

# LABS ACCOMPLISHMENTS



Sandia  
National  
Laboratories

*Exceptional service in the national interest*

*Sandia LabNews*  
*March 2018*

Welcome to the 2018 edition of the annual *Lab News Labs Accomplishments*. In these pages, you will read about a remarkable array of achievements by the staff at Sandia National Laboratories.

Sandia is fulfilling its national security missions, including maintaining the safety, reliability, and effectiveness of the US nuclear deterrent forces against a wider set of threats than ever before. The scope of our capabilities sets us apart. Sandia’s deep science and engineering foundations give us a cross-disciplinary advantage that helps us solve some of the nation’s toughest problems and make the world a safer place.

From critical milestones in our key mission areas to scientific breakthroughs reached via Laboratory Directed Research and Development to valuable advances in mission support, this issue of *Labs Accomplishments* demonstrates that we are providing “exceptional service in the national interest.” And we’re doing our work more safely and with a more diverse workforce. Every Sandian plays a role. Behind every accomplishment is a team of talented and hard-working people at the very top of their game.



STEVE YOUNGER

It’s impossible to collect all the great work done at Sandia in a single volume. Many of our greatest accomplishments have come in areas of national security that are too sensitive for general publication. But you’ll learn here about important experiments with tritium on the Z machine, ground-breaking work that represents a powerful new tool in our Stockpile Stewardship program and could open the door to high-yield inertial confinement fusion. You’ll find examples of the strides we are making in our nuclear deterrence mission, meeting key deliverables in all our weapons programs. You’ll discover how our high-performance computer modeling and simulation capabilities are playing an ever-more-important role in supporting our mission work across the enterprise.

The 2018 *Labs Accomplishments* provides a snapshot of the contributions we are making in supporting the warfighter, protecting the homeland, ensuring the nation’s energy security, working with international partners to ensure global peace, developing innovative approaches to cybersecurity, and supporting research to advance our fundamental understanding of the universe.

Our mission support and mission assurance organizations continue to provide best-in-enterprise leadership in the areas of safety and security, sustainability, quality, and employee benefits. You can read about their latest achievements here as well.

So sit down and enjoy this look at significant work performed at the Labs over the past year. I promise it will be time well spent and make you, like me, proud to be a Sandian.

Steve Younger

Laboratories Director



SANDIA NATIONAL LABORATORIES, with principal locations in Albuquerque, New Mexico (above), and Livermore, California (below), grew out of America’s World War II effort to develop the first atomic bombs. Today, keeping the US nuclear stockpile safe, secure, and effective is a major part of Sandia’s work as a multidisciplinary national security engineering laboratory. Sandia’s science, technology, and engineering foundations enable its unique mission. The Labs’ highly specialized research staff is at the forefront of innovation, collaborating with universities and companies and performing multidisciplinary science and engineering research programs with significant impact on US security.



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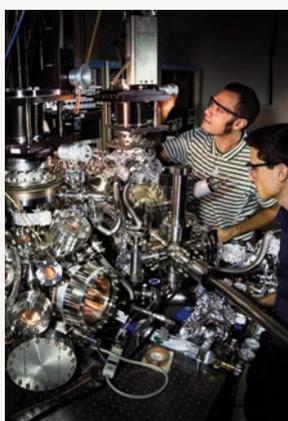
This year’s *Labs Accomplishments* highlights some of Sandia’s best work during 2017, as submitted by the Labs’ Center offices and selected by Division offices. Readers will see numbers in parentheses following many of the entries that indicate the Centers where the bulk of the work for those accomplishments was performed.



### Front cover

TECHNOLOGIST Nicole Cofer inspects a target she fabricated for Sandia’s Thor pulsed-power accelerator, which has a revolutionary architecture optimized for megabar-class material-physics experiments. The target is designed to hold materials that can be studied by pulsed power researchers under extreme conditions.

Cover photograph by Randy Montoya



### Back cover

SANDIA RESEARCHERS Farid El Gabaly, left, and Forrest Gittleston use pulsed laser deposition and X-ray photoelectron spectroscopy to advance solid-state lithium-ion battery performance.

Cover photograph by Dino Vournas

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# Nuclear Deterrence



Overhead View of Rocket Initiation.

In FY17, Group 1530 test completed a rocket-assisted cable pull-down (CPD) test for the B61-11 program. This test was the end-point of over a year of hazardous test activities including static fire tests to characterize rocket motor thrust profiles, and a calibration CPD test. The surveillance test involved accelerating a high fidelity B61-11 test unit into

a concrete target at a controlled impact velocity and angle. Data from internal instrumentation, photometrics, and post-test assessment of the test article provided key data to the surveillance program and to the annual assessment report. (1000, 2000, 600, 4000)

In FY17 the B61-12 and W88 ALT 370 programs successfully conducted key component reviews. The B61-12 program conducted 21 of 44 component Final Design Reviews (FDRs) in FY17 and has conducted 39 of 44 since 2016. The W88 ALT 370 program conducted 13 component FDRs in FY17 and has conducted 16 of 19 component FDRs since FY15. Also in 2017, the Mk21 program conducted five of eight component Baseline Design Reviews (BDRs) and the AFA BDR. Mk21 jointly participated in three of eight component FDRs with the W88 ALT 370 Program. (2000, 1000, 3000, 5000, 8000, 9000, 10000).

The W80-1 Alt 369 first production unit (FPU) was completed on Sept. 30, 2017, concluding a six-year development effort that met such challenges as redesigning components and gaining Pantex authorization. According to the National Nuclear Security Administration, this accomplishment is an important step toward maintaining nuclear capabilities that will help deter attacks on the United States and its allies. The W80-1, a warhead carried by the air-launched cruise missile, was first introduced to the stockpile in 1982. Alt 369 replaces limited-life components in the warhead. (8200, 2000)



THE W80-1 WARHEAD is carried by an AGM-86 air-launched cruise missile, a stand-off weapon deployed from the B-52H Stratofortress bomber.



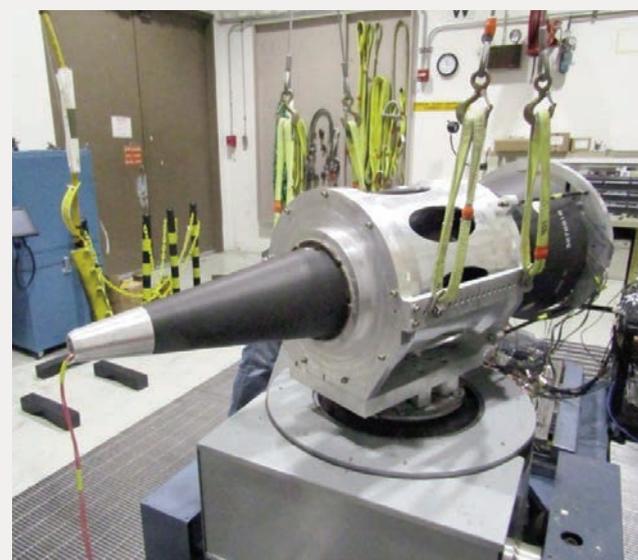
ROCKET SLED TESTS generated B61-12 Nose Bomb Sub-Assembly impact test data. The cost of such tests requires that computational simulation be used to fully evaluate NBSA performance.

The B61-12 Nose Bomb Sub-Assembly (NBSA) team relies on computational simulation to successfully meet requirements for ground impact (e.g. fuzing time, crush, and damage). Only five relevant tests were conducted, but the NBSA team simulated more than 2,000 impact scenarios spanning a range of impact speeds, angles, and orientations, using an estimated 13.2 million cpu hours. The NBSA model enabled evaluation of requirements over the full impact space. (1000)

MESA (Microsystems Engineering, Science, and Applications) delivered a record 26,000 microfabricated parts to DOE for the B61-12, W88-ALT-370, and Mk21 Fuze programs. Parts include Application Specific Integrated Circuits (ASICs) and Heterojunction Bipolar Transistors (HBTs). This is the largest ASIC production run in Sandia history and the first-ever HBT delivery from the MESA microfab. The high volume deliveries were enabled by a new Electronic Production Control System (EPCS) that reduced acceptance time by 80 percent, saved more than \$18 million, and received a Defense Programs Award of Excellence. (2000, 5000, 8000, 9000)



MK21 FUZE GROUND TEST UNIT 1 undergoing lateral vibration testing at Sandia/California.



LIGHT-INITIATED HIGH EXPLOSIVE test shot of the Mk21 reentry vehicle at Sandia/New Mexico.

## Nuclear Deterrence

In September 2017, the W80-4 Life Extension Program team delivered Foundation Bus Development Kits to support integration with the Long-Range Stand Off (LRSO) cruise missile. This is the first hardware delivery to the US Air Force, which selected Raytheon and Lockheed Martin to competitively develop missile designs over the next four years. The development kits provide the LRSO program office and prime contractors with the necessary resources to develop, test, and verify the missile and warhead logical interface. The foundation bus is a Sandia-developed technology. (8200, 5000)

A team from Sandia's DICE and STAR facilities and the nuclear weapons engineering, modeling, and simulation groups made key contributions to the scientific basis for certifying major weapon components and systems. The team instrumented sled track tests, supported the iterative design and validation of a key component, and characterized the crush response of an aluminum honeycomb material. The gun experiments provided cost-effective data to compliment large-scale testing. The new data acquisition techniques afforded a 10-fold improvement in timing resolution compared to previous diagnostics. (1000, 2000)



A DYNAMIC INTEGRATED COMPRESSION EXPERIMENTAL (DICE) Facility team member checks shorting pins on a B61 Rocket Sled Test. Previously these diagnostics were fielded on gas-gun tests.

Partnering with Lawrence Livermore and Los Alamos national lab colleagues, about a dozen Sandians completed an 18-month project to inform the nation's Nuclear Posture Review. This Tri-Labs effort resulted in 16 background papers succinctly describing pros and cons for nuclear weapons policy options. These well-received, high-impact, national-level decision-making products, delivered last year to Energy Secretary Rick Perry and Defense Secretary James Mattis, demonstrated Sandia's ability to anticipate national needs and work at the intersection of technology and policy. (8000, 100, 1000, 2000, 5000, 6000)

Sandia and the Kansas City National Security Campus (KCNSC) have identified, researched, and selected a new conformal coating for the W88 Alt 370 program. A conformal coating is required in the application to provide environmental protection to the sensitive electronics. The new conformal coating replaces a previously selected coating that had demonstrated significant off-gassing of volatile species and poor accelerated-aging performance. The new coating does not suffer from poor aging behavior and exceeds requirements for the program. 1800, 2300, and KCNSC were the lead organizations.

The Program Office led a multidisciplinary team that evaluated nine different stockpile scenarios for the Nuclear Posture Review development. The analysis showed the ability of each site to deliver, what risks would be introduced, what assumptions would need to be made, how each site would be impacted, and how surveillance and dismantlement would be affected. The analysis and the results were compiled in three weeks to inform the discussions at HQ. The work used tools developed by the Enterprise Modeling and Analysis Consortium to quickly perform this task. (2100)

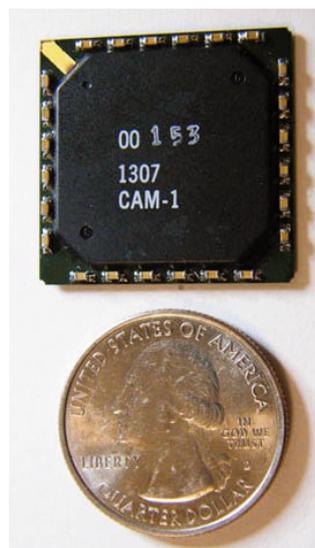
The Product Realization Information Management & Exchange (PRIME) project created an application that consolidated, modernized, and optimized the authorization (EA Web), storage and retrieval (Image Management System-IMS), and exchange (NSE Hub) of engineering authorizations (EAs) and product definition. It was successfully deployed in December 2016 across the NSE. PRIME

has supported a significant increase in EA releases — from 792 per month in 2016 to 1,024 per month thus far, largely in support of product realization activities for the B61-12 and W88 ALT programs. (2000, 9000)

Tonopah Test Range successfully executed 100 percent of all assigned stockpile and developmental flight tests for the year, while integrating new sensor systems, data reduction software, and completing organic equipment upgrades to optical tracking systems, network and communication, and radar systems. Test planning, execution, and recovery processes and equipment were significantly adjusted to meet emerging requirements and mitigate associated hazards. (2000)

The Org. 2250 surveillance tester centrifuge team qualified the 50,000 g lb, Sandia-designed, high-onset QU2777 centrifuge with a new and redesigned centrifuge arm. The qualification marks the culmination of a multiyear effort to ensure the system is operating in a stable, reliable, and predictable manner. The centrifuge is used to simulate missile flight for system-level nuclear weapon surveillance testing at Sandia's Weapons Evaluation Test Laboratory at the Pantex Plant in Amarillo, Texas. (2200)

The design of the Common Authentication Module (CAM) Application Specific Integrated Circuit (ASIC) has been completed and production has commenced with the delivery in October 2017 of 96 diamond stamped parts. The CAM ASIC is a secure processing platform meeting strict National Security Agency security requirements for Nuclear Command and Control and similar high consequence applications and is fabricated using Sandia's 350nm CMOS7 rad-hard process. (2000, 5000, 8000)



Packaged Group 1 CAM ASIC

Sandia provided all its deliverables in support of the Department of Energy's National Nuclear Security Administration (DOE/NNSA) officially authorizing the Production Engineering Phase (Phase 6.4) for the W88 Alteration (ALT) 370 program on Feb. 22, 2017. This milestone represents the culmination of four years of work in the Development Engineering Phase (Phase 6.3) of the program, and marks the beginning of the Production Engineering Phase prior to production. The first production unit (FPU) of this weapon is planned for December 2019. (2000, 1000, 3000, 5000, 8000, 10000)

Sandia successfully executed end-to-end performance functional demonstration of the ISA-SCR (Integrated Surety Architecture-SGT Compatibility Retrofit) components and ALT 940 electronics in the Sandia Test Vehicle. This represents an important integration milestone between the ISA hardware and the transportation venue critical to successful project execution.

This year marked the beginning of the 24-flight, three-year duration, qualification flight test program for the B61-12. Since March 2017, the B61-12 flight test team, in partnership with Sandia's Tonopah Test Range and the Air Force 422nd Test and Evaluation Squadron, have successfully planned and executed five development flight tests. The tests were flown on F-16C and F-15E aircraft originating from Nellis Air Force Base, and exercised both ballistic and guided trajectories with a variety of arming, fuzing, and firing settings. (2000, 600, 1000)

FIRST B61-12 DEVELOPMENT FLIGHT test just after release from an F-16C. Clearly visible are the spin rocket motor flames, which are part of the arming subsystem.



A B61-11 Cable Pulldown Surveillance Test was conducted at the Sandia Aerial Cable Facility on Sept. 7, 2017. This test imparted worst-case temperature and impact environments not achievable through flight testing. This significant accomplishment demonstrated a cross-cutting team's readiness to execute a complex surveillance test that occurs infrequently, as well as an integrated process and ability to successfully manage significant hazards for safe acquisition of high-value data. (2000, 1000, 4000, 6000, 0600, LANL, KAFB Firefighters)

The W88 ALT 370 program completed its first fully functional flight test in FY17. This was the fifth flight test performed as part of the W88-0/Mk5 ALT 370 qualification program. The two flight bodies demonstrated end-to-end functional performance of the development joint test assembly, and collected critical functional data to verify requirements. The successful flight was accomplished by a multi-disciplinary team from Sandia's California and New Mexico sites as well as external partners. (2000, 1000, 5000, 8000, 9000)

Dramatic reductions in size and weight are the result of continuous improvement in Electronic Neutron Generator (ELNG) design. From the first ELNGs incorporated in the B83 and B61, significant reductions in volume and weight were realized for use in the B61-12 LEP. Development hardware demonstrated for the W80-4 is nearly half the size and weight of the original legacy ELNG designs. (2500, 1500, 1800, 2100, 2200, 5200, 8200)

Magnesium oxide (MgO) is a critical material for powering the Nuclear Deterrent (ND) Mission. For the first time, the MgO team has developed the fundamental science-based understanding of the material structure-function relationships for ion transport and have captured the critical parameters needed to replicate its performance. While this work is of primary interest to our ND capabilities, it also impacts the defense community. Significant contributions to this work were made by 1000 and 2000.

# Nuclear Deterrence



The Nuclear Weapon Legacy Hardware Laboratory Team received an NNSA DP Award of Excellence for successfully creating and implementing robust processes for the characterization and disposition of legacy nuclear weapon hardware, while enhancing the preservation of historically significant nuclear weapon systems and hardware knowledge. This work provides the foundation for nuclear weapon engineering education and studies in safety, surety, emergency response, and intelligence analysis and nonproliferation research. (2000, 10000)

THE NW LEGACY HARDWARE LAB TEAM retrieved from storage a rare training version of Fat Man, last seen during President Kennedy's Sandia visit in 1962.

For eight surety mechanism major components, comprising several hundred custom mechanical parts, the following milestones have been completed: five Final Design Reviews, one Baseline Design Review, 12 Production Readiness Reviews, four top level Complete Engineering Releases, and numerous sub-assembly and production tester Qualification Evaluation Releases. First Production Unit is less than one year away for most of these components supporting B61-12, W88 ALT 370, and Mk21 Fuze, and development hardware has been flown successfully in all flight tests. (2600, 2300, 2200, 1800, 1500, 9400)

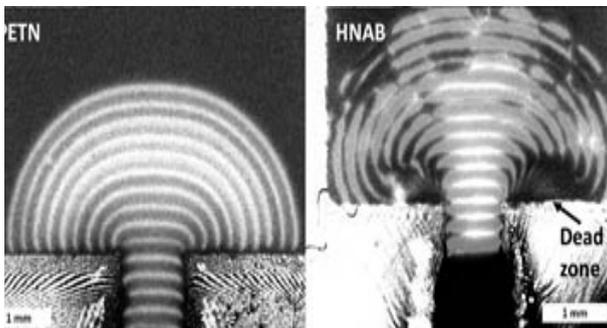
Organization 2630 has successfully completed all component Final Design Reviews for custom connectors, capacitors, cables, and magnetic components for the B61-12 and W88 Alt 370 programs, with many having completed Process Prove-In and several having been qualified. This represents almost 200 component designs. In addition, the COTS department has released life of program buy engineering releases for more than 1,000 parts, with roughly 500 having received their final qualification. This effort represents a tremendous accomplishment in partnership with our production agency, the Kansas City National Security Campus.

The Neutron Generator Enterprise (NGE) met or exceeded all deliverable commitments in the FY17 NGE Integrated Program Plan. This included a significant number of NG builds representing nine NG products in development and production. There were more than 45 unique continuous improvement activities worked within the NGE focused on production operations in FY17, including fixture and inspection enhancements, increased data analytics capabilities, equipment modernization, and optimization and standardization of processes. (2500, 9400, 1500, 2100, 2300, 8200)

Sandia External Production (SEP) delivered thousands of parts for multiple weapon systems, in support of the stockpile, with a budget of more than \$225 million. SEP production efforts focus on a challenging mix of hardware products not produced elsewhere within the Nuclear Security Enterprise. External supplier partnerships exist for products with highly integrated technical production challenges. Hardware is produced internally when vendor base cannot support production. SEP provides program and supply chain management to ensure requirements and expectations for nuclear weapon production deliverables are met. (2000, 5000, 10000)

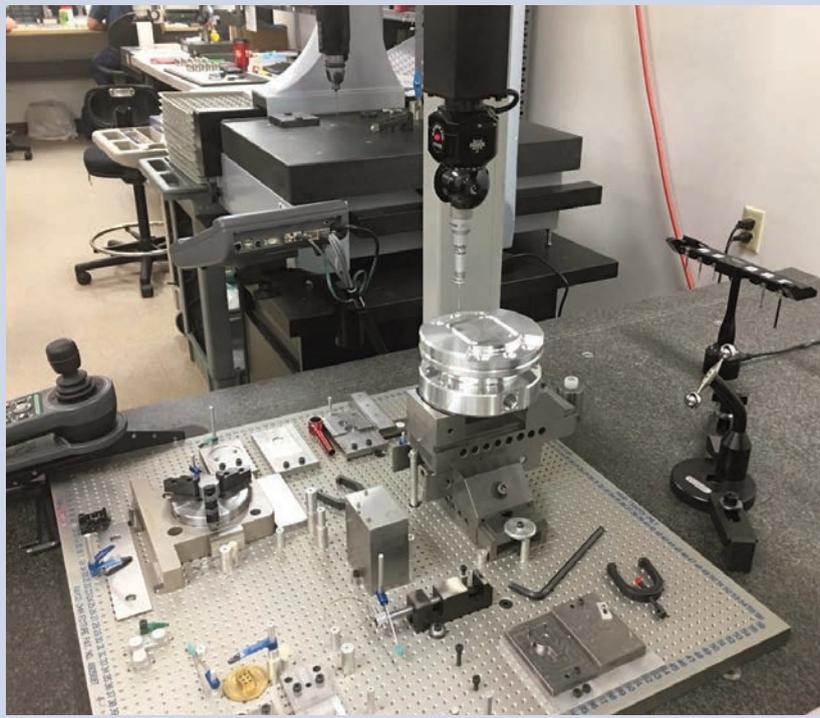
A large remote sensing ground system called FROGS was successfully transitioned into an operational capacity in October 2017. This marks the near completion of a 4.5 year enterprise project to upgrade hardware and software, add new mission capabilities, and improve operator workflow. The new ground station is exemplary in design and function for the nation. As significant contributors to the Advanced Systems Program Office, Data Systems Engineering (2660) staff and management are proud of our contributions to the design, integration, deployment, and operations of this milestone.

What happens when a detonation hits a corner? Modelers/designers need to understand to optimize explosive performance. Techniques to see "inside" explosives during detonation, like flash X-ray, have limited resolution.



IMAGES OF HIGH EXPLOSIVE DETONATION using the micromushroom test. Pentaerythritol tetranitrate (PETN, left) shows no dead zone during corner turning, while hexanitroazobenzene (HNAB, right) does.

Researchers in 02554 developed techniques to deposit and detonate thin-films of explosives to study performance at small scales. Using conventional ultra-high-speed imaging, the first optical images of corner turning behavior were presented at the 2017 American Physical Society Shock Meeting in the paper "Detonation Corner Turning in Vapor-Deposited Explosives Using the Micromushroom Test." (2000, 1000, LDRD)



Division 2000 is exploring model-based processes and tools used throughout the product lifecycle to increase cycles of learning and quality and decrease interpretation errors by collaborating with the Kansas City National Security Campus and NNSA on the Model Authorized Product Realization (MAP-R) project. The MAP-R project is comparing the same product using a conventional 2D drawing-based process and a 3D model-based process and answering questions about the business benefits of model-based definition, how to manufacture and inspect based on a model, and what capabilities are needed for the future. (2000, KCNSC, NNSA)

COORDINATE-MEASURING MACHINE inspection of the 3D model-based MAP-R part.

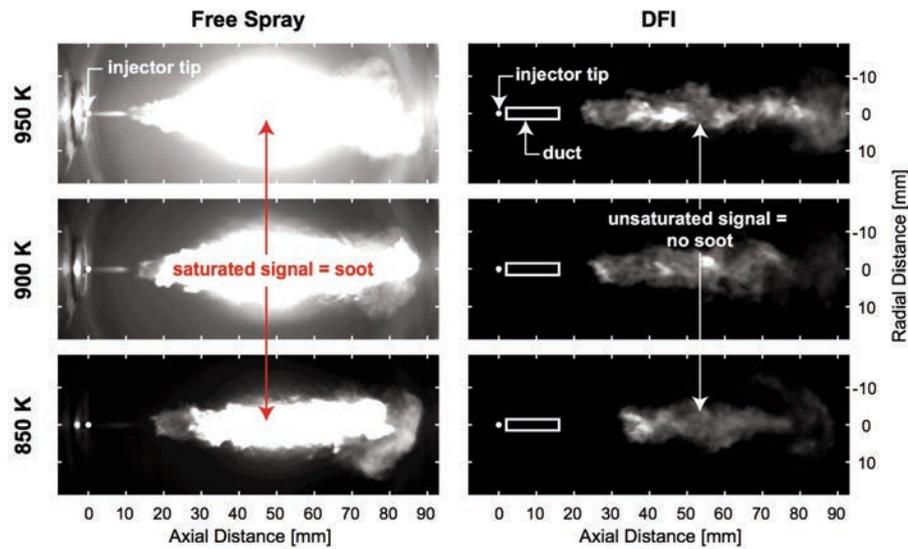
The B61-12 program has successfully executed a series of monthly system-level assembly builds of trainer hardware to support process development, tooling trials, and definition maturation for production transition. Using an early Type-5B trainer, Sandia, in coordination with Los Alamos National Laboratory and CNS Pantex, have successfully demonstrated the ability to safely and securely produce the B61-12 ultimate user configuration. Requirements, tooling, and processes were developed to ensure principles such as nuclear safety, assurance, and use control are at the forefront of the production strategy. (2000)



MEMBERS OF THE B61-12 LEP TEAMS from Sandia and Pantex after completing the assembly of the B61-12 5B Trainer at Pantex.

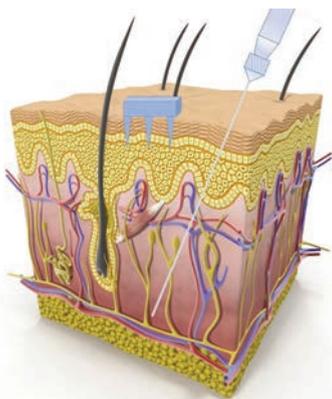
# Energy and Homeland Security

Sandia engine researchers are exploring ducted fuel injection (DFI), a new concept where fuel is injected through a small, cylindrical duct aligned with the fuel axis. Orders-of-magnitude soot reduction was demonstrated, which shows great promise for typical diesel engines. DFI may also increase combustion efficiency by decreasing unburned hydrocarbons and carbon monoxide emissions. DFI research is funded by DOE's Office of Vehicle Technologies and is supported by work-in-kind from Caterpillar and Ford via a cooperative research and development agreement. (8300)



CONVENTIONAL FREE-SPRAY COMBUSTION (left) produces hot soot. Ducted fuel injection (right) shows little to no soot at the same nominal conditions (22.8 kg/m<sup>3</sup> ambient density).

Sandia-designed microneedle sensors can extract interstitial fluid, the clear fluid between cells in the middle layer of skin, for further study. Painless and minimally invasive, the needles can be left in for hours, enabling constant sampling of biomarkers to monitor and diagnose health conditions ranging from dehydration to life-threatening sepsis. A study conducted by Sandia and the University of New Mexico investigated needle length and compared interstitial fluid to blood. Interstitial fluid may someday join blood and urine as a fluid routinely tested for clinical diagnoses. (8600, LDRD)



SANDIA-DESIGNED MICRONEEDLES painlessly sip interstitial fluid from the middle layer of skin beneath dead skin cells and above where veins and nerves reside.

Can one of California's largest and most polluted lakes become its most productive and profitable? To find out, Sandia is testing an algae-harvesting system that uses water



WATER FROM A TRIBUTARY of the Salton Sea being pumped through the Salton Sea Biomass Remediation Project flowway system.

from a tributary to the Salton Sea. The sea contains elevated levels of nitrogen and phosphorus from agricultural runoff that algae thrive on. The algae feed on and remove chemicals in water as it passes through the system and back into the sea. The project could yield renewable energy while providing a safe process for removing harmful chemicals.

Sandia's electric-grid researchers received two R&D 100 awards in 2017. One is for the Microgrid Design Toolkit, a publicly available software product that uses powerful search algorithms to help microgrid designers explore technology and performance trades in the preliminary design phase. The second is for a control system that damps oscillations in transmission lines using new smart-grid technology, enabling greater grid stability, higher power flows, and lower costs. The control system was proven effective during demonstrations on the Western US power grid. (8800, 1000, 5000, 6000)

A joint Department of Energy/Spanish/Korean project was conceived, designed, and managed by Sandia to quantify the shocks and vibrations spent nuclear fuel experiences during transport. A storage/transportation cask containing surrogate nuclear fuel was transported by truck in Spain, by ship to Baltimore, and by rail to Colorado for specialized tests. Data – 6 terabytes – were continuously collected over 9,600 miles. Strains measured on the surrogate fuel tubes will be compared to the strength of irradiated zirconium to assess the fuel's ability to withstand extended storage and transportation. (8800, 1000)



SPENT NUCLEAR FUEL CASK on heavy-haul truck instrumented with accelerometers and strain gauges measuring shocks and vibrations on surrogate spent-fuel assemblies within the cask.

The SolidSense Gas Analyzer on a Chip robust sensor platform combines electrochemical sensing techniques with neural network machine learning to demonstrate the first small, low-cost, high-temperature stable, on-vehicle sensor that detects and characterizes all EPA-regulated automobile gases emissions with unprecedented parts-per-million-level sensitivity. The device enables continuous optimization of combustion chemistry, control of catalytic converter chemistry, and monitoring of exhaust chemistry at the tailpipe. The platform can also be modified to monitor ambient air quality, characterize the chemistry of power plant smokestack emissions, detect

explosives compounds, and address numerous other sensing challenges.

Sandia organic glass is a new class of scintillation material for radiation detection. It has the uncommon ability of being able to distinguish between incident gamma or neutron radiation with high selectivity. This discrimination ability is key for distinguishing between ubiquitous sources of gamma radiation and Special Nuclear Material such as plutonium-239 and uranium-235. Sandia glass can be formulated with various additives, melted, and cast into almost any shape, including thin fibers.

Last year, Sandia developed a lightweight, inexpensive, smartphone app-controlled device that could detect a variety of infectious diseases in less than half an hour. This year, the team added even more capability to their mobile diagnostic device. Now, users can watch the test develop in real time, so they can see the results as they turn positive. In theory, this allows a scientist to estimate the amount of pathogen present in a sample — and help the medical community quickly prepare an appropriate course of treatment. (8600)



SANDIA CHEMICAL ENGINEER Aashish Priye (left) offers a view into the device dubbed the "Zika box," alongside team members Sara Bird and Cameron Ball (background).

Sandia's engineering team has designed, modeled, and tested a control system that doubles the amount of power a wave energy converter (WEC) can absorb from ocean waves, making electricity produced from wave energy less expensive. The team applied classical control theory, robotics, and aerospace engineering design principles to improve the converter's efficiency. Engineers from Sandia's Water Power program are using a combination of modeling and experimental testing to refine how a WEC moves, responds, and survives in the harsh ocean environment to capture wave energy. (8800, 6500, 6500, 1300)



RYAN COE, David Patterson, and Giorgio Bacelli (8822) with the team's wave energy converter (WEC) device tested at the Navy's Maneuvering and Seakeeping (MASK) basin.

Every five years, DOE must submit a compliance recertification application (CRA) to the Environmental Protection Agency for the Waste Isolation Pilot Plant (WIPP). In July 2017, EPA approved the WIPP application submitted in March 2014. Sandia contributions were central to that recertification application. Sandia's estimates of WIPP's cumulative releases 10,000 years into the future are informed by fundamental studies in geochemistry, geohydrology, and geomechanics. The application was some 2,100 pages long, and Sandians authored or coauthored 1,700 of those pages.



THE WASTE ISOLATION PILOT PLANT, which resumed waste emplacement in January 2017 after a nearly three-year hiatus, was recertified by the Environmental Protection Agency in July 2017.

## Infrastructure operations

**Technical innovations in Safeguards and Security are setting standards for other DOE programs.** Among the innovations is a new email marking tool that was beta tested on Sandia's classified network by NNSA's Office of the Chief Information Officer (OCIO) before full deployment across the enterprise — the tool will better detect unauthorized network-based transmissions. Another engineered control reduces complexity for mission partners when working in secure areas, reducing what was a cumbersome eight-step lock process to a simplified, yet more secure, three-step process.

**Sandia's custodial services received three Cleaning Industry Awards in 2017:** 1) Green Cleaning Certified Program of Excellence Award for reducing environmental risks; 2) the Best Safety Award; and 3) the Waste Reduction Heroes Award for a reduction of approximately 2.5 million gallons in water use. The team also received a 98 percent overall score by the nationally recognized custodial management program, Operating System 1, the highest score to ever be awarded.



CUSTODIAL SERVICES REPRESENTATIVES receive industry awards. Left to right: Scott Lafayette, Joshua Konetzni, Charlene Argo, Anthony Baca, and Chris Romero.

**Personnel Security deployed the Sandia Total Access Request Tool (START),** which consolidates eight applications to streamline the clearance/badging process and interfaces with DOE, General Services Administration, and multiple Sandia applications. START simplifies both the experience for members of the workforce and the processing steps for Personnel Security. Improvements include improved uncleared badging, real-time status of requests, and a single location for all badge/clearance related requests.



**An active shooter at the Labs is considered a top safety and security concern.** In July, Sandia's Protective Force and Emergency Management led efforts to develop a joint training exercise with numerous other aid agencies. While exercises and staff trainings at Sandia locations take place regularly, this exercise was the first of this scale that allowed internal and external agencies to practice responding to a simulated incident and assess how response capabilities are integrated on Sandia property.

IN ADDITION TO SANDIA FIRST RESPONDERS, this exercise included the FBI, NNSA, Kirtland AFB, Albuquerque Police, and UNM Hospital, as would be the case in a real-world event. (Photo by Randy Montoya)

**The California site's materials science and microscopy capability greatly advanced** with the acquisition and installation of an aberration-corrected scanning transmission electron microscope (AC-STEM). To house the AC-STEM, the California site operations team had to create a tightly controlled laboratory environment and install dedicated power and cooling systems. A normal timeline for a project of such complexity is about one-and-a-half to two years. However, the AC-STEM project was largely completed in eight months, thanks to the team's agility, creativity, advanced planning, and dedication to cross-functional partnerships. (8500)

**The California Security Operations team facilitated a smooth transition to a competitively bid Protective Force security contract,** significantly reducing Sandia's costs. The team also successfully completed an audit of the Sandia/California Security Program. Requested by the Department of Energy's Office of Enterprise Assessments to provide DOE and Sandia leadership with an evaluation of program effectiveness, the audit concluded that sensitive information and material at the California Laboratory are being adequately protected and that the California site's core Safeguards and Security programs are effective and compliant. (8000)

**Buildings 756 in New Mexico and 936 in California both achieved the Leadership in Energy and Environmental Design (LEED) gold rating** by the US Green Building Council, bringing Sandia's total to 13 certified buildings. LEED is a third-party program and the nationally accepted benchmark for the design, construction, and operation of high-performance green buildings.

LEED Gold-certified Bldg. 926 (California)



**NNSA's Office of Safety, Infrastructure, and Operations received funding above its anticipated allotment.** The \$21 million in additional funds will increase Sandia's recapitalization budget to more than \$40 million for the year. In addition to Sandia's planned projects, the boost in capital will accelerate the start of four large general plant projects

**The Deferred Maintenance Special Emphasis Program effectively managed a \$37-million investment** to reduce delayed maintenance of Sandia's aging buildings and infrastructure. A team of facilities project and construction managers, support personnel, and contractors executed approximately 56 projects at New Mexico, California, Nevada, and Kauai sites in only 10 months.



THE LONG OVERDUE reroof of Sandia's Bldg. 802 administrative building in New Mexico required unique overflow drains due to its historic properties.



THE ORIGINAL 1964-era air handling unit in California's Bldg. 912 was moved from the basement to the roof for easier accessibility by maintenance and to improve efficiency.



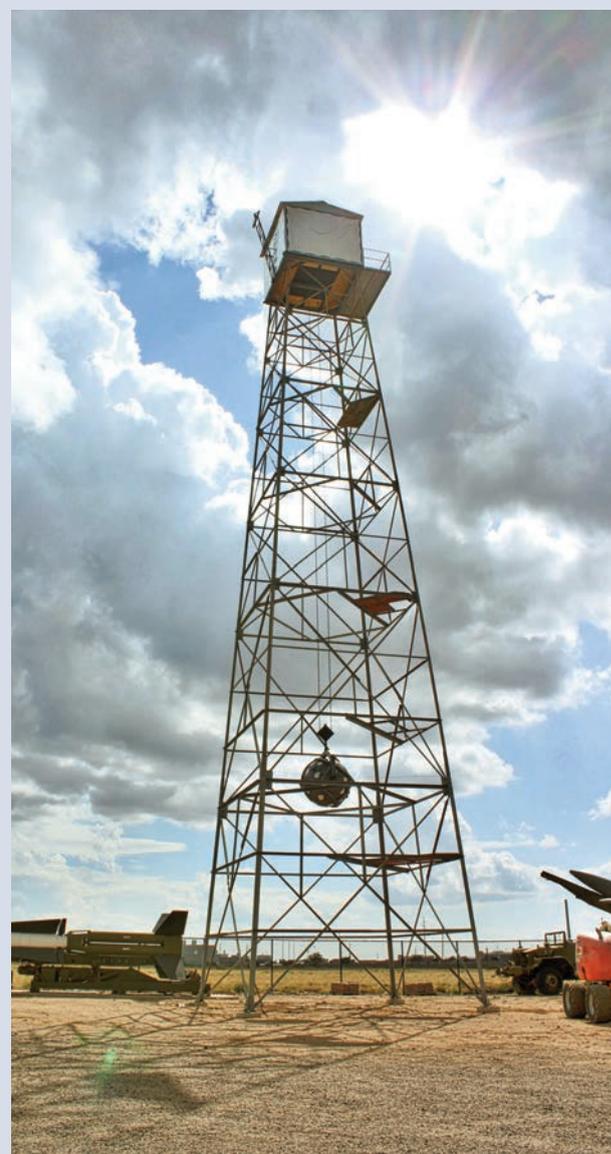
ONCE MOVES were complete to Bldg. 756 in New Mexico (background), demolition on eight trailers was completed. The new building houses 108 people, 48 more than the trailers.

## HR and Communications

**Sandia's health plan ended FY17 \$4 million (2.3 percent) under budget** partially due to negotiated cost savings through effective contract management as well as progressive wellness efforts to maintain a healthy workforce. The low cost means lower premium increases in 2018 at only \$0-\$13 per month for employees. Sandia's low healthcare costs are supported by the October 2017 DOE Contractor Benefits Benchmarking and Metrics Study, which shows total cost for active employee health at \$13,383 per employee per year, well below the DOE

weighted average of \$15,861. (3500)

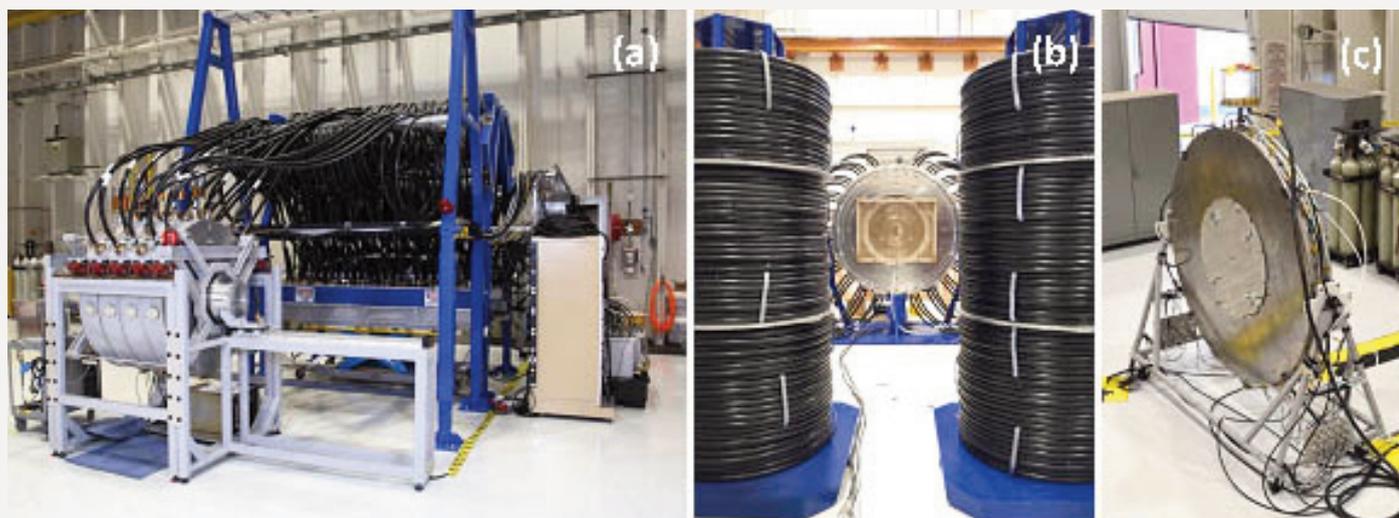
**On Oct. 9, 2017, a new agreement was ratified between Sandia and the Metal Trades Council (MTC)** that is effective through Sept. 30, 2020. There are approximately 440 employees in the MTC labor union at Sandia. The new contract continues world-class benefits, provides wage increase in all three years of the agreement, and simplifies a number of aspects of the prior contract to better support Sandia's critical national defense mission.



**The National Museum of Nuclear Science & History,** managed for DOE by Sandia and operated by a not-for-profit organization, successfully designed, created, and erected a near full-scale replica of the 100-foot tower on which the Trinity Test of the world's first atomic detonation occurred in July of 1945. The exhibit erected outside the museum in Heritage Park includes a replica of the plutonium device "gadget" hanging below the cabin that was atop the tower. The privately funded project enhances community appreciation for the Sandia/DOE role in technology development and history. (3000)

TRINITY TOWER replica at the National Museum of Nuclear Science & History opened October 6, 2017.

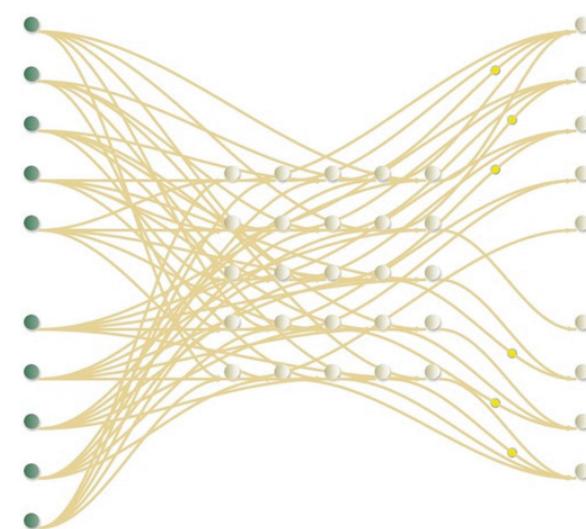
# Advanced Science and Technology



We have developed three prototype accelerators that have established a technical foundation for revolutionary next-generation pulsed-power machines. Centipede (history's first gigawatt-class four-pulse accelerator) is used to evaluate multi-pulse technology for radiographic measurements of sub-critical experiments at Nevada. Thor (history's first megampere-class arbitrary waveform generator) is optimized for megabar-class material-physics experiments. The Z-Next Cavity is history's first 2-meter-diameter 100-gigawatt pulse generator; the cavity could serve as a prime-power source for a future 1,000-terawatt accelerator that is optimized for thermonuclear fusion research. (1000, LDRD)

Sandia advanced its academic partnerships by building new faculty relationships, research collaborations, and strengthening its talent pipeline. Under its Academic Alliance program, the Chief Research Office hosted about 40 early-career professors from leading universities for a two-day orientation in August 2017. They toured Sandia's research facilities and networked with leadership and principal investigators. Sandia also established more than 30 new research collaborations by leveraging faculty expertise in cyber and infrastructure security, shock dynamics, additive manufacturing, data sciences, and other important capability areas. (1000, 2000, 5000, 6000, 8000, 9000, LDRD)

In 2017, Sandia won five Federal Laboratory Consortium awards for remarkable technology transfer achievements. Awards included Outstanding Regional Partnership for the National Rotor Testbed with Oak Ridge National Laboratory and TPI Composites Inc., which works to reduce costs and production time for wind turbine blades; and Outstanding Commercialization Success for SpinDx™ and the Trak® Male Fertility Testing System. These prestigious awards recognize the range of technologies developed at Sandia that are successfully transferred to the private sector, resulting in valuable social and economic impacts.



HAANA DEVELOPED MATHEMATICAL FOUNDATION for designing Spiking Neural Networks that connect inputs (left nodes) to outputs (right nodes) via hidden layer nodes.



ARTIST RENDERING of light passing down a silicon photonic waveguide, and the subsequent encoding of information onto the light using a resonant silicon micro-disk cavity.

A team of researchers in Sandia's National Security Photonics Center demonstrated world record low-temperature, high speed (10 Gb/s) data communication from a 4 Kelvin cryogenic environment using low-energy silicon photonic modulators. This achievement demonstrates a 10,000-times improvement in data bandwidth over current approaches, with approximately a 400-times reduction in thermal load compared to copper cabling. Low-energy signaling is critical for cryogenic systems such as satellite sensors and beyond-Moore digital computers operating at ultra-low temperatures.

A new technique for reducing noise in coincidence measurements of cation mass and electron energy from photoionization events provides unprecedented accuracy for identifying and quantifying products in gas-phase chemical reactions. The approach, invented by physical chemists at Sandia's Combustion Research Facility collaborating with University of the Pacific and Swiss Light Source colleagues, removes "false coincidences" from chemical-physics experiments. Dynamic range is improved by a factor of 100, enabling the quantification of minute amounts of one chemical in the presence of enormous amounts of another. (8300)

Computational analysts deployed and used electrical modeling tools developed by the Qualification Alternative to the Sandia Pulsed Reactor (QASPR) project for the first time to predict the margin of circuit performance in the W88ALT370 AF&F under neutron radiation from hostile nuclear bursts. Advanced Uncertainty Quantification (UQ) techniques were used to raise confidence in the calculations to levels acceptable for qualification evidence. These activities were identified on the FY17 NNSA NA-10 "Getting The Job Done List."

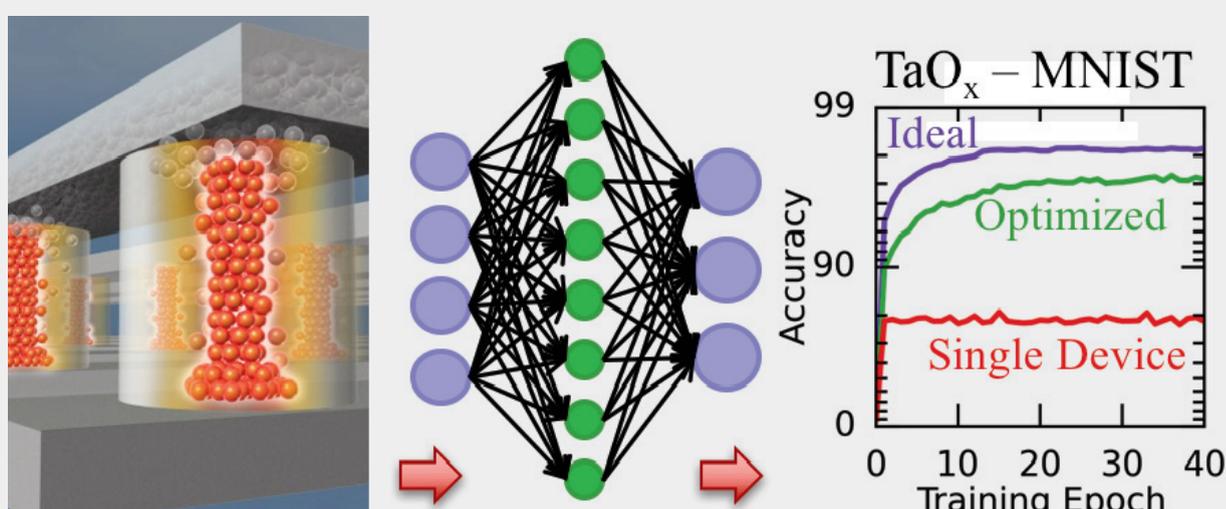
The Focused Ion Beam (FIB) Interferometer team was responsible for inventing and proving the effectiveness of an in-situ interferometer tool within an FIB vacuum chamber. In-situ interferometry is a groundbreaking capability in the world of FIB processing, where ultra-precise measurements of very thin films are crucial for success. The consequences of misjudging thickness measurements by even hundreds of nanometers are typically catastrophic and unrecoverable. In-situ measurement techniques allow an FIB operator to be incredibly accurate in these routine processing steps. (5000)

The Hardware Acceleration of Adaptive Neural Algorithms (HAANA) team concluded a three-year Grand Challenge LDRD, under which the team developed new solutions for low-power brain-inspired computation for scientific computing and data analytics applications in cybersecurity and remote sensing. HAANA has introduced three new brain-inspired architectures, released a formal tool to evaluate neuromorphic hardware (CrossSim), and has produced several brain-inspired spiking and adaptive algorithms for machine learning. (1400, 1800, 2600, 5200, 5800, 6300, 8700, 8800, 9300)

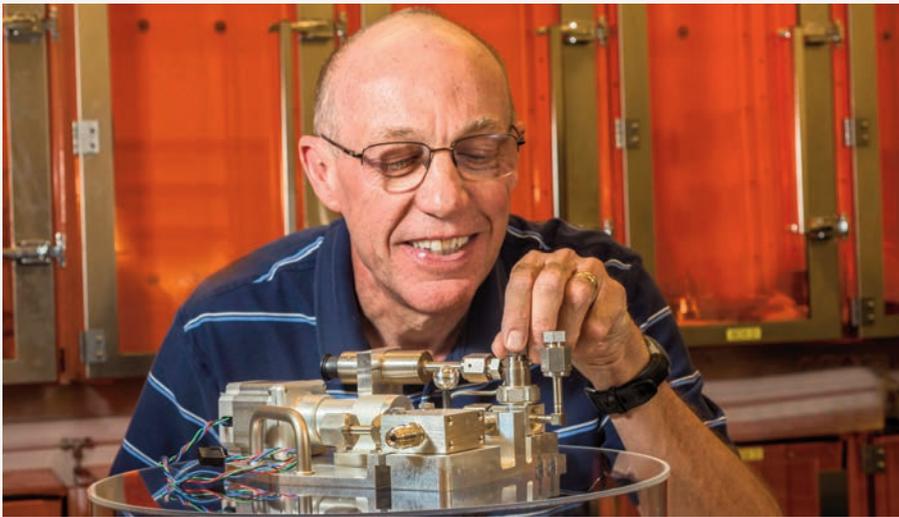
Center 1300's Radiation Effects Science Energetic Neutron Project fielded the first large active electronics payload on a high-yield neutron burst at the National Ignition Facility in August 2017. This marks the first active NW-relevant electronic components tested for fusion neutron effects at Lawrence Livermore National Laboratory's NIF, and is a large step forward for the nation's nuclear survivability experimental capability. This also marked the first collaborative shot between the Inertial Confinement Fusion and National Security Applications groups at NIF, while being led by Sandia. (1300)

To analyze vast quantities of data, Sandia is fabricating hardware using new programmable resistors that mimic neural synapses. The Sandia hardware fundamentally changes how computation is done by using device physics to train neural networks. A key challenge remains for designers as materials, devices, circuits, architectures, and algorithms must be codesigned. A crossbar simulator, CrossSim, that leverages Sandia's Xyce circuit-simulator was created to enable this codesign. CrossSim has guided the development of better artificial synapses and allowed for algorithmic innovations to use noisy, nonideal devices. (8700, 5000, 1000 LDRD)

CROSSSIM USES MEASURED DEVICE properties to model how a neural network performs on a new architecture, allowing for the co-design of materials to algorithms.



# Advanced Science and Technology



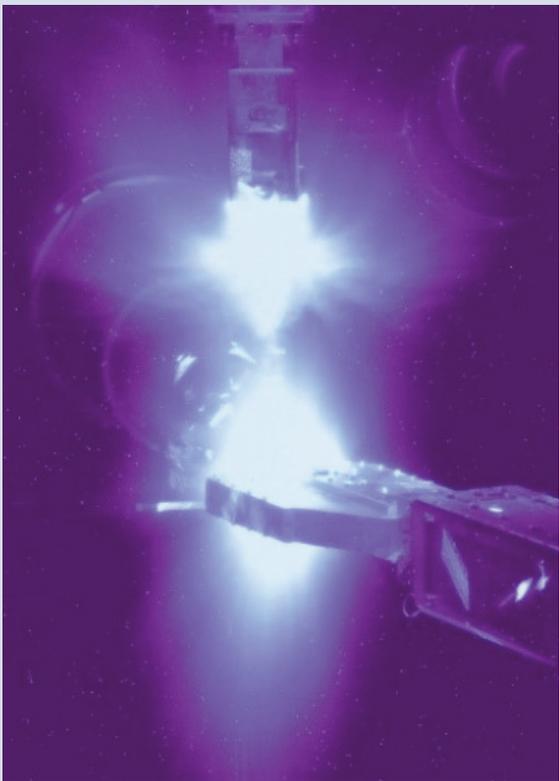
PRINCIPAL INVESTIGATOR Dean Rovang checks out the Z Machine's tritium gas transfer system, which was built at the Labs' California site and filled with trace tritium at Sandia in Albuquerque.



TWO NEUTRON RADIATION effects cassettes aim toward the center of the containment structure housing a tritium gas transfer system in the Z vacuum chamber.

A cross-organizational team executed the first tritium experiment on the Z machine, using engineered systems and thoughtful work planning to mitigate this new hazard at the facility. Thermonuclear fusion of deuterium and tritium can increase the neutron yield ultimately by factors of 50-100, enhancing the impact of Z for Nuclear Survivability and High-Energy-Density science supporting Stockpile Stewardship. This initial experiment opens the door to higher quantities of tritium on the path toward high-yield Inertial Confinement Fusion in the future of the pulsed power program. (1000/2000/8000/0600, LDRD)

Sandia scientists showed that the world's largest laser, the National Ignition Facility at Lawrence Livermore National Laboratory, could be used to study thermomechanical shock from intense X-ray bursts, important for qualifying additively manufactured and other advanced materials to radiation environments. In each experiment, 160 laser beams energized a krypton plasma, launching ~13 keV X-rays into specimens monitored with high-speed, ultralow noise interferometry developed by Sandia. Collaborators from Los Alamos National Laboratory provided high-resolution X-ray tomography using the Advanced Photon Source at Argonne National Laboratory to study microstructural damage caused by the extreme radiation. (1300, 1400, 1500, 1600, 1800)



SHOT TIME IN THE NIF VACUUM CHAMBER showing the intense flash of light during radiation and subsequent cooling of the plasma on the Sandia experiment.

Mission applications such as impact sensor analysis for the B61 require efficient solution of multiphysics problems with multiple material interfaces. Sandia's coupling tool, Forte, enabled partitioned solution of such problems for matching interface computational grids. A recent LDRD project developed and implemented an algorithm for accurate and minimally intrusive couplings, extending Forte to non-matching interfaces, enabling key timely analysis of B61-12 Nose Bomb Subassembly field tests. By allowing reuse of existing production codes, this coupling capability helps to leverage Sandia's extensive investments in simulation technologies. (1000, LDRD)



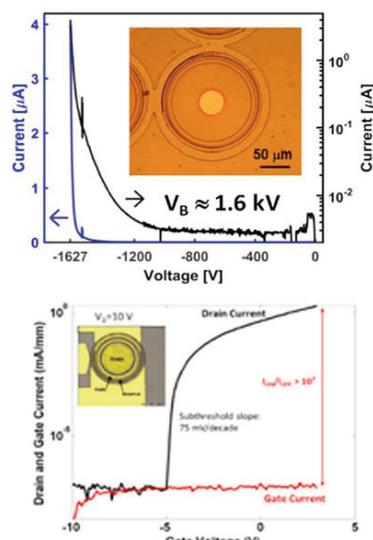
TRINITY ADVANCED TECHNOLOGY SYSTEM — The capabilities of Trinity are required for the NNSA Stockpile Stewardship mission to support annual assessments and qualification.

The Trinity supercomputer, a joint project of Sandia and Los Alamos, successfully passed its Production Readiness Milestone, the final step to transitioning into full production for support of NNSA's stockpile stewardship mission. Trinity features an innovative architecture, including Intel Phi 68-core processors (code named Knights Landing) with integrated high bandwidth memory. The system was integrated by Cray and features its high performance Aries interconnect network. The system architecture effort was led by Sandia, while Los Alamos leads operations and the project office. (1000, 9000)

Reported in November's *Nature Scientific Reports*, researchers from 5200, 1800, and 6700 developed a photodetection paradigm based on graphene, a single layer of carbon atoms, enabling smart charge integrating pixels that offer high-sensitivity while simplifying complex read-out architectures currently employed. Developed under the Smart Sensors Technology Grand Challenge LDRD, this advance provides a path to next-generation multimodal (visible/infrared/radiation) sensors, allowing the use of new absorbers and architectures currently unavailable. Functionally, graphene acts as a local amplifier with large photogain, creating pixels that are individually controllable. (5000)

The Ultra-Wide-Bandgap Grand Challenge Laboratory Directed Research and Development team recently won an R&D 100 award for developing the next generation of semiconductors to enable dramatic improvements in electrical power conversion. The technology will benefit numerous critical applications, ranging from ultra-compact and robust power converters for nuclear and defense systems, to ultra-efficient power converters for a resilient electric grid. The award recognizes two ultra-wide-bandgap semiconductor devices, a diode and a transistor, each of which is the first of its kind and has exhibited record performance. (LDRD)

Over the past three years, the PELE ALMOND\* team has successfully designed and manufactured an "embedded" fuze for the Air Force Research Laboratory (AFRL) capable of surviving extreme pressure and high-G environments. As part of the design task, the Dept. 2627 team collaborated with both internal organizations (2553) and external vendors to qualify a Direct Header Deposition (DHD) Exploding Foil Initiator detonator. The success of this project has led to significant follow-on work with AFRL and a high likelihood of transitioning the DHD technology to industry partners. (2600, 2500, 1800) (\*ALMOND = Advanced Low Density Fireset for Modular Novel Detonation)



THE TWO AlGaIn ultra-wide-bandgap power semiconductor devices for which an R&D100 award was received. Top: Al<sub>0.30</sub>Ga<sub>0.70</sub>N PiN diode. Bottom: AlN/Al<sub>0.85</sub>Ga<sub>0.15</sub>N high electron mobility transistor.

## Defense Nuclear Nonproliferation



DEPICTION of planned GPS III satellite hosting a Global Burst Detector

Image credit: Lockheed Martin

The final payload of the next-generation of Global Burst Detector, GBD III, was delivered Nov. 7, 2017. The first launch of GBD III is expected in mid-2018. This generation, hosted on GPSIII, will join GBD systems on prior generations of GPS satellites. The Global Burst Detection system looks for nuclear detonations around the world, offering real-time information to US policymakers about potential activity. Sandia has developed and delivered satellite-based nuclear detonation detection systems since 1963. (6700)

A multi-level security special communications system that supports multiple transport segments has formally been declared an Initial Operational Capability by DoD. A \$50 million, five-year effort, the Special Communications

Portal for Enterprise (SCOPE), will be operated out of Sandia's California site. The highly complex SCOPE application is built on a modern software architecture and includes ~500,000 lines of source code supporting national security needs. In April and July 2017, the project completed three weeks of customer-witnessed acceptance testing of functional requirements. (6300, 2600, 5100, 8700, 9300, 10600, 10700)

A workshop spearheaded by Sandia researcher David Reyna eventually led to solving a 43-year-old physics mystery. Using the world's smallest neutrino detector, a collaboration of 80 researchers from 19 institutions and four nations detected and characterized coherent elastic scattering of neutrinos off nuclei. Sandian Belkis Cabrera-Palmer

oversaw the analysis of data collected with the Sandia-developed neutron scatter camera. Published as a Science cover article, the COHERENT project's breakthrough research paves the way for additional discoveries in neutrino behavior and the miniaturization of future neutrino detectors. (8600, LDRD)

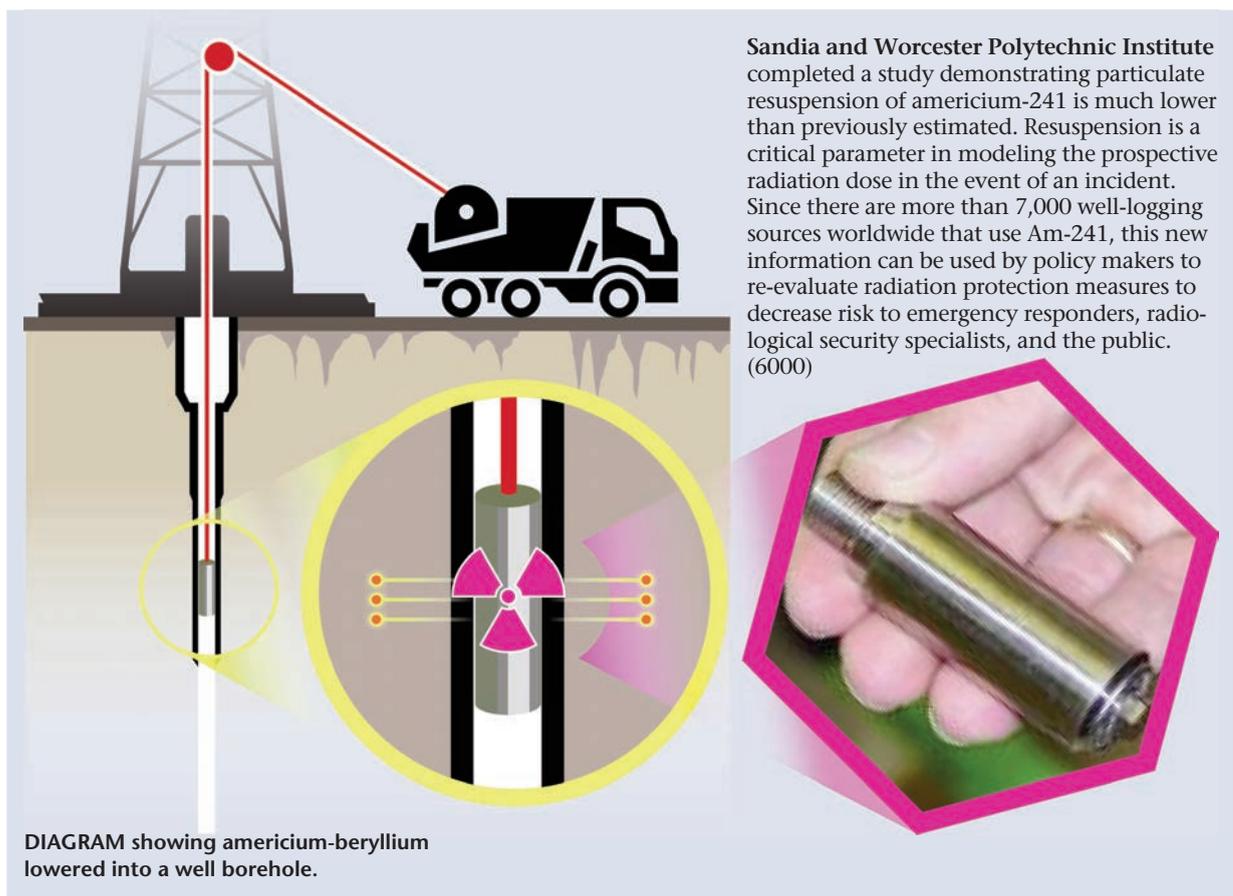
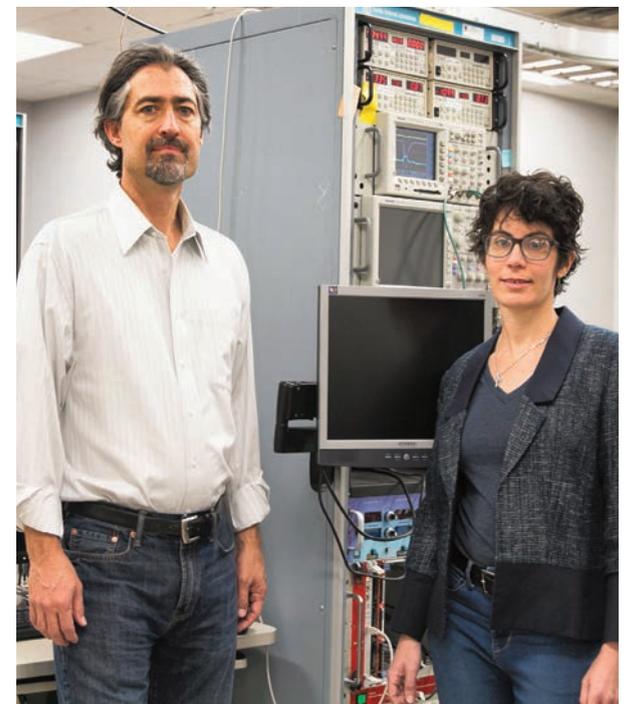


DIAGRAM showing americium-beryllium lowered into a well borehole.

Sandia and Worcester Polytechnic Institute completed a study demonstrating particulate resuspension of americium-241 is much lower than previously estimated. Resuspension is a critical parameter in modeling the prospective radiation dose in the event of an incident. Since there are more than 7,000 well-logging sources worldwide that use Am-241, this new information can be used by policy makers to re-evaluate radiation protection measures to decrease risk to emergency responders, radiological security specialists, and the public. (6000)



SANDIA RESEARCHERS David Reyna, left, and Belkis Cabrera-Palmer oversaw the deployment of multiple detectors and analyzed data collected with the Sandia-developed neutron scatter camera.

Sandia's Physical Security Center of Excellence was tasked to conduct engineering site surveys at nine NNSA sites to gather current physical security system status. Sandia developed optimized technical approaches, rough estimates, and a master schedule to revitalize the security systems at all nine sites in accordance with DOE directives and funded and directed under a Congressional mandate "Center for Security Technology, Analysis, Response and Testing (CSTART)." The 10-Year plan was formally approved by General Klotz, NA-1, in August 2017.

# Defense Nuclear Nonproliferation

Due to the significant proliferation in small Unmanned Aerial Systems (UAS) usage and sales, the commercial sector has begun to market detection, assessment, and neutralization systems to counter potential UAS concerns to national security. Sandia (Group 6520) was tasked by NNSA to develop a methodology to test and evaluate cUAS commercial-off-the-shelf products and provide decision makers with information on performance, maturity, and technology gaps. The cUAS T&E methodology (see illustration at bottom of page) developed provided a comparable, scalable, and repeatable standard whereby all systems could be evaluated equally. (6500)

Sandia (Group 6510) was tasked by DOE to deliver a physical security system solution to include a perimeter intrusion detection and assessment system and supporting security infrastructure at the site. The project was a three-year effort funded for \$12 million. The initial kickoff occurred in January 2015, and the final Government Acceptance Testing was finalized and approved in November 2017. This project represented the first major security design and implementation by Sandia for DOE in several decades. (6500)

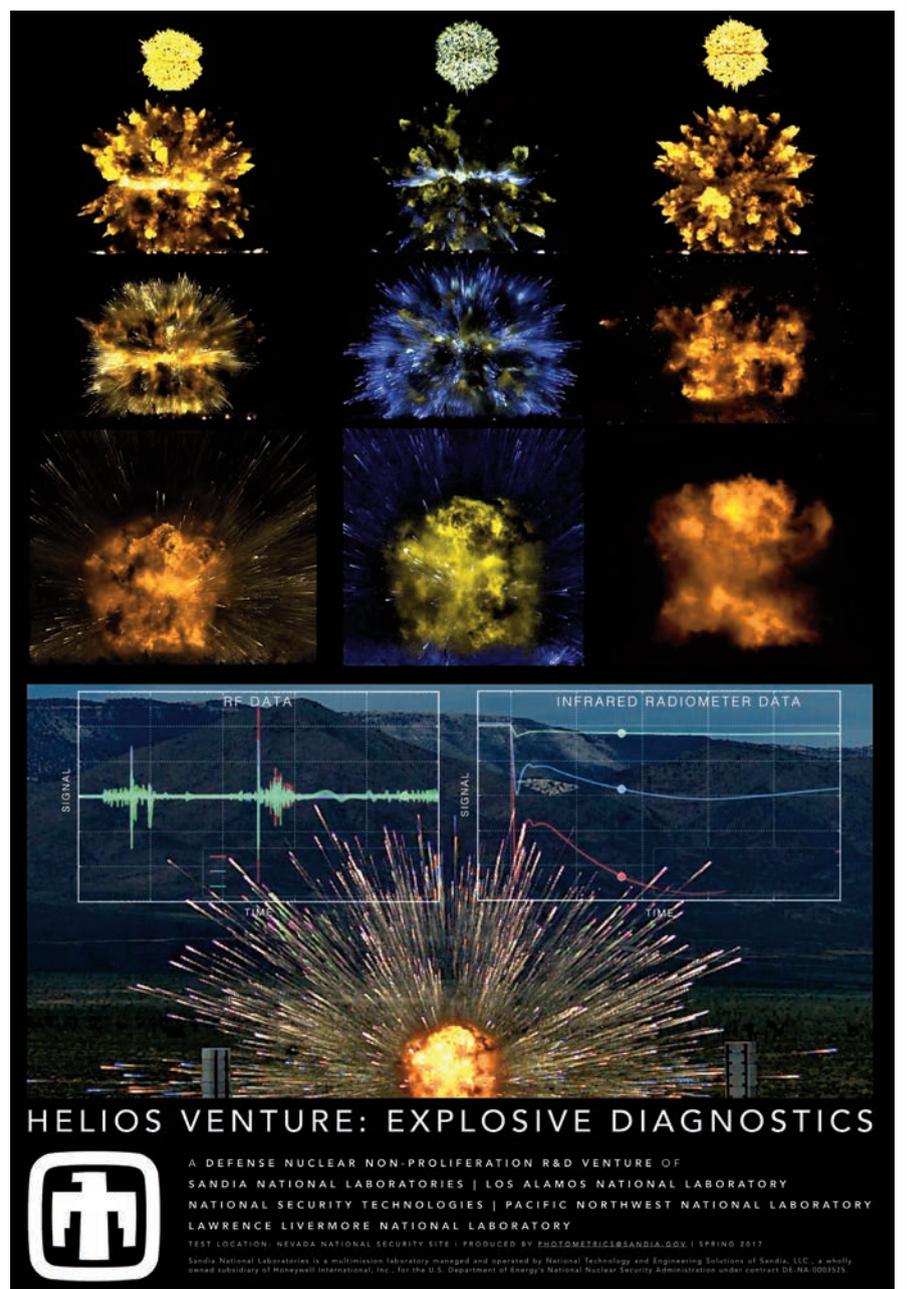


The next generation Global Burst Detector payload, III Prime, is in the critical design phase. This year, a system-level test campaign commenced to perform system-level Assembly, Integration, and Test activities with high-fidelity subsystem engineering units, cables, and system test equipment. Two campaigns successfully tested the integrated payload verifying functionality and interfaces. At the end of the multi-year test series, system test equipment and test processes will be ready for flight use, reducing execution risk in a challenging schedule to deliver the first GBD flight systems to GPS host space vehicles.



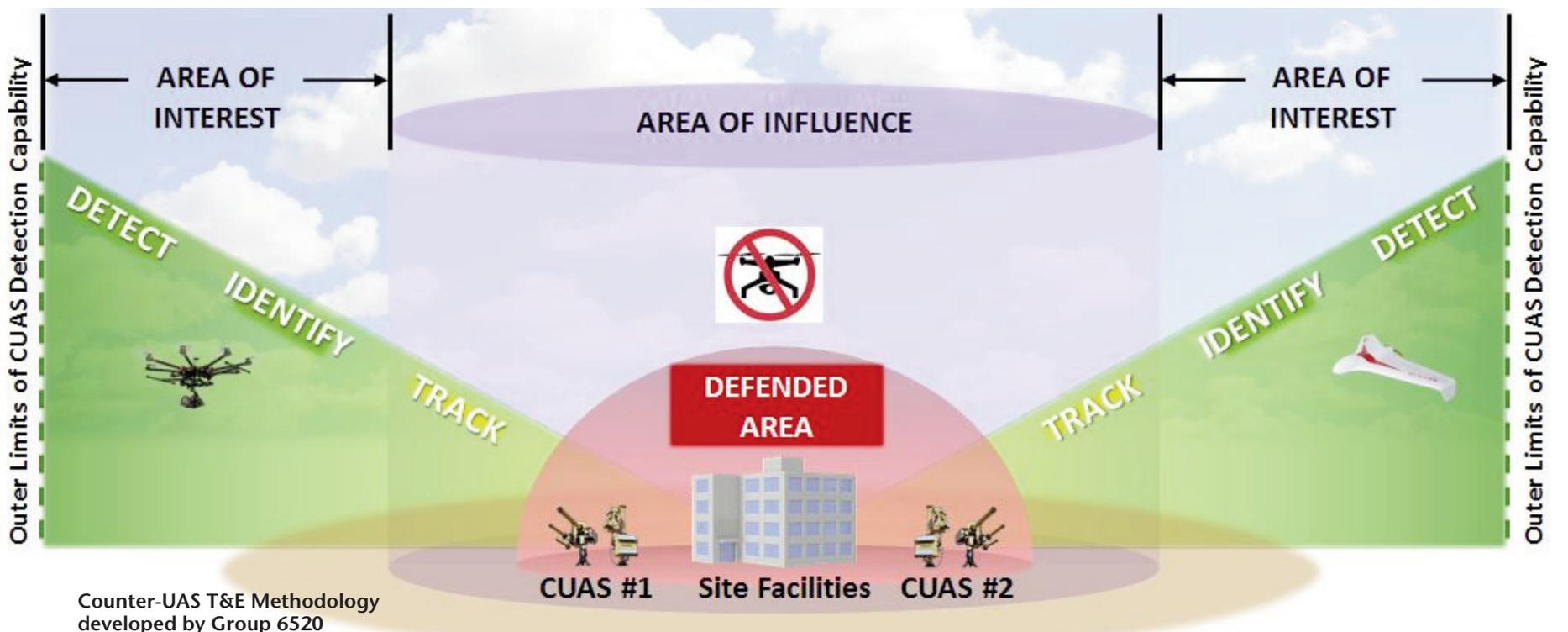
Sandia designed, built, and delivered to the Defense Threat Reduction Agency a replacement for radiation detection equipment (RDE) employed by US arms control treaty inspectors. The new RDE was approved for use in May 2017 and deployed in Russia for a New START (Strategic Arms Reduction Treaty) inspection. The RDE is used to verify that items declared to be nonnuclear are indeed nonnuclear. The original RDE was more than 25 years old, and maintenance was difficult. The replacement RDE offers improved sensitivity, durability, safety, and ease of use. (6000, 5000)

A SANDIA ENGINEER DEMONSTRATES radiation detection equipment used in the New Strategic Arms Reduction Treaty (New START).

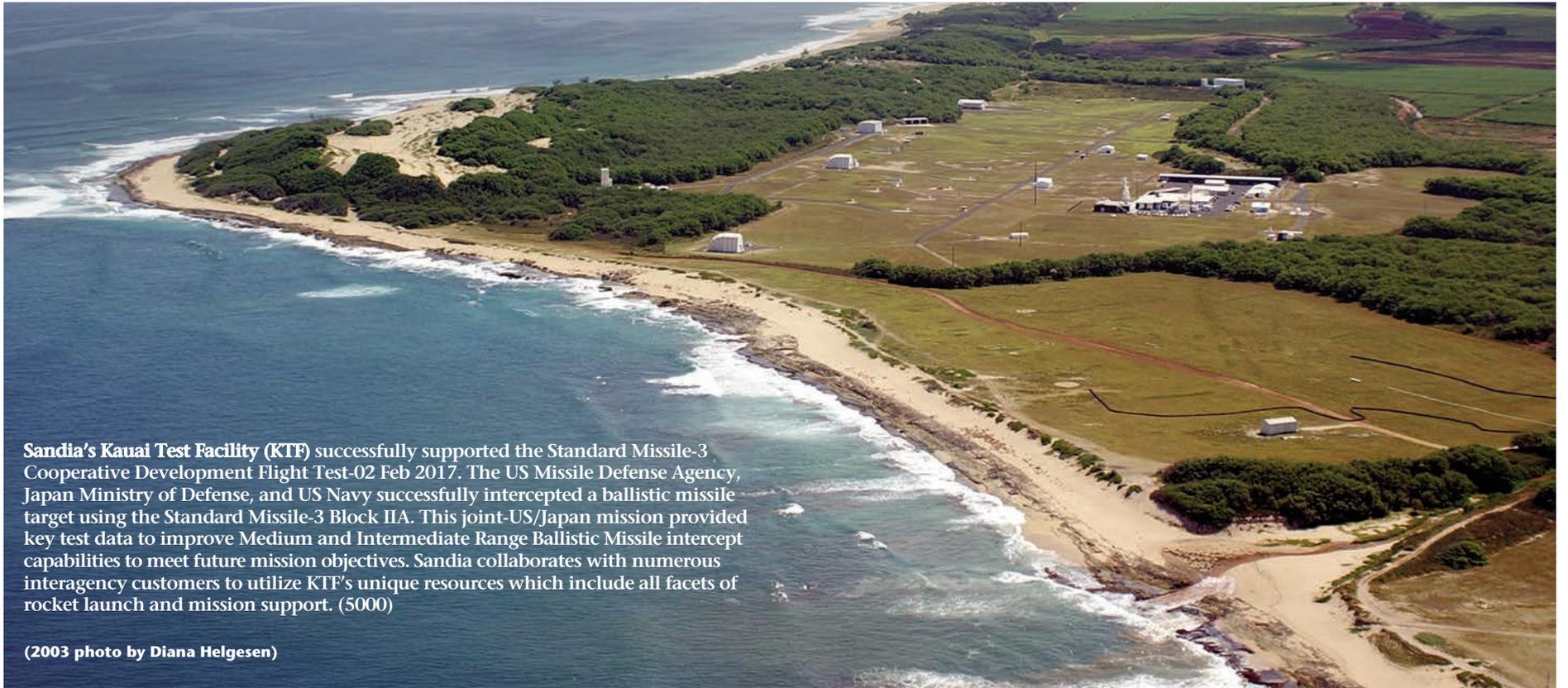


HIGH-SPEED IMAGE OF PYROIS TEST DETONATION. Streamers result from hot device fragments. Upper left trace indicates significant radiofrequency signal; upper right, midwave infrared radiometer signals.

The Helios Venture successfully executed the Pyrois High Explosive (HE) test campaign in FY17. This NA-221 Office of Proliferation Detection Venture conducted 10 tests and gathered 13 unique collection types over five weeks. The data resulting from this campaign are unprecedented and enable forward modeling and simulation tools to simulate signals produced by HE. Sandia introduced a plenoptic camera, gathering videos that identify distinctive signature bands. Other remote optical and electromagnetic emission collections were made, clearly distinguishing the unique articles used in the tests. (6700, 5800, 5300, 1500, 1800, LLNL, LANL, PNNL, NSTec)



# National Security Programs



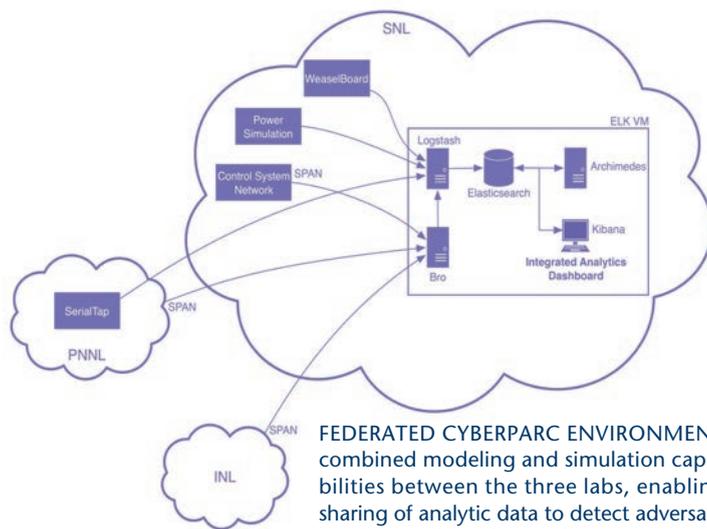
**Sandia's Kauai Test Facility (KTF)** successfully supported the Standard Missile-3 Cooperative Development Flight Test-02 Feb 2017. The US Missile Defense Agency, Japan Ministry of Defense, and US Navy successfully intercepted a ballistic missile target using the Standard Missile-3 Block IIA. This joint-US/Japan mission provided key test data to improve Medium and Intermediate Range Ballistic Missile intercept capabilities to meet future mission objectives. Sandia collaborates with numerous interagency customers to utilize KTF's unique resources which include all facets of rocket launch and mission support. (5000)

(2003 photo by Diana Helgesen)

**Defending information and information technology** resources is not only a research issue but has gained widespread attention over the past year via mainstream news reporting of large-scale hacks and compromises. Forming internal and external communities, Sandia cybersecurity researchers have dug into this problem using behavior-based heuristics, machine-learning, and statistical techniques, and built network threat-discovery tools like Tamizar. Operationally deploying these technologies and understanding partner needs, Sandia has brought next-generation tools to bear on this problem, which has led to multiple discoveries of attackers operating in the early stages of the cyber kill chain. (5000, 8000, 9000)

**CyberPARC is a DOE lab partnership** among Sandia, Pacific Northwest National Laboratory, and Idaho National Laboratory to advance the state-of-the-art of industrial control system cybersecurity. Over the summer, CyberPARC held its first workshop where the three labs successfully federated modeling, simulation, and analytics environments to demonstrate the ability to

combine best-of-breed capabilities to protect, detect, react, and recover from industrial control system cyber attacks. The federated system paves the way for future collaboration



**FEDERATED CYBERPARC ENVIRONMENT** combined modeling and simulation capabilities between the three labs, enabling sharing of analytic data to detect adversary activity in industrial control systems.

and more rapid advancement of industrial control system tools and capabilities. (5000, 8000)

Significantly reduced "footprint" of materials needed for transport to the scene of an explosive threat. Further, a commercial oxidizer, commonly used in pool cleaners, has been tested and proven as an effective additive for chemical and biological agent decontamination. (6000)

**Sandia has successfully developed** a blast mitigation foam formulation that reduces the amount of concentrate by a factor of four compared to previously fielded versions. Thus, blast mitigation and particle capture may be achieved from a significantly

team effort produced an executive product reviewed by the Missile Defense Executive Boards that yielded impactful results and was very well received by executive leadership. Sandia had key contributions in this high-profile study by first influencing the change of course to incorporate a new set of sensor architectures based on latest requirements. Sandia's contributions redirected the MDA AoA to use a new set of architectures developed at Sandia. Included in the large team recognition for the Systems Engineering Award were Sandians Larry Jones, Jeff Spooner, Barbara Funkhouser, Carter Grotbeck, and Jordan Carnahan. (5000)

**An advanced satellite ground system** comprising command and control and data processing for a set of advanced space-based sensors has been under development since May 2013. This system is built on a modern node-based software architecture, and has 3.3 million lines of code and 38 racks of equipment. It has ergonomic operator interfaces and will support new national security needs. The system went into operation in October 2017. The end users are delighted with the enhanced human interface and technical capability of this new ground system. (2600, 6300, 9300, 10600)

**For more than a decade Sandia has worked with General Atomics (GA)-Aeronautical Systems Inc.** under a Cooperative Research and Development Agreement (CRADA). This CRADA has furthered advancements in the GA Lynx synthetic aperture radar product line and has positively impacted deployed systems. On Nov. 15, Steven Castillo, on behalf of Sandia, accepted a licensing royalty check earned through commercial sales of Lynx from General Atomics director of Radar Systems, John Fanelle. This is the result of years of collaborative efforts between the organizations. (5000)

**WeaselBoard Expanded**

The modern world is run by embedded computers that manage physical processes, including electricity generation, manufacturing, and ship operations. The embedded computers that do this work have received a lot less cyber-security monitoring and protection than the ones on our desktops. The WeaselBoard adds cyber-security inspection to these embedded computers. The Department of Defense has begun deploying WeaselBoards to high-value locations where they can be alerted (out-of-band) to adversaries' attacks. The development of this custom hardware/ firmware/software/network solution has engaged experts from Divisions 5000 and 2000.

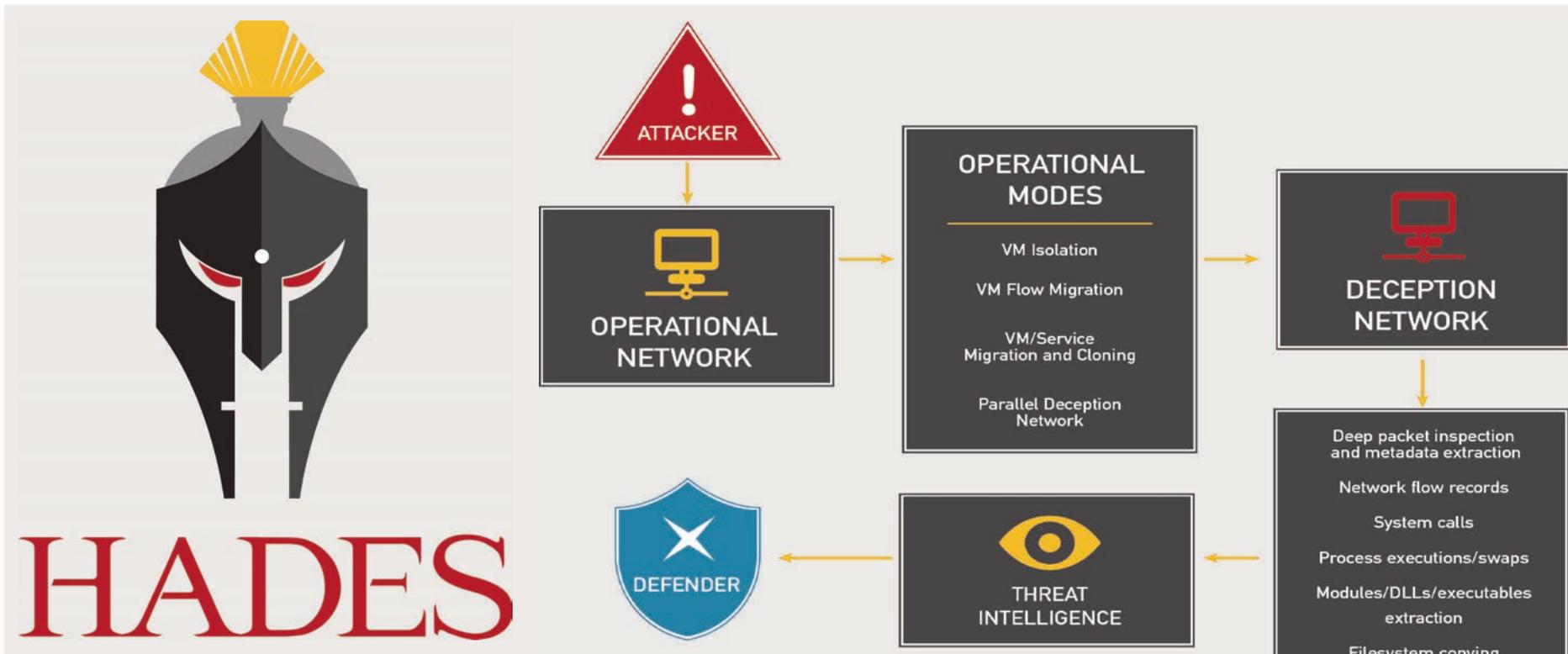
**Sandia's Advanced RF Systems Group** successfully demonstrated its multi-mission, Intelligent Transceiver for Universal Signaling (ITUS) payload during a multi-agency military exercise in Florida. The ITUS payload, integrated into an unmanned aircraft, exceeded expectations as it dynamically detected, tracked, and engaged all targets in its area of responsibility via proven-unique methods. Sandia's successes garnered accolades from the host organizations. (5300)

**The Missile Defense Agency** awarded its 13th Annual Awards in Systems Engineering to the Global Sensor Analysis of Alternatives (AoA) team. This



JOHN FANELLE OF GENERAL ATOMICS, left, presents an MQ-9 Unmanned Aerial System model to Steven Castillo of Sandia. Lynx radar flies on-board the MQ-9.

# Mission Assurance



## HADES

Until now, no single, integrated suite of tools has provided a comprehensive solution for detecting, deceiving, engaging, and analyzing the cyber adversary. The High-fidelity Adaptive Deception & Emulation System, or HADES, provides analysts the ability to isolate an attack while collecting raw intelligence about threat actors and their tools, tactics, and procedures. This increased awareness, and the ability to adjust the deception environment to provide the attacker with a realistic environment that is both challenging and evolving, enables cybersecurity professionals to better defend their networks from current attacks, learn their attacker's methods and motives, potentially identify their attacker, and increase the time and resources the adversary must expend to successfully breach a cyber system. In an era of increasing sophistication among cyber criminals and state-sponsored threat actors, HADES could lead to a dramatically improved cybersecurity posture for American enterprises. (9300, LDRD)



SANDIA CYBER RESEARCHERS Vince Urias, in left photo, and Will Stout and Caleb Loverro, in right photo, have developed HADES, the High-fidelity Adaptive Deception & Emulation System, which won an R&D 100 Award in 2017.



In 2017, weapon response analysts in Surety Engineering & Weapons Quality worked with NNSA, Lawrence Livermore and Los Alamos national laboratories, and Pantex to develop, test, and implement new processes in nuclear explosive operations. Analysts worked on multiple projects — the W88 and B61 stockpile systems, the vacuum chamber, and the warhead measurement campaign — to reduce risk, increase efficiencies in production, and support joint NNSA defense and nonproliferation efforts. Team members, who averaged only two years of experience, benefited from a new training program and enhanced peer review process in partnership with Nuclear Deterrence (2000).

The last of three projects intended to improve Sandia's Mark Quality (MQ) production component acceptance process, Sandia Productions Centers (2500, 2600, 5200, 9400) this year introduced the Component Acceptance Plan/Quality Assurance Inspection Plan (CAP/QAIP). CAP/QAIP identifies critical requirements for product quality and simplifies the inspection process, reducing some product acceptance timeframes from two weeks to two days and achieving labor cost savings ranging from 40 to 80 percent, without decreasing product acceptance rigor. CAP/QAIP was instrumental in achieving Sandia's first-ever Diamond/STAR Stamp authority. (9400)

In 2017, the newly formed Quality Assurance (9100) team applied its specialized technical, systems, and quality assurance expertise to organizations across the Labs to help ensure the continued delivery of exceptional products and services. Highlights include the update of Sandia's Quality Assurance Program regulatory document and corporate roles definitions, managing issue closure efforts during the review of Sandia's highest-risk processes for the incoming NTESS management team, implementation of a Labs-wide quality assurance process through blanket ISO certification, and creation of more user-friendly corporate acronym and dictionary manager and policy informational programs.

On Sept. 14, 2017, Sandia broke ground on a new, ultra-modern computer annex designed by Sandia data center engineers to meet the needs of future high-performance computing systems. New building technology will help minimize water and energy use, and green-building construction and an external solar panel field are expected to help achieve LEEDS certification. The multi-petaflop computer the facility is intended to contain is expected to be as much as a hundred times faster than the storied Red Storm supercomputer, housed in an adjoining center in the early 2000s, in performing large scale weapons simulations.



EAGER TO PLUNGE into their symbolic breaking of bare ground to begin construction of a new computing center are, left to right, Carol Meincke, Steve Fattor, Grant Heffelfinger, Dave Douglass, Tom Klitsner, Scott Collis, Carol Jones, Scott Aeilts, John Zepper, and Betty Payne. (Photo by Lonnie Anderson)

During the past fiscal year, Product Acceptance and Supplier Quality has pursued Diamond/STAR Stamp authority, which would allow Sandia to accept Mark Quality products as a delegate of NNSA and help speed component delivery to meet increased production demand from the Nuclear Weapons programs. To consider awarding this authority, NNSA-SFO performed 14 Quality Assurance Surveys (QAS) to assess inspector competence, procedure and process compliance, and the ability for inspectors to make the right technical judgements, which Sandia passed with a 100 percent performance inspection grade. This outstanding record gave NNSA/SFO the confidence to grant Sandia interim authority, with full Diamond/STAR Stamp authority to follow.

## Mission Services

Sandia executed the most CRADAs in a given year since 1999 and the highest dollar value in recent history. Fifty-eight CRADAs included 41 new agreements valued at \$45 million and 17 amendments valued at \$12 million. Sandia met with Technology Transfer teams from MIT (Lincoln Laboratory), PNNL, SLAC, LANL, LLNL, SRS, and NSC to discuss CRADA best practices and assist with their strategies. The CRADA Portfolio Development Team also received a Federal Laboratory Consortium Award for ingenuity in negotiating/executing an agreement with the New Jersey transit system. (10500)

**POWER TO SPARE** — The New Jersey Transit Rail Operations Center will benefit from the planned NJ TRANSITGRID, a first-of-its-kind electric microgrid for transportation that can supply highly reliable power during storms or other times when the centralized power grid is compromised. New Jersey Transit is working on the project with Sandia, which won a Federal Laboratory Consortium national award for the economic development partnership.

(Photo courtesy of New Jersey Transit)



## Laboratory Operating System

Sandia defined a high-level Laboratory Operating System (LOS) framework to increase Sandia's capacity to learn, innovate, and respond to the rapidly changing environment. LOS is our purposeful multi-year journey to evolve the Laboratory culture to a learning organization, aided by six enablers (Tiered Accountability, Data-driven & Visual Management, Rapid Problem Solving and Continuous Improvement, User-Centered Design, Velocity Technology Development, and Strategy Deployment). One of the six enablers, Tiered Accountability, is currently deployed at the Director-level and above supporting timely information sharing, issue resolution, and transparency. (10100)

The implementation of Division 8000's Diversity and Inclusion five-year strategic plan, Vision 2020, is making an impact to create an inclusive workplace where every voice is heard. As part of this grassroots employee-led effort, 60 employees recently spent an energizing half-day celebrating Year 2 accomplishments and planning Year 3 initiatives. This past year's activities include an unconscious-bias workshop for management, a Friends and Family day celebrating the summer intern projects, and the development of hiring-process tools to hinder bias and hire the best.

Sandia invests in the community by growing our diverse supplier base through monthly Open Houses, allowing suppliers to learn how to do business with the Labs while networking with supplier diversity advocates, technical staff, subcontracting professionals, Sandia risk management and suspect/counterfeit items specialists, and external community partners. In Fiscal Year 2017, 330 supplier representatives attended. Subsequently, more than \$600,000 in subcontracts were awarded to capable Veteran-Owned, Service Disabled Veteran-Owned, Woman-owned, HUBZone, and Small Disadvantaged small businesses that attended the Open Houses. (10200)

Procurement improved the service model by creating the "My Procurements" section on Techweb. "My Procurements" allows internal customers to easily see and interact with orders an individual or program has in process. It provides information on who the buyer is, recent update notes, expiring Purchase Orders (where action may be needed), as well as a link to a site that includes additional information. This is the first of several tools being released to assist members of the workforce in tracking procurement requests. (10200)

The Move-It application, built in-house by IT partners in Advanced Enterprise Software Engineering, is one of Sandia's newest laboratory-wide service-request systems. Move-It replaces two aging systems, which the workforce in both New Mexico and California used to use to request Logistics services for moving, storing, and disposing of all hazardous and nonhazardous materials across both sites. This blend of innovation and familiarity gives customers a single, intuitive, and straightforward system to request Logistics' services. (10200, 10700)

To increase transparency into Sandia's overhead cost pools, the Labs deployed a new financial model at the beginning of FY18. The new Cost Accounting Standards-compliant model reduced the number of overhead cost pools by 50 percent, reduced the number of service centers by 75 percent, reduced the number of rates by more than 75 percent, and provides a significant reduction in indirect cost recycling. It will foster understanding of what Sandia spends taxpayer funds on and allow efficiencies to be gained in future years. (10500)

Sandia made significant changes to the travel process and launched enhancements to the expense report system (ERPlus). These changes included:

- Paperless receipt documentation for travel/non-travel expense reports
- Automated managerial approval for travel expense reports determined to be low risk
- Transition to per diem reimbursement for meals and incidental expenses
- Lodging costs verified using the Federal Travel Regulations that specify allowable costs based on destination

These changes simplified the travel process for employees and aligned Sandia practices to those of other major national labs. (10500)

BEST IN CLASS  
401(k)  
PLANSPONSOR

PLANSPONSOR Magazine named Sandia's Savings and Income Plan as a 2017 Best in Class 401(k) plan. Thirty-four plans were selected out of 3,381 based on 30 criteria related to design, oversight/governance, and participant outcomes. (10500)

On Oct. 30, the Program Management Office launched the Corporate Earned Value Management System (EVMS). It provides enterprise-wide consistency in project management and EVM processes, and also delivers effective and efficient project planning and controls and auditable, traceable, and reliable performance reporting. It improves customer confidence in Sandia, assurance for Sandia's project management professionals that the processes will aid in delivering projects within scope, schedule and budget, and consistency in project management employee onboarding. Five online EVMS courses were delivered; eight more courses are being created. (10600)

Two corporate-supported reporting/analysis applications were released in October. Financial Analytics is a project reporting/visualization application providing financial project reporting from programmatic levels down to the lowest task level. It shows breakdowns of expenditure types and detail, trending projections, and links to other financial systems. Org on a Page shows charged/managed projects at the organization level for divisions, centers, groups, and departments. It lets users drill down into project totals, the top five projects for charging and managed projects, high-level non-base info, and HR counts info. (10600)

New CET functionality enabling users to quickly estimate labor related to chargebacks won a Division 10000 Innovation Award. The project was completed ahead of schedule. The wide-ranging impacts include:

- Reduced the time needed to calculate project impacts from several weeks per project to several days.
- Gives analysts wider consideration when making changes to their financial models.
- Enables the controller to analyze multiple options and communicate the impacts of Burden Rate and Standard Labor Rate changes, which helps support data-driven decisions across the Labs. (10700, 10600)

The EBI team launched the Enterprise Business Intelligence Portal (EBI) to replace older, less user-friendly reporting systems with a modern tool for managing HR and financial reporting. EBI provides a single, trusted source of data for enhanced security and consistency. It will significantly reduce staff time and effort in gathering, interpreting, and sharing data for management decision making and regulatory compliance. (10700)

An outreach effort by Enterprise Collaboration Services (ECS) and partners led to a 50-percent increase in Skype-based collaboration on the classified network. ECS worked with the Nuclear Weapons Planning, Operations office, and Assurance Deputy and Classified Computing Continual Service Improvement to provide cameras, headsets, and microphones to more than 200 people. Personalized training helped make users comfortable using Skype on the classified network. (10700, 2010)

Sandia IT established a new mobile credential that simplifies access to internal web resources for users of Sandia-owned iPhones and iPads. More than 5,500 users have received instructions for installing the credential, which has been loaded so far on about 1,450 devices. The credential allows remote access, without a Crypto-Card, to frequently used resources such as timesheets and expense reports. (10700)

## Executive Support Group



“Get Your Head in the Game,” “Out of Bounds,” and “The Missing” provided the basis for this year’s annual awareness training videos. For the first time, these training scenarios were created from concept to production at Sandia from dramatizations of real Sandia events. This year’s awareness videos received unprecedented feedback for their relatability and usefulness in the Sandia environment. In support of the NTESS contract transition, 100 percent training compliance was also achieved for both the annual awareness training and the newly updated Code of Conduct. (800, 3600)

To further effective and resourceful mission support, the Air Quality Program developed and implemented a site-wide fugitive dust control programmatic permit strategy. By reducing administrative burden and expanding environmental best management practices, this year-long project resulted in a single permit (down from 12) that increased efficiency and decreased regulatory risk to Sandia. This also further enhances the Labs’ reputation as a leader in environmental protection. The collaboration involved both internal and external partnerships, and strengthened relationships with the Sandia Field Office, the city of Albuquerque, and Kirtland AFB. (600,4000)

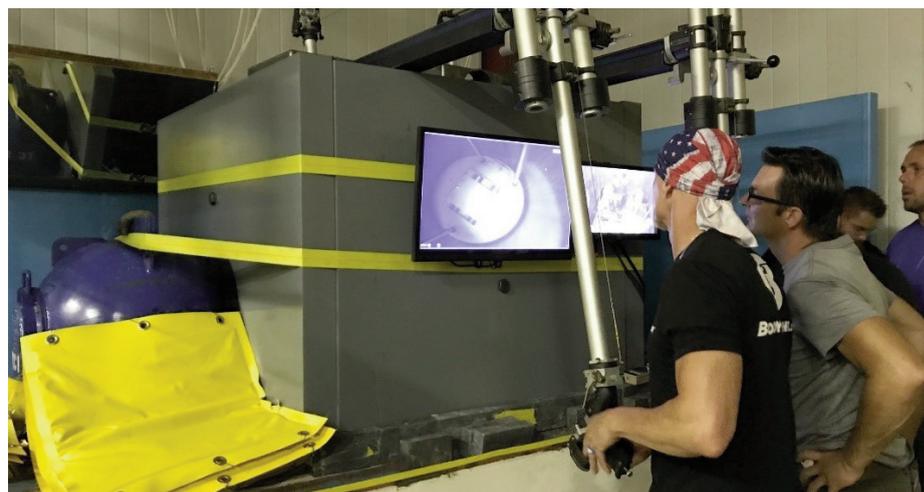
The executive strategy development team led the design and execution of five day-long workshops to explore the future of advanced technologies and global peace and security through the lenses of deterrence, information, innovation, nonproliferation, and population and earth systems. The workshops brought together more than 130 experts and leaders from diverse fields within and beyond Sandia. Workshop participants imagined the global security environment in 20 years and the national security challenges associated with these potential future environments. The output provides the foundation for leaders in shaping the long-term Labs-level strategy. (100)

MESA uses a preventive safety program based on Mistake-Proofing that is derived from quality assurance practices. Inexpensive engineered controls and warnings, created by our technical staff, are used to reduce the likelihood of human error leading to an accident. MESA averages one improvement per month and the controls pay for themselves within 18 months so there is no limitation on the number of improvements, only on the rate of implementation. (5000, 600)

In 2017, the National Security Leadership Development Program (NSLDP) completed the second of two recent 10-month programs focused on developing core groups of Sandia’s next generation of senior leaders. The programs encompassed building leadership skills, site tours that provided exposure to the national security enterprise, and additional project team meetings. Participants explored how their values impact their leadership, behavior, and decision-making; they built relationships with peers, the institution, and other external entities; and applied tools for thinking, leading, and communicating with confidence and courage through changing circumstances.



THE NSLDP CLASS OF 2017 included director and senior manager leaders from across Sandia.



INTERNATIONAL ISOTOPE INC. technicians operate manipulator arms of the Mobile Hot Cell during the retrieval of legacy radioactive sources.

Radiation Protection retrieved, encapsulated, and packaged two highly radioactive cesium-137 sources for disposal using a mobile hot cell as part of DOE’s Orphan Source Recovery Program. The legacy sources were for a project in the 1980s and have not been used since the 1990s because of the potential significant radiological consequence. Collaborative efforts among many support organizations across the Labs contributed to the safe execution of this operation. The project significantly reduced Sandia’s risk, liability, and environmental impact. (600, 4800, 4200)

## Legal

Legal and Prime Contract/Export Div. 11000 was integral to the successful Sandia management & operating (M&O) contract transition, the first for the Labs in more than 24 years. As the M&O contract is the governing vehicle that drives all Sandia requirements and policies, the group led the following key efforts: Ensured new contractual requirements, risks, and government expectations were analyzed and addressed by key stakeholders; adapted two critical compliance programs, OCI and Export Control, to the new contractual environment; and closed out the Lockheed Martin Corporation contract.



