resolve technological problems or business issues**. The program is geared to help retain current small businesses, generate additional employment opportunities, and expand the base of suppliers for Sandia and other large entities in New Mexico. (1300, 12000, 14000) *Olen D. Thompson, odthomp@sandia.gov*

Recent licenses with startups MEMX Inc. and Novint Inc., grant Sandia an equity position in each company in exchange for rights to develop business around Sandia intellectual property. These **first-of-a-kind (for Sandia) equity licenses** offer an opportunity to share in the companies' technical developments and financial successes while enabling Sandia to better meet its national security missions by developing a regional supplier base through the licensing of important technologies. Novint is launching products based on haptics, a technology that adds the sense of



MEMX SPINS OFF — Four Sandia researchers have agreed to join a private spin-off company, MEMX, Inc., to commercialize Labs-developed microsystems technology. They are, from left, Paul McWhorter, Sam Miller, Jeff Sniegowski, and Steve Rogers. (Photo by Randy Montoya)

touch to 3-D computer interfaces, while MEMX, a spin-off company from Sandia's microelectromechanical systems (MEMS) development activity, will commercialize a MEMS-based optical switch for the telecommunications industry. (1300, 1700, 9200) *Olen Thompson, odthomp@sandia.gov*

Sandia and industry partners have launched the **Radio Frequency CRADA** to explore the possibility of commercial manufacture of complex electronic assemblies for weapon applications. In FY00 this CRADA delivered prototype assemblies produced on state-of-the-art automated manufacturing lines, using commercial off-the-shelf components, at a fraction of the cost traditionally incurred for similar products. Continued success

of this CRADA may significantly reduce the cost of RF assemblies for weapon needs in the future. (2300, 1700, 1800, 14100, FM&T) *Ron Diegle, rbdiegl@sandia.gov*

Sandia and other organizations in DOE's nuclear weapons complex (NWC) renegotiated a **volume purchasing agreement** with Parametric Technology Corporation for use of its Pro/E software, the standard 3D solid modeling tool used by the weapons programs. The deal saves Sandia \$1/2 million. The three-year agreement covers 226 Sandia users of Pro/E, and includes the flexibility to adjust that number to accommodate changing program needs. This effort represents the establishment of a significant partnership between members of the NWC and a key software provider for the complex. (2900, 10200) *Charles Fleetwood, cdfleet@sandia.gov*

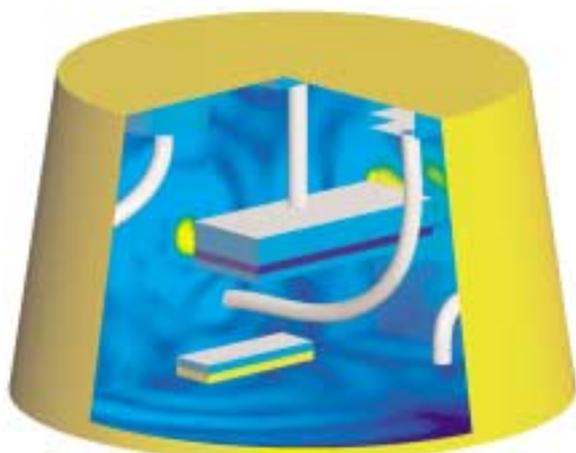
Sandia licensed its technology in a unique, emerging microelectromechanical systems technology known as LIGA to photonic subsystem provider AXSUN Technologies. LIGA, an acronym from the German words for lithography, electroplating, and molding, is a **technique that allows precise microstructures to be fabricated** from metals, plastics, and ceramics. After a successful prototyping effort at Sandia, AXSUN committed to establishing a Livermore-based LIGA production facility. The facility will manufacture alignment structures for use in AXSUN's optical products. The licensed Sandia know-how enables AXSUN to more quickly establish production capabilities. (8700, 11600) *Jill Hruby, jmhruby@sandia.gov*

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Engineering Sciences

Sandia has **successfully simulated a section of the RHP (radiation-hardened Pentium) microprocessor** using the Sandia-developed ChileSPICE™ circuit simulator. Production runs using ChileSPICE have reduced simulation time from 3-10 times when compared to commercial simulators. The increased performance and enhanced convergence technologies will lead to improved circuit designs on a much larger scale than can be achieved today. Initial performance evaluations of Xyce™, the next generation massively parallel circuit code, show a dramatic improvement in circuit simulation performance. (1700, 9200, 8400, 2300, 9300) *Steven Wix, sdwix@sandia.gov*

We have made **significant advances in the parallel performance and physical fidelity** of our suite of electromagnetics and plasma physics computational tools, collectively named EMPHASIS. EMPHASIS is used to qualify systems to intense electromagnetic and X-ray environments,



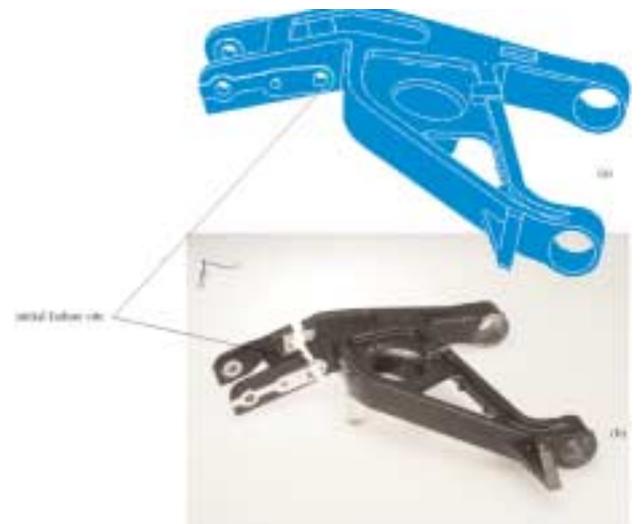
EMPHASIS calculated magnetic fields in a cavity containing cable-connected circuit-board modules in response to an external electromagnetic environment.

design high-frequency electronics, and model pulsed power components. We are using it to assess shielding effectiveness of a Lockheed Martin system. One EMPHASIS tool has demonstrated performance of 1 trillion operations per second on Sandia's teraflops computer. Another has novel algorithms to dynamically balance the computational load. (1600, 9200) *Mark Kiefer, mlkief@sandia.gov*

A **microstructure-property material model** that can predict the accurate stress and failure response for component designs and/or manufacturing processes received an R&D100 award. Three examples exemplify the model. The size/weight of automotive components was lowered resulting in reduced emissions and conservation of fuel. The multiphase aspect of the material model was used in a commercialized heat treatment simulation tool for process design involving carburizing and quenching phase transforming alloy steels. Third, the model was used to optimize die design in a weapons component forging process. (8700) *Mark Horstemeyer, mhorst@sandia.gov*

Predictive modeling of the dynamics of structures with bolted interfaces is of broad engineering interest. The damping generated in bolted joints is particularly difficult to model. A combined experimental and analytical program initiated at Sandia focused on the damping mechanisms in bolted interfaces and led to the **discovery of an underlying power law relationship** between the applied force and the energy dissipation per cycle. Promising reduced-order analytical models developed will be important to successful modeling of weapon system structural performance. (9100) *Dan Gregory, dlgrego@sandia.gov*

The **GOMA software team** has used its broad customer base in defense programs and industry to guide successful research, code development, and analysis projects. In an effort to bring a science-based understanding to manufacturing processes, the GOMA team has worked with manufacturing personnel and material scientists in the areas of welding, brazing, cermet processing, and encapsulation. Driving projects from model



RESULTS of a simulation for the USCAR CRADA show that Sandia's microstructure material property model predicts the exact location of the initial failure site. The model prediction was performed ahead of the test to ensure its predictive capability. Note that the predicted initial failure site was identical to the experiment.

development to code implementation and finally performing high-fidelity engineering analysis has required a team effort with a respect for the talent each member brings to the team. (9100, 9200, 1800, 8700) *Justine Johannes, jejohn@sandia.gov*

The SALINAS massively parallel 3D structural dynamics code was used to **complete critical simulations of W76 system response** to hostile radiation environments, running for 24 hours on 2000 ASCI Red processors. Sensitivity and optimization analyses were performed on the arming, fuzing, and firing (AF&F) model using Sandia's DAKOTA software package. A high-fidelity model for timing and scaling studies was generated with CUBIT advanced meshing software. The Sandia team greatly exceeded the milestone success criteria, demonstrating capability beyond anything commercially available. (9100, 9200, 9300) *James Peery, jspeery@sandia.gov*

Nuclear weapons

Sandia made significant contributions to the Nation's missile defense effort during the previous year in the areas of targets for system testing, lethality, threat and countermeasures, and navigation, guidance, and control. We **provided target objects for three National Missile Defense Integrated Flight Tests** and two National Missile Defense Risk Reduction Flights. Sandia also provided high-fidelity, scaled targets for lethality impact testing, and supported the analyses of the data from these tests with over 100 high-resolution hydrocode calculations. In addition, Sandia is providing the navigation, guidance and control system for the first two National Missile Defense interceptor prototype booster systems. *Jerry Langheim, jrlangh@sandia.gov*

The Advanced Firing & Detonation Systems and Microsystems Advanced & Exploratory (A&E) projects demonstrated **a wide range of new technologies for future firing system applications** in nuclear weapon refurbishment and DoD fuzing options. These included Surface Micromachine (SMM) and LIGA stronglinks, Direct Optical Initiation (DOI) firing sets and micro-DOI concepts, optical charging and triggering of Capacitive Discharge Units (CDUs), and several technologies necessary for microfiring sets. Several demonstration units were fabricated in partnership with the Kansas City plant. (2000, 2100, 2500, 1700, 1100, 1800, 8400) *Larry Hostetler, ldhoste@sandia.gov*

The most detailed structural dynamic model validation experiments ever performed on a nuclear weapon system were completed this year on the W76/Mk4 Reentry Body (RB). These experiments successfully **identified modes of vibration as high as 1,000 Hz** for the RB and each major subassembly. The test series discovered significant unit to unit variability for frequencies above 1,000 Hz. Data gathered from multilevel shock and vibration inputs will be critical to the validation of high-fidelity models that mimic the nonlinear behavior of real weapon structures. (9100, 2100) *Randy Mayes, rlmayes@sandia.gov*

New Weapon Evaluation Test Laboratory (WETL) authorized:

After operating in a more than 30-year-old pre-fab building for years, the construction concept for a new state-of-the-art facility for Sandia surveillance programs passed its final hurdle, the DOE External Review. Design for this \$24 million facility will be done this year, with construction the following two years. Blending the best of the reshaped core surveillance and enhanced surveillance program, this modern facility that will begin to move the DOE toward a predictive capability. (2900, 7800, 9500) *W. L. Norris, wlnorri@sandia.gov*



ARTIST'S CONCEPT of new Weapon Evaluation Test Laboratory.

Working with our counterparts at the Kansas City plant we **designed and built two versions** of prototype firing sets for the W76 Arming, Fuzing, and Firing life extension program. Through the use of simulation and rapid prototyping tools and techniques, we were able to go from paper designs to hardware, demonstrating form, fit, and function in less than a year. In addition, these tools allowed us to evaluate and solve a variety of design and manufacturing issues before the prototypes were fabricated. (2600) *Jim Hole, jwhole@sandia.gov*



MINUTEMAN 2 BOOSTER launched from Vandenberg Air Force Base, Calif., as part of the National Missile Defense initiative, in which Sandia provided target objects and other vital support.

Sandia's **Military Liaison Department**, in partnership with the DoD and the military, implemented an upgraded Unsatisfactory Reporting system for nuclear weapons, ancillary equipment, and publications. The system, known as the "Workflow Enabled UR System," has yielded dramatic improvement in tracking steps in the process and sped up the answer to the operational unit. DOE recognized this effort through the DOE/AL Performance Excellence Award for the Weapons Surety Division's Weapons Logistics Quality Program (Silver Medal). (2900, 9500) *J. Mike Rhoads, jmrhoad@sandia.gov*

On Sept. 22, 2000, the W76-0/Mk4 became the first enduring stockpile weapon to **complete the DOE Seamless Safety Process** for Disassembly & Inspection operations at the Pantex plant in Amarillo. The project included development of new tooling, new procedures, a Weapon Safety Specification, a Hazards Analysis, and hazards controls. DOE authorization for W76 operations makes it possible to conduct weapon surveillance assessments at Pantex, which provide essential information about weapon reliability and state-of-health. (2100, 1600, 8400, 12300) *J. Paul Atencio, jpatenc@sandia.gov*

The Nuclear Weapons Council has authorized initiation of the **W76 Life Extension Project**. Authorization was the culmination of a multiyear effort to assess the warhead state-of-health, develop refurbishment options, and generate management processes and plans to meet aggressive requirements. The conceptual design incor-

porates new performance options and challenges Sandia to implement technical innovation and employ new modeling and simulation tools. Key to winning authorization was our systematic scrutiny of requirements and design options, our plan to reuse selected components, incorporate high-grade commercial electronic parts, streamline production and qualification processes, and rigorously manage risk. (2100, 1700, 2300, 2500, 2600, 8400, 9100, 9800, 12300, 15300, and KCP) *Patrick Sena, pasena@sandia.gov*

Using modern predictive analyses coupled with limited field testing, the **B61-11 ALT 349 weapon design was certified** for stockpile use by Sandia and Los Alamos national labs. The final Design Review And Acceptance Group (DRAAG) meeting for the B61-11 ALT 349 was held in September at Sandia. The DRAAG wields the authority to accept/reject a weapon for use in the stockpile. The design was recommended for acceptance as a standard stockpile item by the DRAAG to the Nuclear Weapons Council Standing and Safety Committee in December 2000. (NW) *Kevin Eklund, kreklun@sandia.gov*

The **In situ-Impregnated Gel Capacitor** is being developed as the energy storage device in firing sets for several Stockpile Life Extension Programs (SLEPs). The gel/Mylar dielectric system results in a volume reduction greater than two when compared to the air/Mylar dielectric used in the majority of firing sets for the enduring stockpile. Further, a cost savings of almost an order of magnitude is realized when compared to older dielectric systems used in other stockpile weapons. The process has been successfully scaled up from 10 to 80 capacitors per run. (1700) *L. Roger Edwards, lredwar@sandia.gov*

The **In-Ground Storage Vault (IGSV)** was designed and constructed to provide high-security, temporary (two-year) storage for the Sandia Pulsed Reactor (SPR) fuel materials. This state-of-the-art facility yields annual security cost savings of approximately \$6 million and is the first step in a comprehensive plan to insure that the SPR is available at a reasonable cost to meet essential nuclear weapons testing requirements. That plan will culminate in construction of a new high-security Sandia Underground Reactor Facility (SURF) to house future SPR operations. (6400, 5800, 7100, 7800) *Kenneth Reil, koreil@sandia.gov*

The DOE National Nuclear Security Administration Office of Transportation Safeguards (OTS) must meet the highest security standards because its mission is critical to the continued effective operations of the nuclear weapons complex. Sandia was directly responsible for four of six mandatory milestones required to obtain acceptable OTS security ratings from DOE HQ, and ensure **uninterrupted operation of the transportation fleet**. All milestones were met, and the OTS security rating was upgraded. (NW) *M. Brad Parks, mbparks@sandia.gov*

Reliability and data credibility probability analyses have

been completed for the B61-7/11 and Redesigned W76 Type 2F telemetry systems. Both studies used a new methodology for estimating the reliability of commercial parts, as well as a software

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IN THE CAB of an armored Safeguards tractor.



Nuclear weapons

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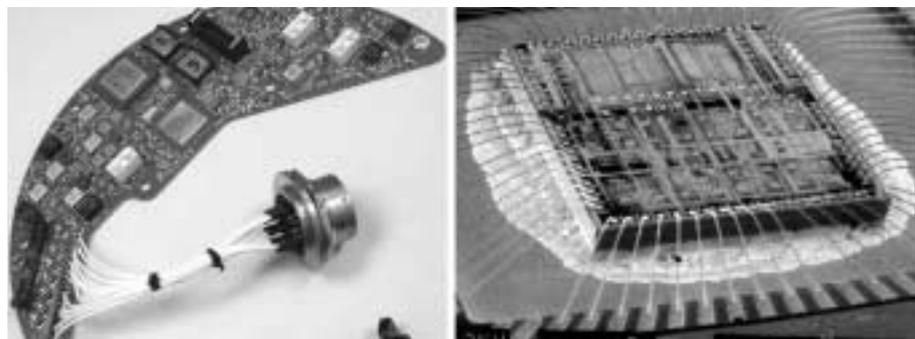
tool that allowed for examination of key contributors to unreliability. A report has been published documenting the results of these studies. In addition, a complete description of the general methodology for analyzing instrumentation systems (both reliability and data credibility) has been included in the study report. (8400, 12300) *Rene Bierbaum, rlbierb@sandia.gov*

A Sandia team in collaboration with Lawrence Livermore National Laboratory and Lockheed Martin designed and flight tested a warhead concept under the Submarine-launched Warhead Protection Program (SWPP). Warheads currently deployed by the US Navy were designed and certified prior to cessation of underground nuclear testing and the closure of major DOE weapon component facilities. The SWPP Pit Reuse Project investigated potential future replacement options. While no stockpile hardware is intended, the flight test exercised DOE/DoD interfaces and exposed new staff to this important national security mission. (2200, 2600, 8400) *Bill Wilson, wgwilso@sandia.gov*

Sandia contributed to the successful completion of the Phase 6.2/6.2A study for the W80 life extension program (LEP). The Nuclear Weapons Council accepted the recommendations provided by the study team and approved entry into Phase 6.3, with a first production unit date of February 2006. The W80 Phase 6.3 represents a significant effort for Sandia, requiring new designs for the entire warhead electrical system, neutron generators, gas transfer system, and several new mechanical structural components. (2100, 2200, 2300, 2600, 8400, 10100, 12300) *Doug Gehmlich, dlgehml@sandia.gov*

The W76 Joint Test Assembly telemetry system redesign was employed in a re-entry body, which was launched from a submarine in February 2000 as a "Follow-on CINC Evaluation Test." The flight resulted in a **successfully scored weapon system test**. Advancements in space radiation tolerance were proven, as was the efficacy of the Modular Telemetry Design Methodology as a design tool. An important first for this design was the digitization and transmission of neutron and firing system waveforms. This instrumentation system is significantly more complex, having ten times the data rate of the original, yet the production costs are significantly less. (8400, 2100) *Art Hull, alhull@sandia.gov*

Tech transfer comes full circle: Organic hydrogen getters, invented by Sandia to scavenge



ANALOG ASIC — As the stockpile ages and electronic components show the first signs of degradation, Manufacturing Development Engineering (MDE) steps in to design and validate new War Reserve quality components that use technologies often many generations ahead of the old ones. These new technologies, once validated, are far more reliable and many times lighter and smaller. MDE developed an analog ASIC used in an encryption translator. The chip-sized ASIC replaces a much larger printed-wiring board (PWB) that held individual electronic components. Note that the Application Specific Integrated Circuit at right is many times smaller than the printed wiring board circuit it replaces. (1700) *Donald Evans, dcevans@sandia.gov*



MESA MOVES FORWARD — The conceptual design for Sandia's Microsystems and Engineering Sciences Applications (MESA) complex has been completed. This major piece of work was a substantial effort for many organizations across Sandia. The final Conceptual Design Report (CDR) was printed and distributed in May 2000. The effort led to the authorization of funds to start the next phase (Title I/II Design) of the project. Completion of the CDR is enabling Sandia and DOE to make investments which will create technological capabilities to meet near-term and future mission needs for nuclear weapons. (1000, 2000, 6000, 7000, 9000, 10000) *Don Cook, dlcook@sandia.gov*

unwanted hydrogen in various systems, have been reinvented, patented, and commercialized through a 100-percent funds-in cooperative research and development agreement with Vacuum Energy Inc. Sandia's **hydrogen reduction technologies** are now found in numerous con-



MAIN ELECTRONIC subassembly of the New W76 Telemetry System .

sumer and industrial products. Millions of units have been purchased for products such as flashlights, refrigerators, and heat exchangers. The advanced getters created for consumer markets are now being certified for the shipment of radioactive materials within the Nuclear Weapons Complex. (8700, 6100) *Tim Sheppard, tjshepo@sandia.gov*

The Nuclear Weapons Strategic Business

Unit (NW SBU) developed and deployed its Quality Management System and Policy for organizations that perform work for the SBU. The management system provides taxonomy for the SBU and its requirements, processes, and products, and is based on ISO 9000, the nationally recognized set of Quality guidelines. The policy provides high-level direction for the SBU and internal

requirements to support its advancement. Policies and Processes can be found from the Sandia home page and the NW SBU button. (9000, 1000, 2000, 8000, 12300, 14000) *Mark Dickinson, mddicki@sandia.gov*

We have completed an assessment of **Sandia's current and long-term equipment recapitalization needs** for capital-intensive facilities that support the Defense Programs (DP) mission. A methodology was developed to assess needs based on different levels of potential future capability for each facility and to estimate the associated labor and expense costs for each level. Capital equipment investment at Sandia has declined dramatically since the 1980s. The study is intended to provide a starting basis for developing capital equipment strategies and priorities for future DP needs. (9800) *Keith Almquist, kjalmqu@sandia.gov*

The **multidisciplinary MAVEN Fire Team** demonstrated that laboratory-quality diagnostics, particle image velocimetry, and planar laser-induced fluorescence could be brought into a field-test-scale facility and used to obtain velocity, temperature, and species concentration validation data.

We completed a test series involving 42 experiments for a one-meter-diameter flow for helium plumes and methane and hydrogen fires. Limited data analysis has been completed and compared with Large Eddy Simulation computations. These data will be applied to validate transport models in the FUEGO fire code. (9100, 6400) *Gene Hertel, esherte@sandia.gov*

The Security Matrix Project, jointly chartered by DoD's Office of the Assistant to the Secretary of Defense (Nuclear-Chemical-Biological)/Nuclear Matters and DOE's Defense Programs-20, provided an **integrated assessment of weapon security and use control**. Team members visited all US sites where weapons are held and conducted in-depth analyses of locations, weapon configurations, site infrastructure, and physical and operational security. The study played a significant role in the W80 Lifetime Extension Program and led to changes in Air Force security posture, Navy/Marine Corps security capabilities, and overall DoD security requirements. (12300) *Timothy Petersen, tppeter@sandia.gov*

The W76 SLEP down-select for Phase 6.3 for the Navy Mk4A weapon systems occurred in July. A 12300 independent Weapon Assessment Team reviewed the warhead candidates for quality, reliability, nuclear safety, stockpile surveillance, and security/use control attributes and effectiveness. **The Weapon Assessment Team confirmed the Preferred Option candidate**, recommended by Div. 2000, as a viable design that enhanced reliability over the extended lifetime and afforded nuclear safety and significant use control enhancements to the present baseline W76 design. The selection of the Baseline Option was made with idea of a block upgrade approach, where the surety advantages of the Preferred option could be incorporated at a later date. (12300) *Frederick Trussell, fgtruss@sandia.gov*

In FY99, a **new approach to evaluating weapon safety** in thermal accidents was developed. This approach (the FINDV code) uses the ALASKA distributed computing platform to evaluate probabilistic weapon safety for a wide range of scenarios. Thermal responses are obtained using the COYOTE code. In FY00, this process was used to evaluate candidate design options for the W80 Lifetime Extension Program (LEP). A wide variety of engulfing, planar, and directed fire scenarios were evaluated and compared against similar results for the design currently in the stockpile. These comparisons showed that the downselected Option 3a conceptual design has significantly improved safety performance in the range of fire
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Partnerships

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Sandia has significantly improved the accuracy while also expanding the frequency range of structural dynamics models for the noise, vibration, and harshness response of passenger vehicle tires. These improved models have been experimentally validated and have directly led to improvements in Goodyear's relationship with vehicle manufacturers. Goodyear has stated that this effort has reached **technical achievements "previously thought unattainable by industry experts."** The experimental and analytical tools and techniques developed during this partnership are directly applicable to model validation for DOE defense programs. (9100, 9200, 2100) *Curt Nelson, cnelson@sandia.gov*

By integrating Sandia-developed sensing, cutting, and contour generating technologies, a cross-organizational team led by the Labs' Robotics Center successfully **demonstrated an automated meat cutting system** for industry sponsor IBP, Inc. Last September, the prototype device was shipped to IBP for further testing and development. The shipment marks Sandia's successful completion of all technical tasks spelled out in the Sandia/IBP cooperative research and development agreement a year-and-a-half ahead of schedule and under budget. Sandia and IBP have filed a number of technical disclosures and patent applications as a result of this work. (15200) *Jerry Langheim, grlangh@sandia.gov*

The **Sandia Science & Technology Park** program office spearheaded the creation of a landmark Memorandum of Understanding (MOU) that binds public and private parties to develop the 219-acre park just outside the Kirtland AFB Eubank gate. The park aims to attract technology-based companies. Signato-



SANDIA SCIENCE & TECHNOLOGY PARK

ries to the MOU include Albuquerque Public Schools; New Mexico State Land Office; Shaw, Mitchell, & Mallory Limited Partnership; City of Albuquerque; Sandia; and the Science & Technology Park Development Corporation. The MOU was two years in the making and a necessary step for the creation of a Master Development Plan. (14000) *Jackie Kerby Moore, jskerby@sandia.gov*



SAR SCIENCE — Sandia researcher Bill Hensley checks the Lynx synthetic-aperture radar (SAR) installed on an unmanned aerial vehicle. During the past year, the Sandia-developed General Atomics Lynx system attained several significant achievements, resulting in a fielded demonstration system for the US Army. (Photo by Randy Montoya)

General Atomics Lynx Synthetic Aperture Radar: The **Lynx Synthetic Aperture Radar (SAR)** system developed by Sandia for General Atomics had several significant accomplishments which have resulted in a fielded demonstration system for the Army as well as providing key support for DARPA-funded Ground Moving Target Indicator (GMTI) efforts. The system was installed on the Predator unmanned aerial vehicle (UAV) including a satellite down-link capability for remote operations. It was also installed on Army U-21 and C-12 aircraft. The U-21 system was then used in DARPA-funded data collections demonstrating its advanced GMTI collection capabilities. (2300) *Jerry Langheim, grlangh@sandia.gov*

A **newly patented pressure indicator** designed specifically for a medical application was licensed to the cooperative research and development agreement partner Numotech, Inc. The device monitors the pressure within the topical hyperbaric oxygen therapy enclosure used to treat hard-to-heal wounds including burns, diabetic ulcers, and pressure sores. The device uses no electricity, is inexpensive, disposable, has no enclosure penetration, requires no calibration, and is readable from several meters. FDA has approved use of the device. Keith Miller and Mark Vaughn (both 15252) are co-inventors. *Jerry Langheim, grlangh@sandia.gov*

Nuclear weapons

(Continued from preceding page)

scenarios examined (12300) *Michael Bohn, mpbohn@sandia.gov*

A recent survey of the **laboratory balance calibration process** revealed that some calibrations being performed were technically inad-

quate, leading to questionable calibrations. The survey also showed that many balance users lacked proper training in the use of balances. The process was improved to assure technically adequate calibrations and a user training program was established assuring proper balance use. Customers are delighted with the process and now have confidence in the quality of the balance measurements they make using balances calibrated by the Primary Calibration Laboratory. (2500) *Jim Simons, jmsimon@sandia.gov*

The Purchased Material Team (PMT) was chartered by Neutron Generator (NG) Production Management to **develop and implement an overall procurement process** to ensure supplier quality for purchased neutron generator components. The team partnered with Honeywell's FM&T division, a proven leader in meeting and maintaining DOE requirements for supplier quality. FY00 metrics showed that the team's efforts led to significant improvements: PPA (percent parts accepted) from 80 percent to 96 percent and PATF (percent accepted trouble-free) from 62 percent to 86 percent. (14400, 10200) *Lorraine Senar-Rondeau, lsenar@sandia.gov*

The **Manufacturing Development Engineering (MDE)** program is a model for manufacturing low-volume, high-reliability parts for the NWC. Since its inception in 1992, we have achieved mission assignment requirements of delivering more than 40,000 components needed for the enduring stockpile. More than 6,400 MDE parts were manufactured during FY00 by 12 private sector companies that have partnered with Sandia's design community in this critical nuclear

weapons program. Products manufactured include: actuators, thermal batteries, igniters, gas generators, capacitors, magnetics, frequency devices, and electronic components. (1700, 2500, 14000, 10250) *Eva Wilcox, ewwilco@sandia.gov*

The Manufacturing Development Engineering (MDE) department **designed and tested a replacement digital ASIC** (application-specific integrated circuit) microcontroller used in a specific B61 configuration. During testing, a problem was discovered with the memory working at cold temperature. A failure analysis team worked for two months to pinpoint the problem. In order to best use materials, the wafer lots in process were stopped at the silicide stage (before metal contacts were made) to accommodate a change in metal routing. The fix was made and new masks were ordered to process the lots on hold. In November 2000 the design fix was proved. (1700) *Tim Mirabal, mirabatj@sandia.gov*

A **high-voltage power transformer** was developed for use in firing sets for several weapon systems in the enduring stockpile. The original transformers had relatively low yields due to cracked encapsulation around and in the core and/or separation between the contact assembly and encapsulation. The MDE program developed design improvements such as use of a stress barrier between the core and the epoxy encapsulant and elimination of the contact assembly. Transformers produced via this design are much more robust with respect to mechanical environments. More than 250 war reserve (WR) transformers with these design improvements have been successfully produced. (1700) *Wendel Archer, wearche@sandia.gov*



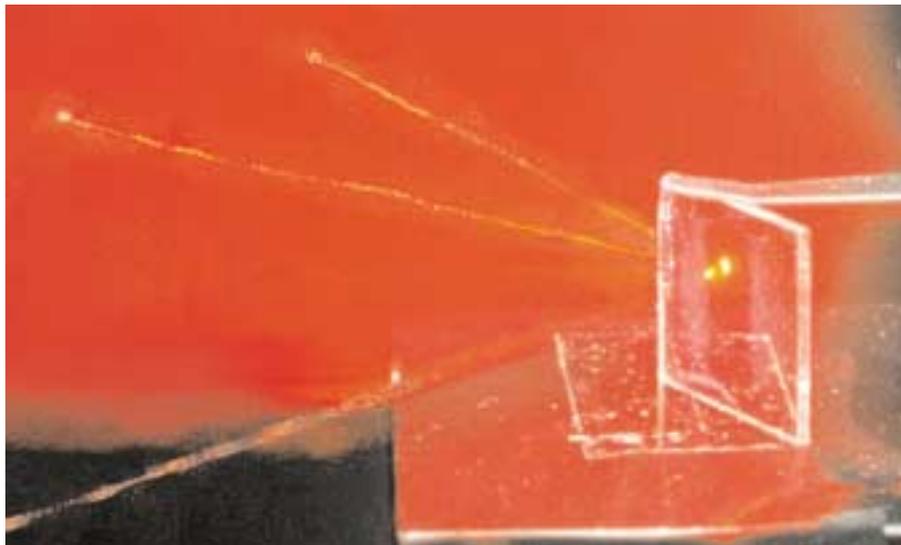
GETTING BALANCED — Jay Bennett (2544) calibrates a laboratory balance. These balances, used in labs throughout Sandia, are used to weigh chemicals, explosives, and other research materials.



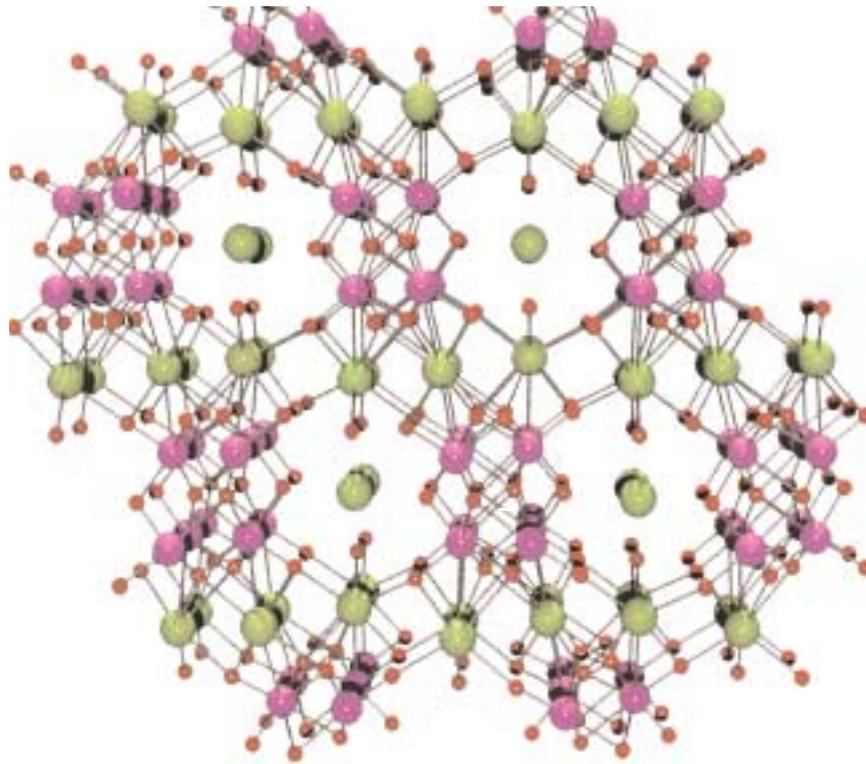
Materials

Collapsing tunnels are disastrous in mining and transportation. In an atomic world, however, they can be extremely useful when they trap hazardous materials. Under the Environmental Management Science Program, Sandia scientists discovered a family of tunnel-collapsing materials named **Sandia Octahedral Molecular Sieves (SOMS)**. When SOMS are submerged in waste solutions, specific metals like radioactive strontium stick inside its tiny tunnels. Heating the SOMS collapses the tunnels and traps the hazardous contents so they can be safely disposed. Immobilizing the waste is vital to DOE cleanup efforts. (6200) *Tina Nenoff, tmnenof@sandia.gov*

A new ion beam analysis facility enables researchers to measure — non-destructively and in depth — the constituents (including tritium) of neutron tube targets and sources. Further improvements of the process



OPTICALLY DEFINED multifunctional patterning of nanocomposites was the subject of a *Science* article submitted by Sandia researchers working with an international team of scientists.



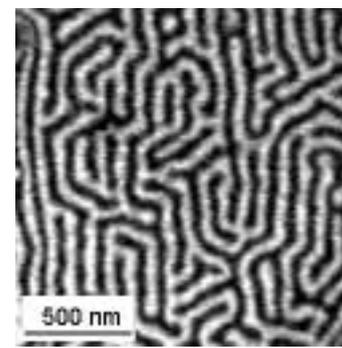
MODEL of SOMS, showing its framework and tunnels.

will enable War Reserve certification of our beam-line. This system serves the neutron tube science program, which is closely coordinated with the Labs' neutron tube design and production processes. (1100, 2500, 14400) *Wil Gauster, wbgaust@sandia.gov*

Sandia researchers, working with an international team of scientists, developed **a photochemical technique for producing unique nanostructures** (hexagonally-packed tubes or 3-D tetragonal configurations). In the process, silica gels containing photo-activated acids are locally exposed to ultraviolet light,

thereby engineering particular nanostructures. This photo-induced densification process has been shown sufficient to modulate the refractive index of the resultant material enough to make a diffraction grating or other optical device. This work was featured in a *Science* magazine article. (1800, 1100) *M.J. Cieslak, mjciesl@sandia.gov*

The Low Energy Electron Microscope (LEEM) offers Sandia researchers an invaluable tool for learning how certain combinations of atoms spontaneously self-order into stunning structures consisting of nanometer-sized dots, stripes, or polygons. Such nanostructured materials frequently exhibit unique mechanical, optical, or electronic properties. Recent experiments provided the elusive proof of a simple theory that explains how inter-atomic forces compete to pro-



Spontaneously formed pattern of alternating lead and lead/copper alloy stripes imaged by LEEM.

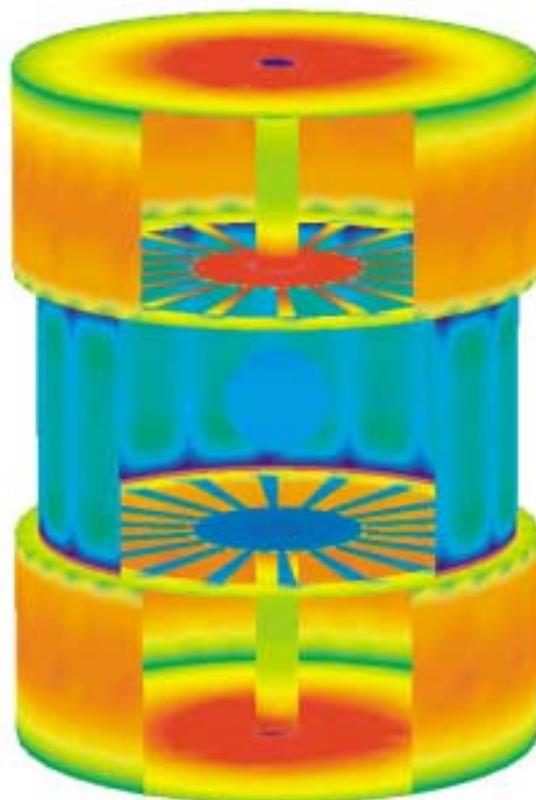
duce these structures. Once understood, self-assembly can be exploited to synthesize new classes of materials with tailored properties for multi-functional, miniaturized actuating or sensing systems. (1100, 8700) *Neal Shinn, ndshinn@sandia.gov*

Dynamics of Alloying at Surfaces: What are the atomic mechanisms when metals mix to make alloys? Using a unique microscope, Sandians Schmid, Bartelt, and Hwang (8700) discovered the surprising way bronze alloy forms when tin is evaporated onto copper. Microscopic tin crystals slowly shrink while "grazing" the copper surface in an entertaining, almost life-like dance. To explain this peculiar motion, the team proposes that a repulsion between tin atoms within the crystals and tin atoms left in their wake pushes the crystals forward, away from the bronze in their tracks. (8700) *Andreas Schmid, akschmi@sandia.gov*

Pulsed power

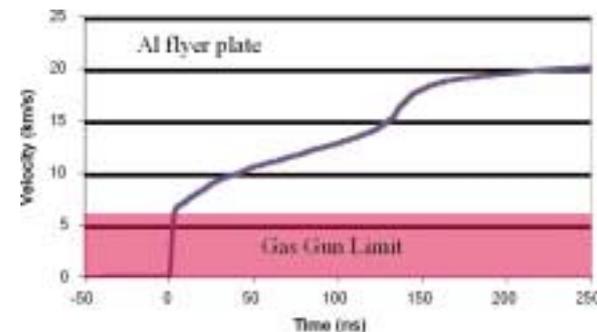
Novel Methods to Study Radiation Symmetry in ICF Hohlräume: What does an architect have in common with an inertial confinement fusion (ICF) target designer seeking 1 percent radiation uniformity at a fusion capsule? The Lightscape™ commercial lighting simulation package from the architecture world has been adapted to accurately **model radiation transport in complex 3-dimensional z-pinch hohlraums**. Complementary research uses Sandia-developed viewfactor codes and constrained optimization algorithms to automatically find hohlraum geometries with optimal symmetry. These are two examples of the novel methods we recently developed to study radiation symmetry in ICF hohlraums. (1600) *Roger Vesey, ravesey@sandia.gov*

The Annular Core Research Reactor was modified to provide **hostile environment testing for weapon components**. The reactor was reconfigured for pulse operation with experiments located in the center of the reactor. Exceptional efforts by many people enabled completion of high-level programmatic goals for both ACORN and neutron generator programs. NNSA Defense Programs official Gen. Thomas Gioconda praised the reactor reconfiguration effort, which earned a DOE Nuclear Weapons Program Award of Excellence



LIGHTSCAPE™ simulated radiation flux contours in z-pinch ICF hohlraum.

and a Sandia President's Gold Quality Award. *John Guth, jrguth@sandia.gov*



MAGNETICALLY accelerated flyer plate velocity as a function of time. The large magnetic fields produced in the insulating gaps of the Z accelerator have been used to "gently" accelerate relatively large aluminum, copper, or titanium flyer plates (9-12 mm in diameter by 200-300 mm thickness) to velocities in excess of 20 km/s.

A Revolutionary New Method for Launching Flyer Plates with the Z Accelerator: Recently a new, revolutionary capability has been developed at Sandia to **magnetically launch macroscopic, hyper-velocity flyer plates**. The large magnetic fields produced in the insulating gaps of the Z accelerator have been used to "gently" accelerate relatively large aluminum, copper, or titanium flyer plates (9-12 mm in diameter by 200-300 mm thickness) to velocities in excess of 20 km/s. This technique is being used to perform equation-of-state experiments with unprecedented accuracy in ultrahigh-pressure studies. (1600) *Marcus Knudson, mdknuds@sandia.gov*