

SANDIA NATIONAL LABORATORIES

# Partnerships

ANNUAL REPORT FY2013



Lab-on-a-Disk Spins Off  
Multiple Testing Products



Sandia  
National  
Laboratories



*“Sandia’s dynamic Partnerships Program engages industry, academia, and other government agencies to create and commercialize new technologies, fulfilling our technology transfer mission while supporting the nation’s economic competitiveness.”*

**Dr. Paul J. Himmert**

*President and Laboratories Director  
Sandia National Laboratories*

*2013 Federal Laboratory Consortium  
Laboratory Director of the Year*

*“Our technology partnerships help to sustain a culture of innovation, ideas, and solutions that enables a broad spectrum of mission challenges, and ultimately benefits our nation’s prosperity through strategic technology transfer mechanisms.”*

**Dan Sanchez**

*DOE Technology Partnerships Manager  
NNSA Sandia Field Office*





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### About the cover:

From left, Sandia National Laboratories’ Matt Piccini, Chung-Yan Koh, and Anup Singh lead the SpinDx team. SpinDx is a diagnostic tool with medical and non-medical applications.

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*Dr. Julia M. Phillips  
Vice President and  
Chief Technology Officer  
Sandia National Laboratories*

*Dr. Peter R. Atherton  
Senior Manager  
Industry Partnerships  
Sandia National Laboratories*

## LDRD Program Benefits Our Partners and the Public Good

Research conducted within the Laboratory Directed Research and Development (LDRD) program is essential to maintaining the vitality of Sandia National Laboratories' mission-critical science, technology, and engineering capabilities.

Sandia partners with industry, academia, and other government agencies to carry out much of the research. Many of the technologies developed through the LDRD program are transferred to industry and commercialized under licensing agreements for the U.S. public good.

The LDRD program has benefited Sandia's work in all of its mission areas. Breakthroughs have occurred

in areas as diverse as new sensor technologies, quantum science and technology, nanotechnology, metamaterials, computational modeling and simulation, molecular biology, energy, and cognitive science.

Look for the LDRD logo in this year's Partnerships Annual Report to discover which technologies grew out of the LDRD program.



To learn more, visit  
[www.sandia.gov/research/laboratory\\_directed\\_research](http://www.sandia.gov/research/laboratory_directed_research)

# Sandia, Partners, and the Public Benefit from Lab Partnerships

Partnerships are a win-win for Sandia National Laboratories and its partners. They enable Sandia to execute its national security, research, and technology transfer missions, while providing partners, and the public, a number of benefits. Strategic partnerships with industry, academia, and other government organizations are essential to securing our nation and moving technologies from the Labs to the marketplace.

In this FY2013 report, you'll learn about a few of the many achievements and activities of the Sandia Partnerships Program. These collaborations are improving national security, energy security, health and safety, and industrial and consumer products. Stories include:

- Utilizing open-source software to enhance interactions with industry and academia
- Sharing simulation expertise to speed design of consumer products
- Using microresonators to reduce the size and cost of mobile devices
- Ensuring electric power for the military, and ultimately, the domestic grid, using cybersecure microgrids
- Saving energy with a novel heat exchanger that has commercial applications ranging from computers to LED lighting and HVAC systems
- Spinning off multiple medical and public health testing products based on a lab-on-a-disk
- Cleaning air and water with biomimetic membranes
- Leveraging local and regional partnerships to promote technology transfer

***“Partnerships are key to Sandia’s ability to meet its national security and technology transfer missions. They foster collaborations with industry, academia, and government; enable technologies to be deployed for the U.S. public good; and contribute to the economic well-being of the nation and the region.”***

***Dr. Julia M. Phillips***  
*Sandia National Laboratories*

By working closely with other institutions, Sandia’s researchers have opportunities to contribute to their fields and connect with skills and expertise we do not possess in-house. Partnerships with universities and other organizations also help us attract and retain top talent. As our partners learn more about Sandia’s mission needs, they can help support them by ensuring the availability of products the U.S. government needs to secure our nation.

By partnering with Sandia, organizations can access intellectual property developed by the Labs. With this knowledge, they gain a competitive advantage and help drive economic growth for our region and our country. The public benefits as well. We maximize the return on taxpayer investments when new and improved products based on Sandia research are available in the marketplace. Everybody wins!

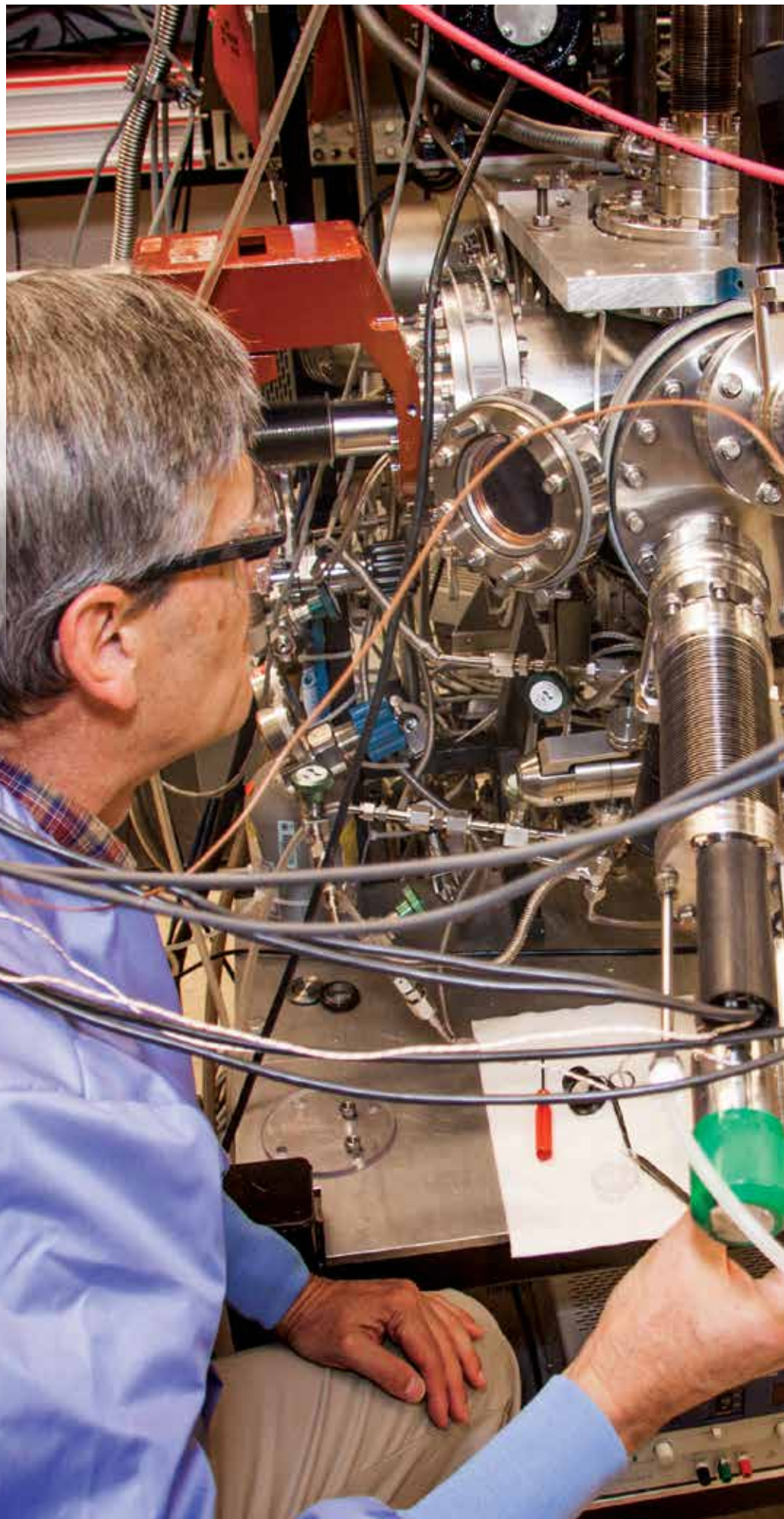


*“Sandia is a great example of the strong partners that make JCESR successful. The JCESR research Sandia is conducting will enable us to achieve the important goals we are all working toward.”*

**Dr. George Crabtree**

Director  
JCESR

■ Kevin Zavadil, Sandia Distinguished Member of Technical Staff, Advanced Materials Laboratory, deposits an electrode film for investigation as an air cathode for use in a metal-air battery.







# High Density Energy Storage for Electric Vehicles and the Grid

Our nation's energy systems are being transformed. More and more renewable energy is being added to the grid, and transportation is moving from being powered by oil to electricity. The bottleneck for reducing our dependence on fossil fuels is inexpensive, high-performance electrical energy storage. Working to overcome this challenge is the Joint Center for Energy Storage Research (JCESR), a major research initiative and public-private partnership.

Led by Argonne National Laboratory, JCESR is one of five U.S. Department of Energy (DOE) Energy Innovation Hubs. JCESR has an aggressive goal of moving beyond lithium-ion batteries to energy storage technologies with five times the energy density of today's systems at one-fifth the cost, in just five years. The research expertise of multiple national laboratories and universities combined with industry's skill at bringing practical, competitive solutions to the marketplace will help JCESR achieve their ambitious goal.

JCESR is focusing on three energy storage approaches. Sandia National Laboratories is working on two of these—storing energy in chemical bonds and using multi-charged ions. In fact, Sandia leads the chemical transformation research thrust, with materials scientist Kevin Zavadil heading a team of senior investigators based at Sandia and other national laboratories and universities.

In order to go beyond lithium-ion, it is necessary to focus on fundamental research, and to understand electrochemical materials at the atomic and molecular scale. Sandia brings a unique set of technical skills to JCESR research, including

experience in developing, testing, and qualifying batteries. At Sandia, investigators are conducting research that spans the range of discovery from the underlying principles that govern electrochemical charge storage, to the demonstration of these principles in cell prototypes.

Sandia's research focus on metal-air and polyvalent metal chemistries could lead to five-fold increases in stored energy density, enabling extended range electric vehicles. Sulfur-based chemistries are being explored as a means of reducing the cost of storage to enable electric grid applications.

A number of specialized facilities located at Sandia are being utilized for JCESR research. The reaction pathways for charge storage are explored at Sandia's Processing Environmental Technology Laboratory through materials and electrolyte synthesis, and subsequent measurement and visualization of interfacial processes.

At the Center of Integrated Nanotechnologies, a DOE user facility, researchers perform electron microscopy of electrodes operating in liquid electrolytes to determine the rates and extents of structural changes during the energy storage and release processes. Materials integration into prototype cells is performed in the Power Sources Laboratories to evaluate the performance of these materials and to explore their stability and resulting cell reliability.

Sandia's researchers, facilities, and expertise in meeting battery technology needs for national defense are now being employed by JCESR to address the challenge of ensuring a resilient energy infrastructure for the nation.

*“Sandia’s open-source software capabilities are absolutely essential to the rapid ramp-up and impact of CASL on the nuclear engineering industry.”*

**Dr. Doug Kothe**

Director

Consortium for Advanced

Simulation of Light Water Reactors



■ Michael Heroux, Sandia Distinguished Member of Technical Staff and Mantevo Project Co-Leader, stands in front of code from MiniFE, one of the Mantevo miniapps.



# Software Opens Labs Up for Partnership Opportunities

Open-source software is an important collaboration vehicle for Sandia National Laboratories that enhances cooperative research and development efforts. By making open-source software available to public and private institutions and individuals, Sandia creates opportunities for research funding through Cooperative Research and Development Agreements (CRADAs), Work for Others Agreements (WFOs), and other mechanisms which allow for collaboration with corporate and university partners.

Over the last two decades, U.S. Department of Energy (DOE) labs have accelerated the release of more software as open-source and reaped the benefits resulting from increased interactions and collaborations with research partners, industry, and the scientific community. Sandia's open-source software covers most areas of computer modeling and simulation for science and engineering, as well as data analytics.

With more than 20 open-source software products now available from Sandia, the Labs gain important external visibility, enhance their reputation, and attract new talent. As potential employees hear about leading-edge software developed at Sandia that is related to their research areas, the Labs become an attractive place for them to work.

One of the many available Sandia open-source software suites is Mantevo. Winner of a 2013 R&D 100 award, Mantevo is a collection of small software programs, or miniapps, that enable rapid exploration of the design of new high performance computing systems and applications. These programs embody the performance-relevant elements of large-scale

applications in far fewer lines of code, enabling easy execution, analysis, and redesign. Mantevo pioneered a collaboration model that has become increasingly important in the advancement of high-performance computing. As clock speeds are no longer getting faster, computers are becoming more complex with greater numbers of components. In this environment, co-design has become very important. Miniapps have emerged as central to this collaborative development model. Today, every major computer vendor and dozens of university research teams are using Mantevo miniapps for the design of next-generation systems and tools.

Sandia's open-source software is also helping the DOE Consortium for Advanced Simulation of Light Water Reactors (CASL) meet its objectives of deploying advanced computational tools to the U.S. nuclear industry. Sandia researchers are now leading CASL efforts in multiphysics coupling, verification and validation, and uncertainty quantification.

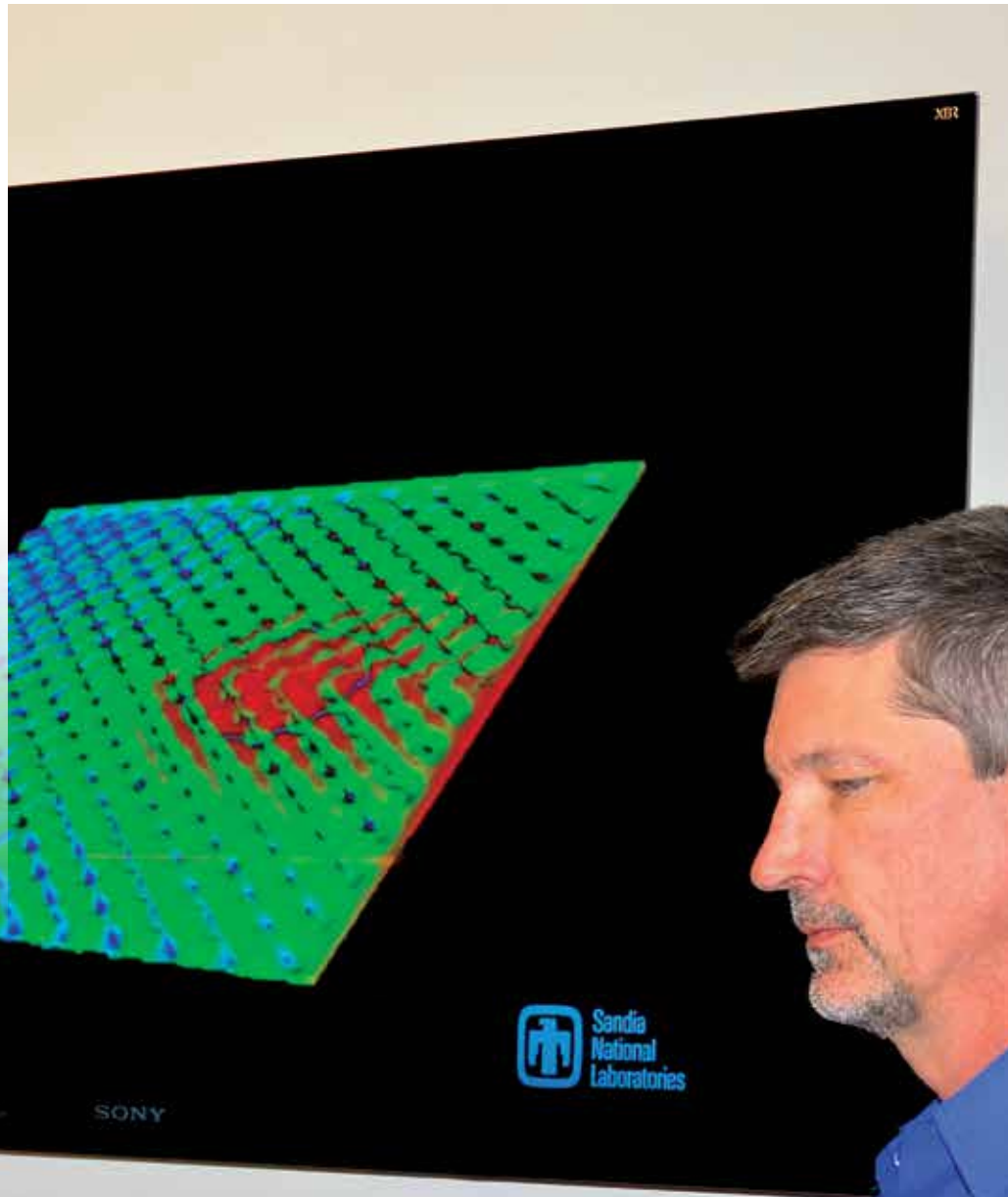
Sandia-developed open-source software, including Trilinos, Dakota, LIME, and Drekar, is being used to create a state-of-the-art "virtual reactor." The Virtual Environment for Reactor Applications (VERA) will run on the world's most powerful computers to enable significant leaps forward in nuclear reactor design, engineering, and operation. The resulting high fidelity computer models and simulations will help extend the life and efficiency of existing nuclear reactors.

There are many other open-source software products available from Sandia that are being used to help solve innumerable scientific and industrial challenges. In 2013 alone, there were over 220,000 downloads of Sandia open-source software. To learn more, visit [software.sandia.gov](http://software.sandia.gov).

*“The partnership with Sandia and access to their world-class modeling and simulation capabilities and staff has been a great resource helping us tackle multiple technical challenges across our businesses.”*

**Dr. Ken Comer**

Senior Engineer  
Modeling & Simulation  
Procter & Gamble R&D



■ Ward Ostendorf, Principal Engineer, Product Development, Procter & Gamble R&D, reviews modeling results.





# Sandia “Rocket Science” Speeds Design of Consumer Products

Why does a multinational manufacturer of consumer products look to Sandia National Laboratories for “rocket science”? Procter & Gamble (P&G) brands touch about 4.8 billion of the nearly 7 billion people on the planet today. In order to keep offering innovation to their customers, P&G needs to deliver products that overcome technical contradictions. Some of these products require absorbent materials including textiles, non-wovens, and paper that are strong, yet soft; that breathe, yet contain liquid; that break, but don’t tear; and that stretch, but don’t break.

Sandia and P&G have been working together for many years, with an Umbrella Cooperative Research and Development Agreement (CRADA) in place since 2002. Originally P&G was part of an industry consortium working with Sandia on software that helped model coatings on porous substrates. To further take advantage of Sandia’s expertise in manufacturing thin film coatings and software modeling, P&G has worked with the Labs on a number of projects targeting technical challenges across the company.

These projects have addressed product performance and, more specifically, the interaction of liquids with specially designed porous, absorbent materials in a variety of configurations. They have also had an impact on product manufacturing through process model designs of everything from paper-making to the deposition of glue beads for product assembly.

Underpinning every project are the fundamentals of incompressible fluid flow

and transport in deformable porous media. Many of P&G’s products in the Family Care, Home Care, and Baby Care business units are designed to take-up, dispense, store, and distribute liquids for everything from the application of lotions and creams, to personal hygiene, and for cleaning and treating everything from skin to floors. Depending on the performance goals, these products comprise various materials and layers. Most products include some sort of thin-porous sheet which is designed for suction (take-up) or fluid storage, and even rapid distribution.

One recent project has addressed reduced-order modeling capabilities to address thin-porous sheets. Specifically, the project studies how such sheets can be designed to interact with the intended environment (spills, lotions, dirt) and how they manage the liquid through take-up or expulsion.

Sandia’s approach to the problem is unique. Rather than using a full three-dimensional simulation which is expensive and doesn’t provide much additional accuracy, a unique reduced-order shell model was developed. Shell models are used to reduce the dimensionality of a problem by integrating out some known or analytically determined portion of the solution in one direction (in this case the thin dimension). The result is a formulation that can be solved more expediently on a two-dimensional sheet.

This approach greatly expedites design studies, through rapid throughput models, while maintaining the necessary accuracy. While still under development, the hope is to incorporate the Sandia-developed models as part of the product design process at P&G.

*“Working with Sandia allows each company to focus on what we do best. Sandia designs cutting-edge microfabricated components and Rockwell Collins can integrate them to demonstrate new radio capabilities.”*

**Jon Lovseth**

Senior Engineering Manager  
Advanced Radio Systems: Receiver  
Exciter Technology  
Rockwell Collins Advanced  
Technology Center

Ken Wojciechowski, Sandia Principal Electronics Engineer, holds a wafer of microresonator filters and oscillators monolithically integrated with CMOS electronics while Troy Olsson (right), Sandia Principal Electronics Engineer, holds a wafer of packaged microresonator filter arrays.



# Microresonators Reduce Mobile Devices' Size and Cost

Cell phones and other mobile devices keep adding functionality, yet continue to get smaller. Electronic integration of components allows more to fit in smaller spaces. But one component was not following this trend until recently—radio frequency (RF) filters. As phones add features, including GPS, Bluetooth, and WiFi, each needs its own RF filter. RF filters provide channel selection, letting many people talk on phones at the same time as each device selects and operates at a different frequency.

Microresonators are miniature acoustic resonators developed at Sandia National Laboratories which have applications in consumer mobile communications and defense. Microresonators will put RF filters on the same track as the other components in mobile communications devices, helping to reduce size and increase functionality, while lowering cost.

These miniature acoustic resonators use complementary metal-oxide semiconductor (CMOS)-compatible microfabrication techniques. This lets multiple filters exist on a single chip that can be integrated with other CMOS electronics

Rockwell Collins has partnered with Sandia since 2008 under a Cooperative Research and Development Agreement (CRADA), and licensed the patented microresonator technology in 2010. The aerospace and defense company, which specializes in communication and aviation electronics, is excited about the potential of microresonators to improve both their commercial and military products. When applied to RF filtering in high performance

defense radios and radars, microresonators can reduce size and cost by more than 100 times.

In 2011, Sandia's microresonator technology won an R&D 100 Award. Since then, some of the remaining challenges to commercialization have been overcome by the Rockwell Collins-Sandia team.

The first oven compensated MEMs oscillator was produced this year. An oven is used on traditional quartz oscillators to heat the entire metal package can above the ambient atmosphere, so the oscillator can stay on frequency. Microresonators, on the other hand, can be compensated by embedding a heating element directly on the surface of the device. Heating the surface of the resonator uses only 10 milliwatts of power while providing high levels of thermal stability.

Also, after a two-day tutorial by Troy Olsson, one of the Sandia microresonator inventors, Rockwell Collins engineers have been able to design filter arrays for their products which were then fabricated by Sandia and delivered packaged and ready to surface mount so they could be assembled on a printed circuit board like any other integrated circuit die. Finally, the partners are working together to search for a commercial supplier who can produce microresonators at higher volumes than is currently possible using Sandia facilities.

This is all part of the maturation of the technology, which is now ready to go out into the marketplace and become a component in multiple devices thanks to the efforts of the successful Sandia-Rockwell Collins partnership.

*“USNORTHCOM’s partnership with Sandia has resulted in successfully demonstrating a microgrid that was designed with cyber security and mission assurance from the start. We look forward to continued National Lab support as we move into Phase 3.”*

**Randy Zeller**

Director

Interagency Coordination

NORAD and USNORTHCOM

Colorado

■  
Bill Waugaman, Energy Security Lead and SPIDERS Operational Manager, plugs in an electric vehicle to one of the bidirectional charging units at Fort Carson.





# Microgrids Ensure Military Power and Ultimately Domestic Grid

SPIDERS is helping the military to improve its mission assurance, lessen its “carbon footprint,” and ultimately, continue to operate during prolonged electric grid outages. The Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS) is a three-phase multi-agency project being conducted under a Memorandum of Understanding (MOU) between the U.S. Department of Energy (DOE) and Department of Defense (DoD).

Sandia National Laboratories was selected as the lead designer for SPIDERS. The project builds on Sandia’s long-term experience with microgrids, localized grids that generate and consume power, and can run connected to or independent of the larger utility grid. The vision of SPIDERS is to create cybersecure microgrids which match energy system assets (generation and storage) to mission critical needs. The microgrids will be resilient to power disruption, protected against cyber attack, and include sustainable energy practices.

The SPIDERS microgrids combine renewable energy sources with a more traditional backup power source, diesel generators. Smart, cybersecure microgrids allow solar, hydrogen fuel cells, wind, and other alternative energy sources to be integrated into the system during grid outages, reducing petroleum demand. While it uses existing technologies, SPIDERS combines them in a new way and is demonstrating them in an operational military installation environment.

Microgrids are being installed at three DoD bases and tested to see if they are meeting their goal of

handling mission-critical electric demands during simulated power outages. Phase 1 was tested at Joint Base Pearl Harbor-Hickam, Hawaii, in January 2013. Results showed a 39-fold increase in power reliability while achieving a 30.4% diesel fuel savings and 90% renewable energy penetration.

In Phase 2, a 72-hour operational demonstration was completed in October 2013 at Fort Carson, Colorado. The demonstration was deemed a success and an assessment showed that the microgrid could sustain mission-critical capabilities in the event of a long-term electrical outage. In Phase 3, to be run at Camp Smith, Hawaii, in 2015, the entire base’s electrical distribution will be a collection of microgrids, with significant renewable energy and storage included.


The microgrid tested at Fort Carson includes five electric vehicle supply equipment (EVSE) bidirectional charging units. The EVSE bidirectional units can provide up to 300 kW of power to plug-in electric vehicles. Yet when needed, the same amount of energy can be discharged from the vehicle batteries back to the microgrid. This validated an important concept that had been discussed for years, but which had never been demonstrated.

SPIDERS partners include five national laboratories, the military services, electric utility associations, and state governments. The large array of SPIDERS partners from both the public and private sectors means that the lessons learned from DoD microgrid applications can be transitioned to domestic utility and grid upgrade applications. The lessons learned will benefit the government and public, ultimately leading to more resilient and cybersecure electric distribution.

*“Our relationship with Sandia began in 2007 and they have always supported us in our mission of being the leader in optical fibers for harsh environments. We are pleased to have exclusivity on this patented technology.”*

**Dr. Abdel Soufiane**

President and CEO  
Verrillon



■ Jeff Mayfield, Verrillon's Senior Glass Technologist, works on creating a hydrogen-resistant glass preform for drawing into optical fibers with hermetic and high temperature coatings.



# Optical Fiber Technology Improves Drilling Sensor Data

Sandia National Laboratories researcher Jonathan Weiss worked with the Labs' geothermal program to come up with a solution to the problem of sensors being used to monitor geothermal wells losing transmission. Hydrogen was diffusing into the optical fibers being used to transmit data, particularly at high temperatures. His solution? Optical fiber designed to withstand hot, hydrogen-rich environments.

The Sandia technology was patented in 2005, but since the Labs generally invent technology, and don't manufacture it, the Downhole Hydrogen-Resistant Optical Fiber was not immediately produced and put to use.

Dr. Abdel Soufiane of Verrillon heard about the Sandia optical fiber technology. An inventor and businessman, he saw the potential of applying the Sandia technology to oil and gas in addition to geothermal wells. His company secured a nonexclusive license in 2007 and commenced research and development to move the patented intellectual property (IP) towards a commercial product.

Both steam injected oil wells and geothermal wells have extreme downhole conditions, where heat, hydrogen, and corrosive chemicals can affect the reliability of standard optical fibers. Distributed temperature sensors are used to measure temperature along the entire length of a wellbore, which in some wells, might be miles deep. Regular optical fibers can be used under lower, more normal temperature conditions, but for harsh environments, a more robust fiber was needed.

The core of the Hydrogen-Resistant Optical Fiber is doped with fluorine to give it the correct refractive index profile and allow it to resist the formation of OH (hydroxide) ions when hydrogen diffuses into the fiber at high temperatures. It is the OH ions that cause the problem with optical transmission. Conventional fibers contain germanium as the dopant in the core, but this element does not resist the formation of OH ions.

Verrillon's product line incorporating Sandia optical fiber technology was introduced in late 2010. The VHM 5000 series products help Verrillon customers increase the accuracy of their sensor-generated data.


By using hydrogen-resistant optical fiber, the useful life of distributed temperature sensors is greatly extended and costs are reduced. This family of optimized glass, graded index, multimode optical fibers is ideally used in high temperatures (up to 300° C), hydrogen-rich and corrosive environments.

Late in 2012 the Sandia license was amended. Verrillon converted its nonexclusive license to an exclusive license for its field of use. Today, Verrillon is selling over \$1 million in products based on this licensed Sandia IP. Sandia receives royalties on these sales. Verrillon and its customers who use the fiber in their own systems receive the benefits of patent-protected Sandia technology brought into the commercial marketplace by a licensing partner.

# SCALED WIND FARM TECHNOLOGY FACILITY

*“The partnership between Sandia, Texas Tech University, Vestas, and Group NIRE resulted in the creation of a state-of-the-art facility to investigate turbine-to-turbine interaction, optimize new and existing wind farms, and ultimately, lower the cost of energy.”*

**Dr. John Schroeder**  
National Wind Institute  
Texas Tech University

A photograph of two large wind turbines at sunset. The sky is filled with colorful clouds in shades of orange, yellow, and blue. The sun is low on the horizon, creating a bright glow. The turbines are silhouetted against the sky. The turbine on the right is closer and more prominent, while the one on the left is further away.

■ The DOE/Sandia SWiFT facility allows for rapid, cost-efficient testing and development of transformative wind energy technology, with specific emphasis on improving wind plant performance.



# Testing Facility Increases Wind Farm Efficiency

Lowering the cost of wind energy will reduce the dependence on foreign sources of energy and decrease U.S. carbon emissions. To help achieve that goal, work needs to be done to increase the efficiency of wind farms. Some estimates show that from 10 to 40% of production and revenue are lost due to turbines shadowing each other, reducing the output of turbines located in their wake.

The U.S. Department of Energy (DOE)/ Sandia National Laboratories Scaled Wind Farm Technology (SWiFT) facility is the first in the U.S. specifically built for the study of wind farms. SWiFT brings together Sandia's expertise in wind energy with the resources of Texas Tech's National Wind Institute. Sandia has been working in the field since 1973 and Texas Tech had been conducting interdisciplinary research in wind science for decades. The Sandia Wind Energy Technologies Department's strength in the design and innovation of wind rotors, facilitated by their skills in advanced instrumentation and data acquisition, is complemented by Texas Tech's focus on wind and weather research.

The partnership between Sandia and Texas Tech is further enhanced by industry partner, Vestas, a leading wind turbine manufacturer, and Group NIRE, a renewable energy development company that is helping to fill the gap between research and commercial production of power. A Memorandum of Understanding (MOU) among the partners allows for use of the SWiFT facility for both collaborative and proprietary research.

Located near Lubbock, Texas, in a consistently windy location, SWiFT was commissioned in

July 2013. It currently has three heavily instrumented and modified variable-speed, variable-pitch Vestas V27 turbines on site, but is designed for the future addition of more, up to a total of ten. Power produced by SWiFT's turbines is already generating revenue which is being used to fund graduate research at the Texas Tech National Wind Institute.

The facility uses medium-scale turbines that offer significant advantages. Their size allows for rapid, cost-efficient testing—research that is 10 to 100 times less costly than research conducted using full-scale turbines. The data from these mid-sized turbines is collected by state-of-the-art synchronized control and data acquisition systems, and is relevant and scalable for both researchers and industry.

Research is currently focusing on several areas, including turbine-turbine interaction. SWiFT is the first facility to study the impact of turbine spacing and wind conditions on power production. One way to improve performance being studied is wind farm control, or using a controller to manage and monitor all the turbines collectively, rather than just individually.

As a DOE testing facility run by Sandia, SWiFT also offers opportunities for collaborative research and development conducted by other universities, labs, and companies beyond the key partners who are part of the MOU. Partnership opportunities and proprietary research can be facilitated through Cooperative Research and Development Agreements (CRADAs), Work for Others agreements (WFOs), joint funding opportunities, or other mechanisms.

For more information, visit [swift.sandia.gov](http://swift.sandia.gov).

*“Partnership with Sandia’s world-leading expertise in nanoscience and computational biology is critical for the team to understand the subtle biomimetic processes in nanosystems, which in turn has led to the revolutionary designs of high-performance membranes.”*

**Dr. Ying-Bing Jiang**

Assistant Research Professor and  
Manager of Transmission Electron  
Microscopy and Focused Ion Beam  
Laboratories  
University of New Mexico



■ Yaqin Fu, UNM Postdoc, assembles an atomic layer deposition reaction chamber used in fabrication of the biomimetic CO<sub>2</sub> membrane, as (left to right) Ying-Bing Jiang, UNM Assistant Research Professor, Susan Rempe, Sandia Researcher and UNM Adjunct Professor, and Jeff Brinker, Sandia Fellow and UNM Distinguished and Regent’s Professor, look on.



# Biomimetic Membranes Clean CO<sub>2</sub> from Air with Enzymes

With the growing concern about global warming caused by CO<sub>2</sub> emissions, there is an immediate and urgent need for efficient CO<sub>2</sub> capture and reuse.

About 80% of the CO<sub>2</sub> added to the air annually is removed through either dissolution in the oceans or absorption by living organisms. Since water dissolution is slow and indiscriminate, researchers are studying how natural systems trap CO<sub>2</sub> and how it might be separated from a mixture of gases. Nature uses membranes for separating molecules, and enzymes to catalyze CO<sub>2</sub> absorption in water. By translating the molecular designs of biological membranes, and incorporating enzymes, biomimetic membranes can be developed.

A team of researchers from Sandia National Laboratories and the University of New Mexico (UNM) have worked together since 2004 on biomimetic membranes. Their joint efforts led to a 2011 R&D 100 award-winning membrane for water purification that improves access to clean water. That membrane mimicked the nanoscale pore design of cellular membranes that filter water in the human body.

The Sandia-UNM team's latest success applies biomimetic membranes to CO<sub>2</sub> capture. UNM Assistant Research Professor Ying-Bing Jiang is fabricating membranes in his lab based on a nanoporous platform developed by Jeff Brinker, a Sandia Fellow and Distinguished and Regent's Professor of UNM. Modeling work done by Sandia Distinguished Member of Technical Staff and UNM Adjunct Professor Susan Rempe guides membrane design.

Biomimetic membrane technology depends on advanced synthetic strategies, including molecular self-assembly of nanoporous membranes and atomic layer deposition to tailor pore geometries and interior surfaces. Theoretical studies reveal how nanopores stabilize water solutions and how biological enzymes in those solutions speed up CO<sub>2</sub> dissolution. Those insights are important to optimize pore design and enzyme function for commercial applications.

The current biomimetic membranes trap water droplets within the nanopore structures. Each water droplet contains enzymes that specifically convert CO<sub>2</sub> into bicarbonate, a charged molecule that is highly soluble and moves rapidly across the water layer. On the other side of the membrane, the enzyme carries out the reverse reaction, converting bicarbonate back to CO<sub>2</sub>. Thus, the liquid-layered membrane permits highly efficient CO<sub>2</sub> absorption from power plant flue gas and produces pure CO<sub>2</sub> gas for reuse in oil recovery.


Compared to conventional CO<sub>2</sub> absorption methods, biomimetic membranes provide a simple, compact, and more energy-efficient approach. Biomimetic membranes also separate CO<sub>2</sub> from mixtures of gases faster and with higher selectivity than other membranes.

Future applications for the Sandia-UNM team's work might include embedding multiple types of enzymes that convert CO<sub>2</sub> to fuel, or tuning the membranes to transport ions for efficient power generation from seawater. The potential for biomimetic membranes to help clean up our air and water or lower the cost of power generation will continue to be developed by the Sandia-UNM collaborative partnership.

*“By supporting his research work at the University of Florida, and by also providing him with the opportunity to cooperate with Sandians on important security-related problems, the Sandia Campus Executive Program is helping Deon Burchett grow as a researcher and is giving him tools to address tomorrow’s grand challenges.”*

**Dr. Jean-Philippe Richard**

Associate Professor  
Industrial and Systems Engineering  
University of Florida



John van der Laan, PhD candidate from the University of Arizona, readies some experiments to test the propagation of polarized light through fog generated in Sandia’s environmental testing facilities.



# Relationships with Universities Advance Research and Recruiting

Sandia National Laboratories' university partnerships foster collaborations that advance cutting-edge science and engineering. Sandia partners with key universities to conduct world-class science, identify and hire many of the nation's best scientists and engineers, and develop strategic collaborations in focused research challenge areas.

The Campus Executive Program is one of the programs managed by the University Partnerships Office. It pairs Sandia executives with university officials at schools that share research interests and capabilities. As part of these efforts, Sandia funds student research projects to establish relationships with students, develop capabilities, and build long-term relationships with faculty.

John van der Laan, a PhD candidate from the University of Arizona, is one of the students currently taking part in the Campus Executive Program. He and his Sandia mentors, David Scrymgeour and Shanalyn Kemme, are looking at how people can see better where their vision is obscured by fog, dust, or other scattering particles. His research is inspired by the mantis shrimp, an animal with one of the most complicated vision systems known. With 16 color channels, the shrimp can see not only with linear polarization, but also with circular polarization.

How humans can take advantage of polarized light to see more clearly and farther, especially in turbid environments, is of interest to Sandia for applications including its national security missions, environmental monitoring, and oil

spill cleanup. The Campus Executive Program funds John's research while at the University of Arizona as he does computer simulations, and in the summers, he can come to Sandia to do experimental work to verify his simulation work, teaming with Sandia's researchers and making use of Sandia facilities and equipment.

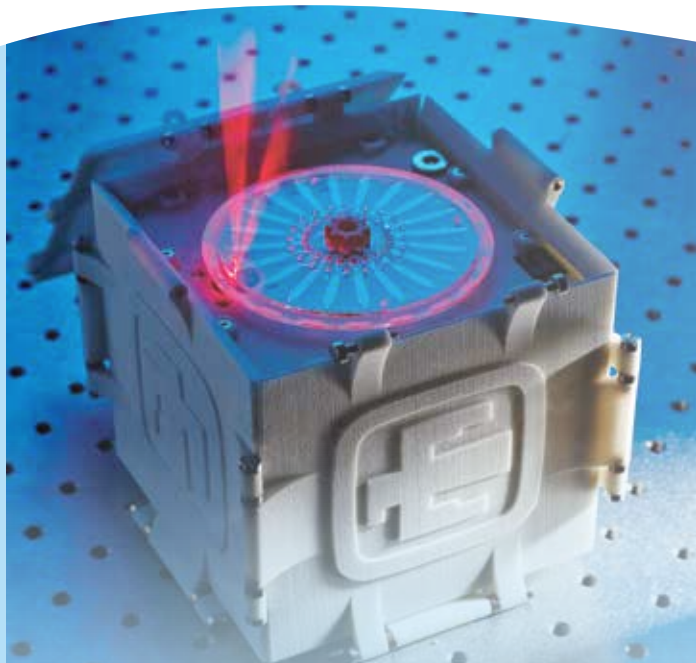
Deon Burchett, a PhD student from the University of Florida, is another participant in the Campus Executive Program. His research, being conducted with Sandia mentors Cindy Phillips, Richard Chen, and Regan Stinnett, is focused on multicommodity network design.

The multicommodity flow problem optimizes the movement of products through networks such as transportation or telecommunications networks. Burchett, along with his university advisor, Jean-Philippe Richard, discovered a new mathematical constraint that could allow solvers to find optimal flows faster.

Burchett learned Pyomo, a new modeling language from Sandia that allows him to consider a more complex problem: designing robust networks. His results may have applications in building networks that will be resilient to attack, either by an adversary or forces of nature. His work extends previous Sandia research to designing networks with asymmetric channel capacities.

Established in 1997, Sandia's Campus Executive Program continues to help the Labs further their research, interact with university faculty and PhD candidates, and attract the best students as future Sandia employees.

# Lab-on-a-Disk Spins Off Multiple Testing Products



**N**eonatal sepsis, a bacterial infection in the blood, is one of the leading causes of death in newborns. It takes 24 – 48 hours to get results from current test methods, and a high volume of blood must be drawn—a challenge when you’re dealing with a tiny infant.

Routine screening for sepsis may soon be much faster and easier with a point-of-care diagnostic tool being developed by Sandstone Diagnostics. The company is using Sandia National Laboratories’ SpinDx™ platform as the basis for an instrument that can diagnose the condition in about 15 minutes, with just a small drop of blood.

Sandstone Diagnostics was founded by Greg Sommer and Ulrich Schaff, former Sandians who are licensing the SpinDx, which they invented together with other Sandians. The company’s long term goal is to manufacture and sell instruments and disposable test kits for different medical testing applications based on SpinDx technology. Sandstone is also working on an over-the-counter male fertility test kit which would allow for semen analysis at home.

Under a National Institutes of Health (NIH) Small Business Innovation Research (SBIR) grant, Sandstone

is working with researchers at Stanford University to look at blood-based biomarkers for earlier detection of sepsis proteins and cell markers. The new tool would require less blood (a few drops from a heel stick vs. a venous draw), and would provide faster results, allowing the appropriate therapy to begin sooner, giving the affected babies a better prognosis.

Originally developed for biodefense applications with funding from a Laboratory Directed Research and Development (LDRD) project and the NIH National Institute of Allergy and Infectious Diseases (NIAD), SpinDx is a lab-on-a-disk, using 4-inch plastic CD-like disks with etched microfluidic channels containing beads designed for specific assays.

Test samples are placed on the disks which are then spun in a “reader” device. SpinDx combines bead-based assays with sedimentation to separate the beads, which differentiates it from other centrifugal devices.

SpinDx has both medical and non-medical applications, ranging from detection of markers of infectious diseases to food and water safety testing. It can quickly complete a variety of lab screening tests and be used by people with minimal scientific training, in a lab or in the field. Instead of waiting days for results, a sample is placed on the disk in the small SpinDx device and results are available in minutes. A new test can be run as soon as a different disk is inserted, making it highly versatile.

The new product Sandstone Diagnostics is introducing for the neonatal market is just the first of what may soon be many based on the SpinDx platform. The technology has been licensed by several companies that are working on point-of-care diagnostics testing, water pathogen testing, and other applications.



■ Anup Singh, Sandia Senior Manager, holds a SpinDx disk. The SpinDx device features centrifugal microfluidics, or “lab-on-a-disk” technology, which uses centrifugal forces to manipulate samples and reagents through microfluidic channels implanted on disks that are of the same size as a standard CD or DVD.

“Our team is ecstatic to take SpinDx from the research bench to the commercial space. As former Sandians, it’s so exciting to be a part of this cutting edge technology that was born out of urgent biodefense needs, but has grown into a high performance healthcare platform.”

**Dr. Greg Sommer**  
Chief Executive Officer  
Sandstone Diagnostics



*“The partnership with Sandia’s world-class research team has provided a strong foundation for U.S. manufacturers to build upon. This technology has the potential to enable the introduction of other state-of-the-art technologies in a wide range of advanced building equipment.”*

**Antonio M. Bouza**

Technology Manager  
HVAC, Water Heating and  
Appliances  
Building Technology Office  
U.S. Department of Energy

■ Lower cost manufacturing options for the Sandia Cooler are discussed by (left to right), Jeff Koplow, Sandia Principal Member of Technical Staff, Daniel Matthew, Sandia Senior Technologist, and Imane Khalil, Sandia Cooler Program Manager.

# A New Way to Move Heat Cuts Energy Use in Buildings

The U.S. Department of Energy (DOE) Building Technology Office (BTO) is looking for new technologies to reduce building energy use. Heat exchangers are used everywhere in our homes and buildings—in HVAC systems, refrigerators, and other appliances. So when the radically different Sandia Cooler technology was first presented, BTO Technology Manager Antonio Bouza immediately saw its potential to not only replace current heat exchangers, but to enable other innovative, cost-effective, energy-saving technologies.

Heat exchangers are used to move heat to and from a wide range of equipment such as computers, refrigeration, heating, air conditioning, and nearly every application that generates waste heat—accounting for 53% of building energy consumption. As the biggest transformation in air cooled heat exchangers since the 1960s, there is huge interest in the Sandia Cooler for a variety of markets.

This technology solves the key heat transfer bottleneck—the boundary layer of dead air that clings to cooling fins in conventional coolers' heat sinks. The Sandia Cooler provides a dramatic increase in cooling performance without resorting to exotic methods. It is exceptionally quiet, highly resistant to dust fouling, smaller than state-of-the-art alternatives, and relatively simple to manufacture.

Invented by Sandia National Laboratories researcher Jeff Koplow, Principal Member of Technical Staff, and his team, the technology has generated multiple patents and patent filings. In 2012 the Sandia Cooler won an R&D

100 Editor's Choice Award, giving the invention even more visibility. Subsequently, more than 50 companies have expressed interest in licensing this technology from Sandia.

Sandia Cooler technology was originally funded by Sandia's Laboratory Directed Research and Development (LDRD) program. With additional funding from the BTO, work to refine the technology and scale it for a variety of applications has accelerated.

Support from the BTO is not limited to funding—they also help move technology to the marketplace. Their mission and connections allow them to introduce technologies to relevant manufacturers and researchers. Besides its potential for cooling computers, HVAC systems, and large appliances, cooling for LED lighting is also being explored. Axial and radial flow variants, along with scalability, help make the Sandia Cooler extremely adaptable. Currently, BTO funding is enabling prototypes to be built at the Labs, so companies can use them to see how the technology might be integrated into their own products.

A DOE-funded project announced in August, 2013 with the United Technologies Research Center (UTRC) will demonstrate the Sandia Cooler technology for residential HVAC systems. The heat pump will improve HVAC system cycle efficiency and increase the use of heat pumps in colder climates. UTRC is the central research organization of United Technologies (NYSE:UTX), and advances technologies that support Carrier heating, air-conditioning and refrigeration solutions, along with research support for other United Technologies businesses.



# ANTHRAX DETECTION CARTRIDGE

*“Aquila sees a lot of business potential for the Anthrax Detection Cartridge and its variants among our government and commercial customers.”*

**Dr. Markku Koskelo**  
Chief Scientist  
Aquila

■ Markku Koskelo, Chief Scientist, and Judy Beckes Talcott, President, Aquila; discuss integration of Sandia and Aquila technologies with Thayne Edwards, Senior Member of Technical Staff, Sandia.

# Portable Anthrax Testing Now Possible with Card-sized Device

Anthrax poses a significant threat to U.S. national security as demonstrated by the 2001 terrorist attacks targeting the U.S. Postal Service and Hart Senate Office Building in Washington, D.C. The causative agent, *Bacillus anthracis*, is ubiquitous worldwide, making this an international concern.

Anthrax outbreaks are common in livestock globally, and pose significant risks to animal and public health. Diagnosis often requires isolation and culture of the organism, which can be extremely dangerous if not carried out in appropriate laboratory conditions. These conditions are often absent in low-resource environments, creating safety and security risks in countries where diagnosis of the disease is critical for animal and/or public health purposes.

A Laboratory Directed Research and Development (LDRD) project at Sandia National Laboratories to develop an anthrax detection sensor for low-resource environments has resulted in the Anthrax Detection Cartridge, an inexpensive, fast, and portable device that requires no power to run, and minimal training to operate. It provides highly reliable anthrax detection in controlled environments, rivaling the selectivity of rigorous laboratory analysis.

The Anthrax Detection Cartridge is a self-contained, credit-card sized test system which cultures a sample in a patent-pending amplification chamber using selective growth media. It tests it with a lateral flow assay (LFA) to determine if it is dangerous anthrax, and

then eliminates the sample threat with disinfectant. Once a sample is inserted, patent-pending magnetically operated valves allow the sample to advance from stage to stage to complete the testing process.

Aquila, a woman-owned small business based in New Mexico that specializes in the design and manufacture of technologies and services for nuclear security and international safeguards, is licensing the Anthrax Detection Cartridge technology and is getting ready to manufacture the devices. They see a lot of potential for their government customers as well as commercial markets. With minor modifications, simply swapping out the selective growth medium and LFA strip, the cartridges can be adapted to detect other bacteria, such as salmonella in agricultural settings, as well as bacteria of medical interest.

While Aquila has licensed other Sandia technologies in the past, they are particularly enthusiastic about the Anthrax Detection Cartridge. They feel that the technical support and collaboration with Sandia researchers, as well as the smooth and rapid licensing process, have both been excellent. An Umbrella Cooperative Research and Development Agreement (CRADA) between Aquila and Sandia should result in more collaboration on this and other joint projects.

The Anthrax Detection Cartridge is a sophisticated and complex device that has become successful due to its engineered simplicity. Sandia is continuing to refine the technology and adapt it for other markets interested in rapid detection of biological hazards.



## EMCORE Solar Farm Powers Company Headquarters in Park

EMCORE Corporation has completed a new 17-acre solar power array project, located next to its corporate headquarters in the Sandia Science & Technology Park (SS&TP). Situated on a former landfill, the \$10 million, 2-megawatt solar farm provides about 20% of the energy requirements of EMCORE's two buildings in the SS&TP.

The solar farm represents a partnership between Suncore Photovoltaics, a leading provider of Concentrator Photovoltaics (CPV) solar modules, and EMCORE, a leading provider of components and subsystems for the fiber optic and solar power markets, along with PNM, the primary electric utility company in New Mexico. Partnerships with Bernalillo County, the New Mexico State Land Office, City of Albuquerque, Folium Energy, and the SS&TP also helped bring this project to fruition.

The Eubank Landfill Solar Array project was supported by PNM's solar incentive program and is the largest commercial distributed power generation project in the state of New Mexico. The site features Suncore's Gen-3 CPV solar systems in combination with traditional silicon PV solar panels. The Suncore

CPV modules incorporate EMCORE CPV solar cells developed and manufactured in Albuquerque. Some of the modules are mounted on dual-axis trackers to better match peak energy consumption than fixed tilt photovoltaics.

Due to the success of their photovoltaics business in Albuquerque, EMCORE moved its headquarters from Somerset, New Jersey, to the SS&TP in 2006. Currently, EMCORE employs approximately 300 employees in Albuquerque. Facilities at the SS&TP are at the center of the company's design and manufacturing of space and terrestrial solar cells, as well as corporate functions.

EMCORE's location in the SS&TP has also enabled a strong synergistic relationship with various Sandia technical groups. Sandia has supported EMCORE product development activities through several partnership agreements, and the company is currently advising Sandia on the development of a next-generation solar technology.



**The 2-megawatt Solar Farm at the former Eubank Landfill.**







Daniel Dedrick, Sandia Hydrogen Program Manager, welcomes new H2FIRST partner, Catherine Dunwoody, of the California Fuel Cell Partnership.

## Partnership Fills a Need for Fuel Cell Vehicle Fill-ups

Hydrogen fuel cell electric vehicles (FCEVs) will soon be appearing on American roads, but they won't get very far without gas stations where they can refuel. Sandia National Laboratories and the National Renewable Energy Laboratory (NREL) have joined forces to leverage their expertise in support of industry and government efforts toward the widespread deployment of hydrogen fueling infrastructure.

The mission of the Hydrogen Fueling Infrastructure Research and Station Technology (H2FIRST) partnership is to ensure that FCEV customers have a positive fueling experience similar to conventional gasoline/diesel stations. This will smooth the introduction of FCEVs to the market and support the transition to advanced fueling technologies beyond 2017.

H2FIRST's high-level technical goals are focused on reducing the cost and time to build fueling stations while improving station availability and reliability. H2FIRST will develop and apply physical testing, numerical simulation, and technology validation capabilities to support U.S. industry innovation for new, low-cost, high-performance materials, component

technologies, and station architectures. H2FIRST will collect and distribute data supporting industry's efforts to reduce the costs of integrated fueling systems and networks. H2FIRST will also work on integration of renewable hydrogen and the power grid through development, optimization, and validation of technologies that enable distributed generation of renewable hydrogen in a broader energy ecosystem.

As the lead partners for H2FIRST, Sandia and NREL will share their hydrogen research and engineering expertise in hydrogen-specific materials and systems engineering. Two research facilities, Sandia's Center for Infrastructure Research and Innovation (CIRI) and NREL's Energy Systems Integration Facility (ESIF), will provide core capabilities for H2FIRST. The H2FIRST partners will make use of CIRI's new hydrogen fueling research station under construction on the Livermore Valley Open Campus.

The success of H2FIRST is ensured by meaningful partnerships with companies and organizations in the automotive, energy and industrial gas sectors, fuel cell manufacturers, station component providers, state and regional government agencies, and research institutions.

## Keeping Medicines Cool Without Electricity

Vaccines must be kept cold or they're ruined. A refrigerator might seem to be the logical answer. But when you're dealing with medical clinics in the developing world where the electricity supply may not be reliable, a different solution is needed.

Knowing that millions of lives could be saved if only biologic vaccines for hepatitis B and other diseases could be shipped and stored at the proper temperatures, SAVSU President Bruce McCormick developed the NanoQ. This container uses ice and nanoporous insulating material to maintain the 2–8° C temperatures vaccines require.

The NanoQ is designed for long-term storage of vaccines in remote areas, and the ice needs to be replenished every 7–10 days. Yet how can ice be produced without electricity or batteries?

Solar thermal ice making is the elegant solution that meets these requirements. With technical assistance from the New Mexico Small Business Assistance (NMSBA) Program, SAVSU was able to work with some of the world

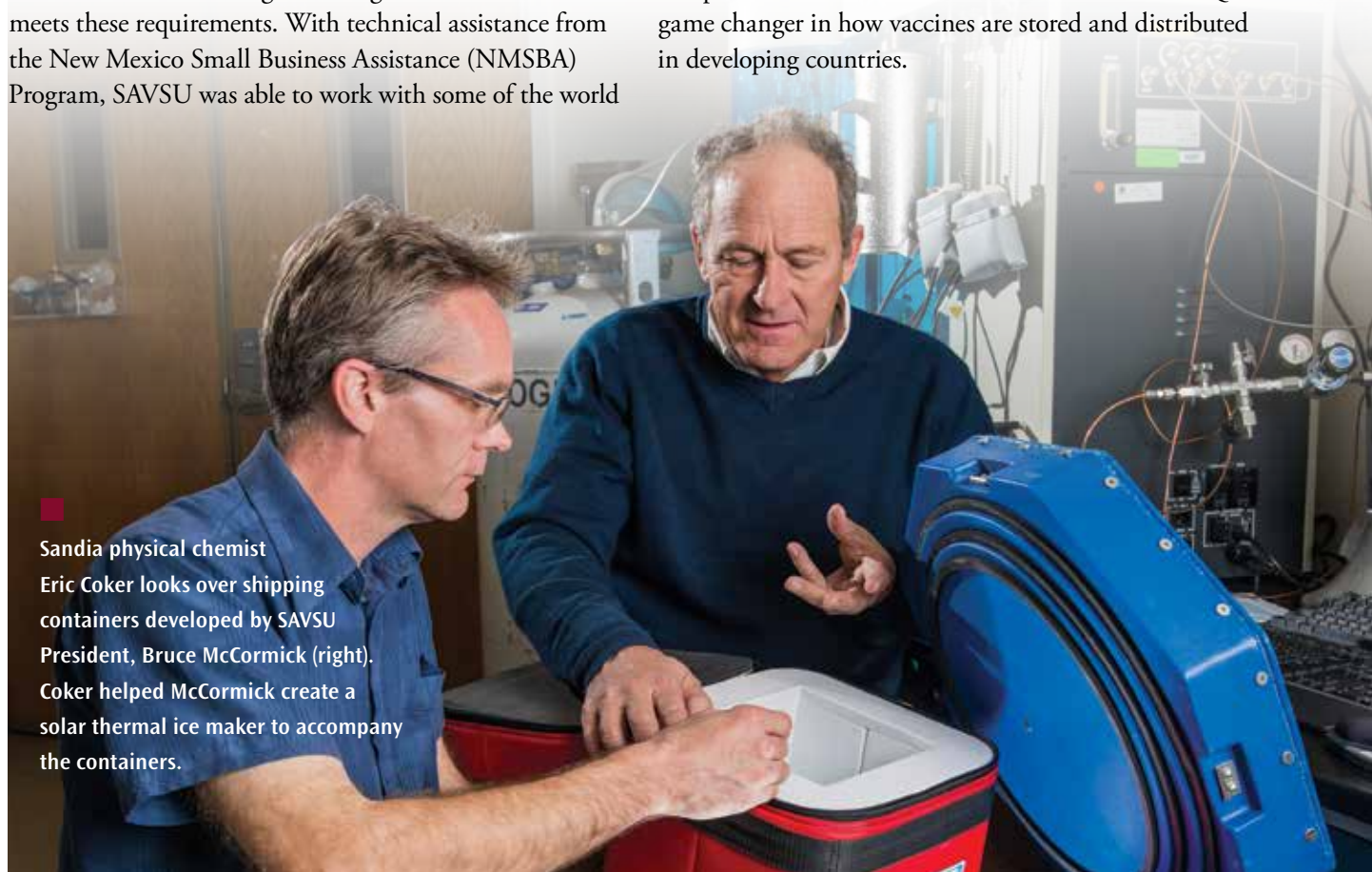
leaders in solar thermal at Sandia National Laboratories. The NMSBA Program allows Sandia to provide small businesses in New Mexico access to laboratory experts who help them solve technical challenges.

Together, Sandia and SAVSU built on previous research to develop an optimal design for a solar thermal ice maker sized appropriately to accompany the NanoQ. It requires no electricity, and has no motor, fan, or other moving parts.

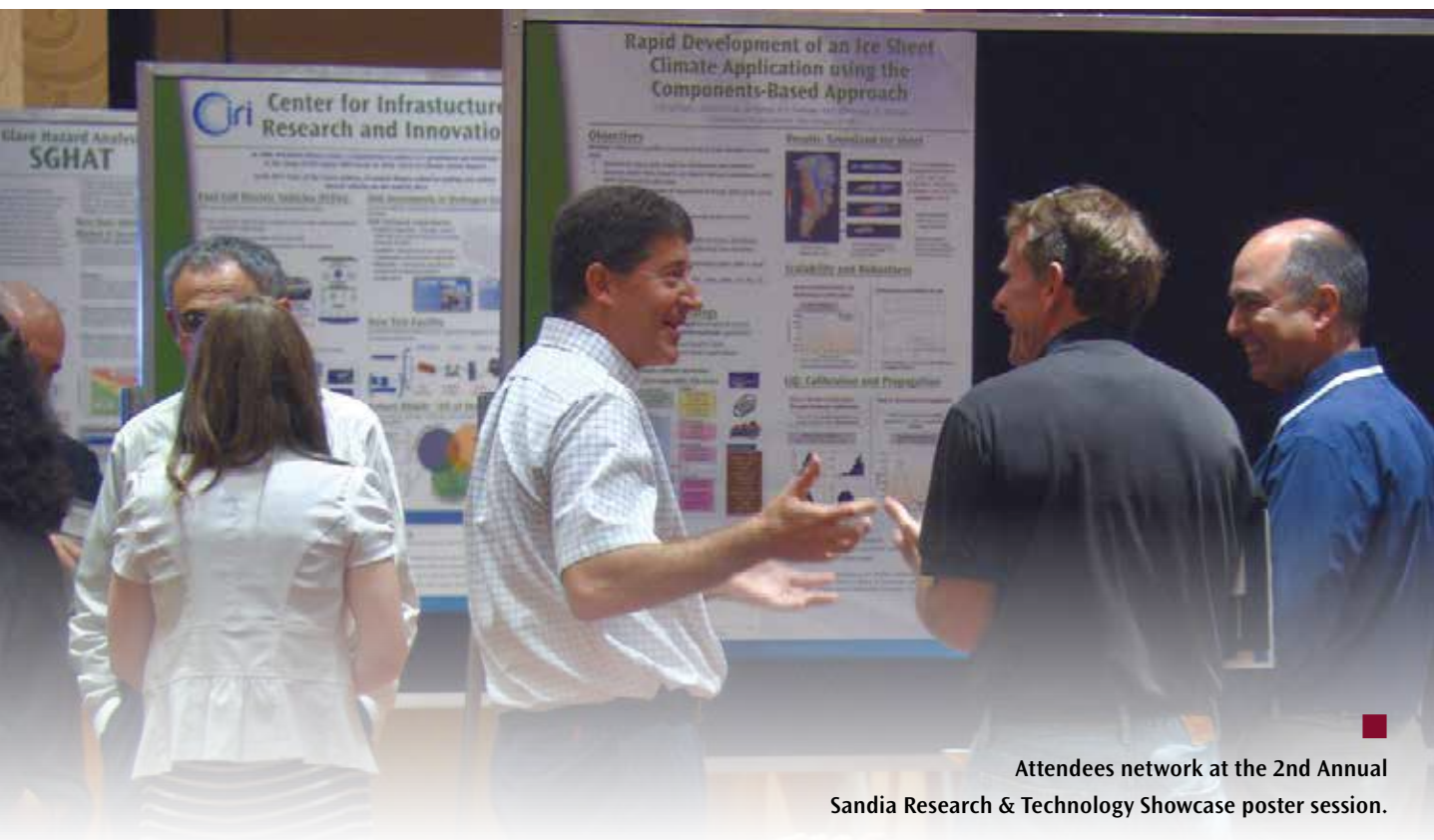
The NanoQ is currently being used at community health centers in Asia, Africa, and Latin America. With a specification recently written by the World Health Organization (WHO), the NanoQ can now be purchased by organizations that require WHO approval for funding of products used in their vaccination programs.

Coupled with the solar thermal ice maker, the NanoQ is a game changer in how vaccines are stored and distributed in developing countries.

Sandia physical chemist Eric Coker looks over shipping containers developed by SAVSU President, Bruce McCormick (right). Coker helped McCormick create a solar thermal ice maker to accompany the containers.







Attendees network at the 2nd Annual Sandia Research & Technology Showcase poster session.

## Shining a Spotlight on What Sandia Has to Offer

Julia Phillips, Sandia National Laboratories Vice President and Chief Technology Officer, invited attendees of the second Annual Sandia Research & Technology Showcase to “taste from the smorgasbord” of technologies being put before them at the day-long event.

After a successful launch in 2012, the 2013 Showcase provided an opportunity to learn about some of the cutting-edge research and technology taking place at Sandia and how to do business with the Labs. A diverse roster of speakers, including Sandians and business leaders, discussed research and partnerships, technology transfer, available intellectual property, partnership success stories, economic development programs, and university partnerships.

Forty technical posters spotlighted Sandia work in four thematic areas: bioscience, computing and information science, energy and climate, and nanodevices and microsystems. Attendees were able to discuss

technologies with principal investigators during the afternoon poster session. They were also able to speak with Sandia and New Mexico representatives about potential business opportunities and network with other attendees.

The free event drew attendees from eight states, including representatives from industry, academia, and government, as well as venture capitalists and entrepreneurs. The Labs sponsored the event with other organizations in the community, including Bernalillo County, City of Albuquerque, New Mexico Economic Development Department, New Mexico Manufacturing Extension Partnership, Sandia Laboratory Federal Credit Union, Sandia Science & Technology Park Development Corporation, and Technology Ventures Corporation.

For more information about the Sandia Research & Technology Showcase, visit [www.sstp.org/showcase](http://www.sstp.org/showcase).

## Sandia Micro Tech Helps HT Micro Continue to Grow

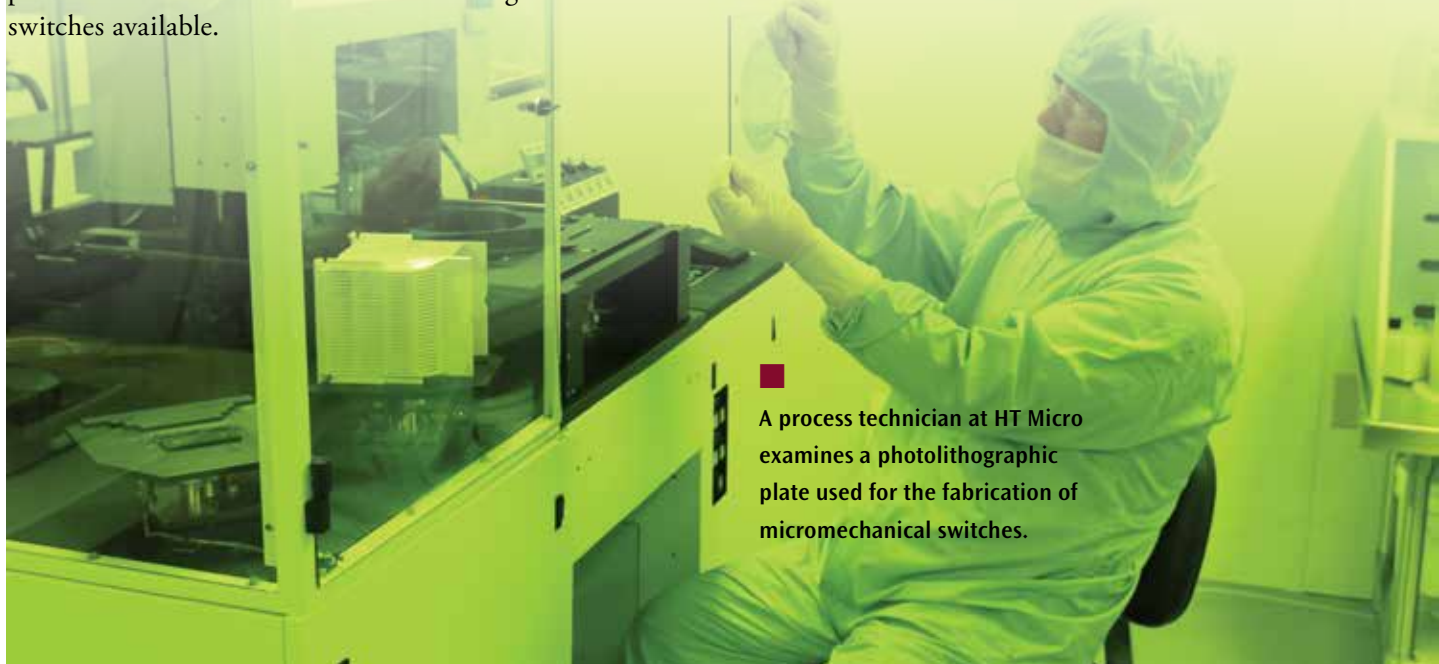
Todd Christenson founded HT MicroAnalytical (HT Micro) in Albuquerque, NM, in 2003 in order to apply his specialized expertise in high aspect ratio microfabrication (HARM) technology gained while at Sandia National Laboratories to the creation of the world's smallest electromechanical switches. The company originally created prototypes for other manufacturers, but now HT Micro is a large-scale manufacturer itself, producing microfabricated switches and connectors.

In 2013 the company expanded into a new 18,000-square-foot facility and doubled its workforce. This move came after partnering with Rosenberger, Inc., a global leader in connector solutions.

Rosenberger was a customer of HT Micro and impressed by the smaller company's capabilities. They invested in HT Micro to help them create a facility that could manufacture miniature parts in higher quantities, while maintaining tolerances. HT Micro's high aspect ratio technology and use of metal, instead of usual semiconductor materials like silicon, make it possible for them to build the smallest integrated switches available.

Christenson began HT Micro by taking part in Sandia's Entrepreneurial Separation to Transfer Technology (ESTT) program, which allows Sandia employees to leave the Labs in order to start up new technology companies or help expand existing companies. HT Micro continues to fulfill the vision Christenson had of creating products from HARM technology which would meet the needs of manufacturers requiring smaller and higher density electronic parts.

While the ESTT program made his company's start easier, Christenson says growing HT Micro has also depended on sticking to his vision, hiring good people, and engaging trusted and experienced advisors. HT Micro continues to do work for a balanced mix of commercial and government customers while continuing to further develop their technology. Looking ahead, the company plans to almost double its workforce again in 2014. Christenson is happy he could bring manufacturing jobs to New Mexico while serving the needs of customers worldwide.



■ A process technician at HT Micro examines a photolithographic plate used for the fabrication of micromechanical switches.

■ Damian Rouson, former manager of Sandia's Reacting Flow Research Department, and founder of Sourcery, Inc., teaches "Software Design in Modern Fortran for Scientists and Engineers."

The whiteboard shows the following content:

$$u_t = \nu u_{xx} - u u_x$$

**DISTR OBJ** (with arrows pointing to  $u_{xx}$  and  $u u_x$ )

**FORTTRAN :**

$$u_t = \nu u * u_{xx}() - u * u_x$$

**PARALLEL, ASYNCHRONOUS FUNCTIONAL OPERATIONS** (with arrows pointing to the Fortran code)

## Sandians Transfer Expertise to Other Ventures

Entrepreneurial Separation to Transfer Technology (ESTT) is a valuable tool helping Sandia National Laboratories transfer technology to the private sector. The program allows Sandia employees to leave the Labs in order to start up new technology companies or help expand existing companies. Entrepreneurs are guaranteed reinstatement by Sandia for up to two years if they choose to return to the Labs.

Three Sandia employees utilized ESTT this year. Their companies all originated in New Mexico.



Howland Jones started his own company, HyperImage Solutions, to transfer hyperspectral image analysis software

developed at Sandia to the private sector, where it's being used in research and quality control for the food, agricultural, and pharmaceutical industries. Jones is also working part-time helping OPOTEK, Inc. develop their near infrared imager and integrate the licensed Sandia software with the imager. In addition,

he is assisting other companies with diverse spectroscopic applications using Sandia's software.

Damian Rouson began his company, Sourcery, Inc., to train scientists on the programming paradigms enabled by modern Fortran. Rouson and his Sourcery team consult and present short courses. His work developing open-source software and training courses at Sandia led to his seeing the need for modern Fortran education for government, academia, and industry.

Robert Taylor joined PRISM Analytics Corporation, which his former Sandia colleague, Paula Sue Downes, founded. His expertise in system dynamics and supply chain modeling is being put to use at the predictive analysis company. Simulation techniques, originally developed for the Department of Homeland Security, are now applied to industry. Taylor, with his background at the Labs and in the private sector, is excited about having the opportunity to help a startup company reach its potential.



## Investor Funding Brings Safe H<sub>2</sub>O to People in Remote Places

Entrepreneur and engineer Rodney Herrington is bringing clean water to developing countries, disaster areas, the military, and outdoor enthusiasts with the H<sub>2</sub>gO Purifier.

Herrington's company, Aqua Research, is leveraging water disinfection technology originally developed through Defense Advanced Research Projects Agency (DARPA) funding for military applications and later commercialized by MIOX, his previous company. Besides being small, lightweight and effective, the H<sub>2</sub>gO Purifier requires no consumables other than common salt, a convenience for campers, but essential to people with no access to safe water and limited resources.

Sustainability is one of the requirements of non-governmental organizations (NGOs) operating in developing countries. By meeting NGO's stringent specifications, the product is more than able to meet the needs of military forces, as well as recreational campers. Instead of requiring replaceable batteries, the H<sub>2</sub>gO uses a cell phone battery which can be recharged with the product's integrated solar panels or via a cell phone charger. No bleach is required; a

disinfection solution is created with the device, a little water and salt.

Aqua Research was a presenter at the 2013 Technology Ventures Corporation (TVC) Deal Stream Summit, receiving investment funding that has allowed the company to prepare for product production and finalize a distribution agreement for outdoor stores. Herrington credits the assistance from TVC in preparing his pitch with his success in attracting investment.

TVC was formed in 1993 as a nonprofit charitable foundation by Lockheed Martin Corporation as part of the management contract for Sandia National Laboratories. Its mission is to commercialize federally funded technologies. Its goals: job creation, business formations, and equity funding.

With new funding in place, Aqua Research is on its way to achieving its goal of bringing safe water to emerging countries, while offering a sustainable and easy-to-use water disinfection solution to others who need it, including the military and first responders.

■  
Rodney Herrington, CEO, and Lois Warren, QA Director, Aqua Research, inspect pilot production H<sub>2</sub>gO Purifiers.





Awards given to honorees at the Innovation and Intellectual Property Celebration.

## Honoring People Who Demonstrated Innovation

### **Innovation and Intellectual Property Celebration**

An event hosted by Sandia National Laboratories' Industry Partnerships Team was held to recognize Sandia scientists and engineers whose work resulted in intellectual property (IP). Sandians who received patents and copyrights were honored at the dinner celebration. Their IP has contributed to Sandia's IP and licensing portfolios, royalty streams, and outstanding reputation in innovation and technology transfer. This year 108 patent holders and 18 copyright authors were recognized.

Up-and-Coming Innovators, people who were nominated for displaying potential for impactful innovations, entrepreneurial talent, and unique solutions to complex scientific challenges, were also given awards. Twenty individuals received this honor.

Sandia President and Laboratories Director, Dr. Paul Hommert, who gave the keynote address, was also recognized for being named 2013 Federal Laboratory Consortium (FLC) Laboratory Director of the Year. Hommert was selected for this award based on his leadership and support of Sandia's technology transfer activities. The FLC is a network of federal laboratories that provides the forum to develop strategies for linking laboratory technologies with the marketplace.

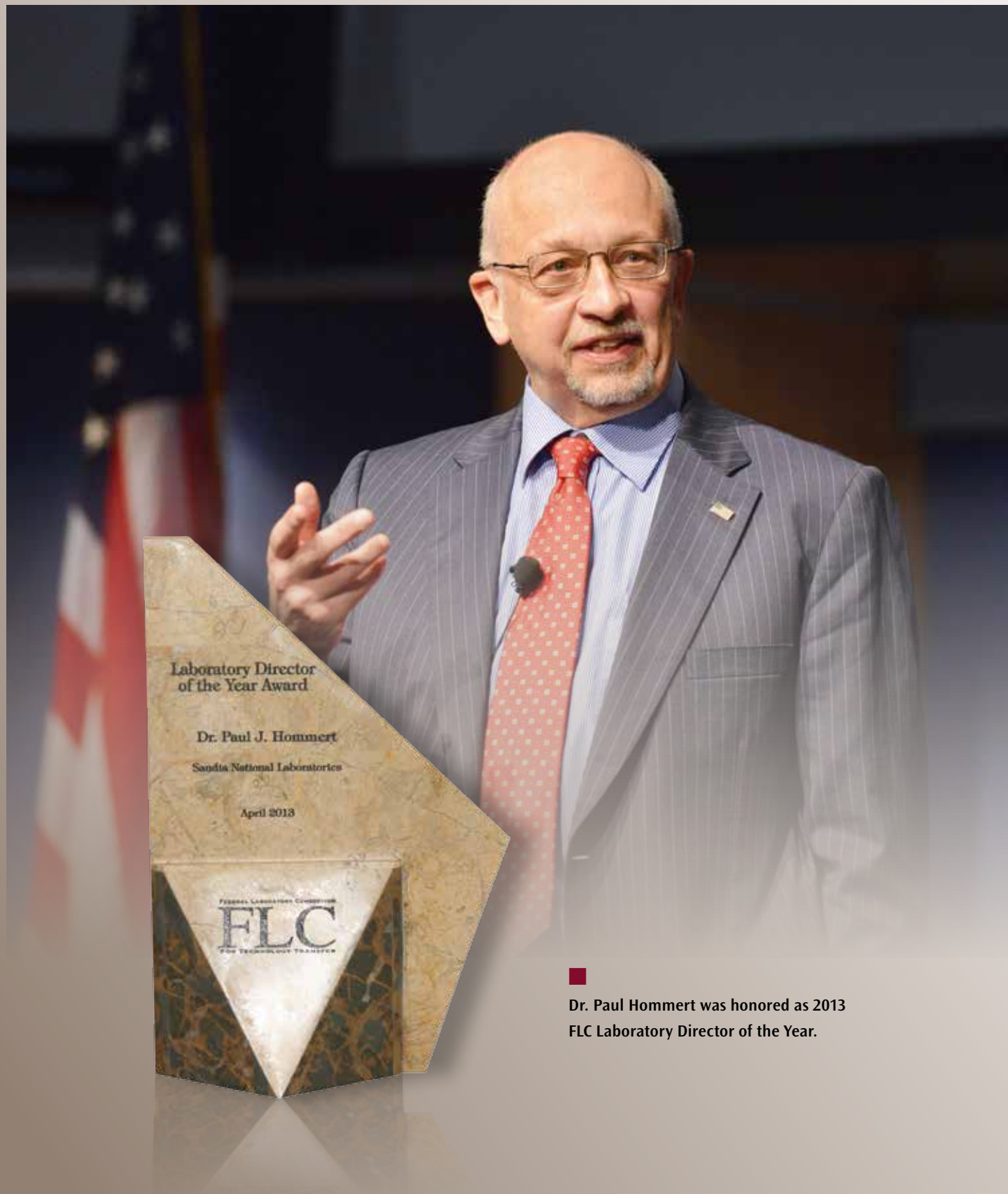
### **NMSBA Innovation Celebration**

Ten New Mexico Small Business Assistance (NMSBA) Program projects were showcased at the annual event held at the Technology Ventures Corporation 2013 Deal Stream Summit. Four of the projects received technical assistance from Sandia.

Inspyrd Products Corporation received help in reducing manufacturing costs for a device that retrieves up to 50 feet of oxygen tubing, eliminating tripping hazards; Kids Hardware Kompany obtained design assistance to improve safety and other features of a children's shoehorn; Sulptures, Inc. received help identifying foreign material in the clay that created flaws in a unique clay monoprinting process; and the Wave Energy Leveraged project, with modeling help from Sandia, was able to show that their system, which converts wave power into electricity, was feasible, making it possible to attract a six-figure investment. In addition, Wave Energy received the "Honorable Speaker Ben Luján Award for Small Business Excellence" for demonstrating the most economic impact.

NMSBA assists for-profit small businesses in New Mexico with access to laboratory experts at Sandia and Los Alamos national laboratories. These experts help them to gain knowledge and solve challenges utilizing the labs' cutting-edge technologies.





■ Dr. Paul Hommert was honored as 2013 FLC Laboratory Director of the Year.

Sandia National Laboratories has won a number of awards this year recognizing its achievements in technology development, technology transfer, and technology partnerships.

## R&D 100 Awards

### ADIOS

A scalable software framework designed to handle the input/output requirements of large datasets. Sandia assisted Oak Ridge National Laboratory on this project.

### Mantevo Suite 1.0

An integrated collection of small software programs (miniapps) that models the performance of full-scale applications, yet requires a fraction of the code. Miniapps are now being used to design next-generation computer systems.

### Membrane Projection Lithography



A fabrication technique that enables the creation of a diverse array of microscopic 3-D structures.

### Solar Glare Hazard Analysis Tool (SGHAT)

A free web-based tool that addresses federal guidelines requiring quantified assessments of glare from proposed solar installations. SGHAT predicts potential ocular hazards to pilots, air traffic controllers, and motorists.

## Federal Laboratory Consortium (FLC) National Awards

### 2013 FLC Laboratory Director of the Year Award: Dr. Paul Hommert

Being selected as a recipient is an honor that recognizes the excellence of Paul Hommert's leadership and Sandia's technology transfer program.

### Excellence in Technology Transfer Award: Crystalline Silico-Titanates (CSTs)



Patented CST technology is being used for cleanup of radiation-contaminated water at the Fukushima Daiichi nuclear power plant. Quick action by Sandia and its corporate partner UOP, A Honeywell Company, led to rapid deployment.

## FLC Mid-Continent and Far West Region Awards

### Notable Technology Development Award: Self-Assembled Multifunctional Optical Coatings (SAMOC)



SAMOC inexpensively forms film-like coatings already widely used in consumer electronics, semiconductor devices, and high-performance glass and ceramics.

### Outstanding Technology Development Award: Sandia Cooler



The Sandia Cooler reduces the energy needed to cool processor chips and has the potential to decrease overall electrical power consumption in the U.S. by more than 7%.

### Outstanding Technology Development Award: SpinDx™



SpinDx is a lab-on-a-disk, a medical diagnostic tool that can process up to 64 assays from a single sample, in just minutes.

### Regional Partnership Award: SPAWAR Systems Center Pacific (SSC Pacific), Department of Homeland Security (DHS), and Sandia National Laboratories

Sandia has partnered with SSC Pacific and the DHS to research, develop, test, evaluate, and transition new cargo security technologies to meet DHS and Navy requirements.

### Regional Partnership Award: UNM Health Sciences Center (HSC) – Sandia National Laboratories

The UNM HSC and Sandia partnership has developed a protocell that is a novel nanoparticle that can dramatically improve the efficiency of chemotherapy drugs, antibiotics, and vaccines.

## Association of University Research Parks (AURP) Awards of Excellence

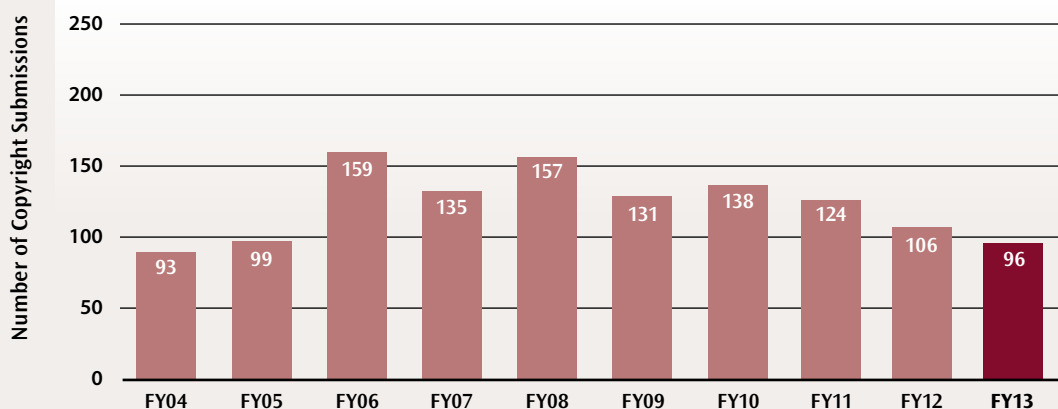
### Innovation: EMCORE Corporation

A company located in the Sandia Science & Technology Park (SS&TP), EMCORE was recognized for the success of their high-efficiency multi-junction solar cells for satellite and space power applications.



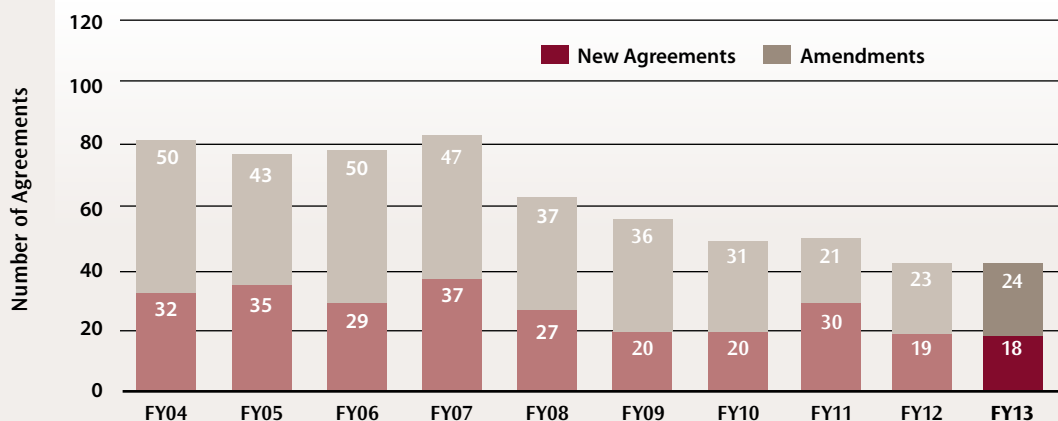
## Copyrights

### Copyright Submissions

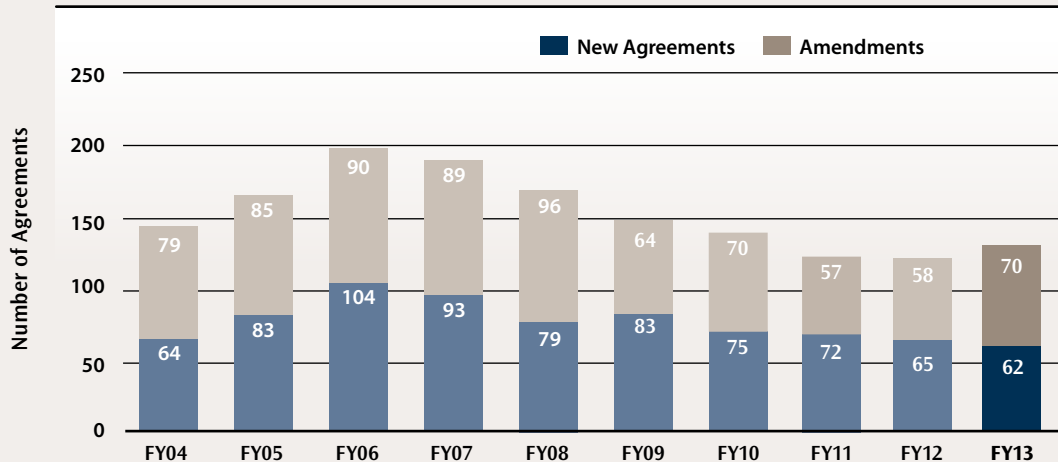


## CRADAs and WFO-Industrial

### Sandia CRADA Program Activity



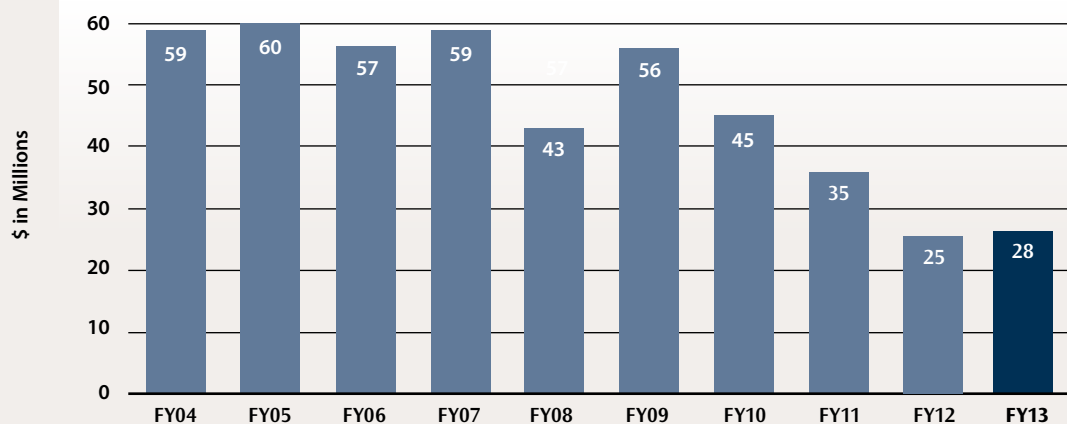
### Sandia WFO-Industrial Partners Activity



## Industry Funds-In

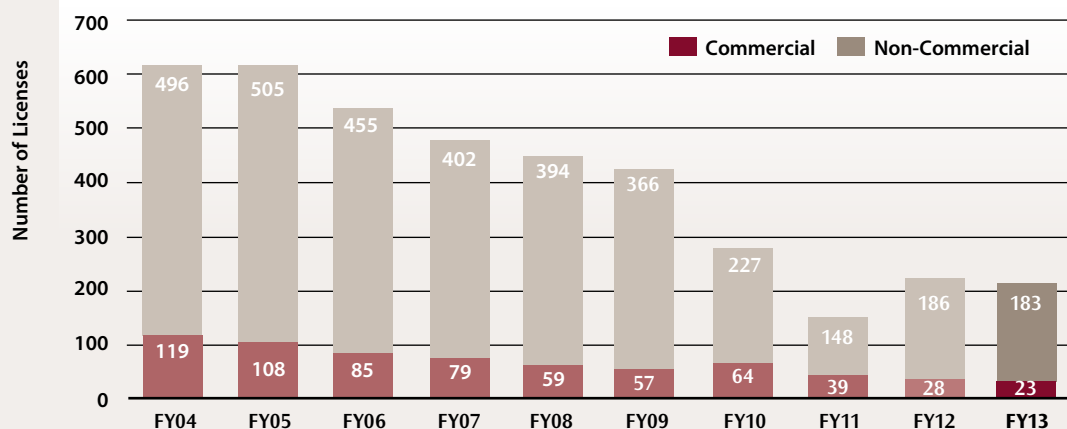
### Industry Funds-In to Sandia (\$M)

Value represents Funds-In for CRADAs, WFO Non-Federal Entity Agreements, and Licensing Income.

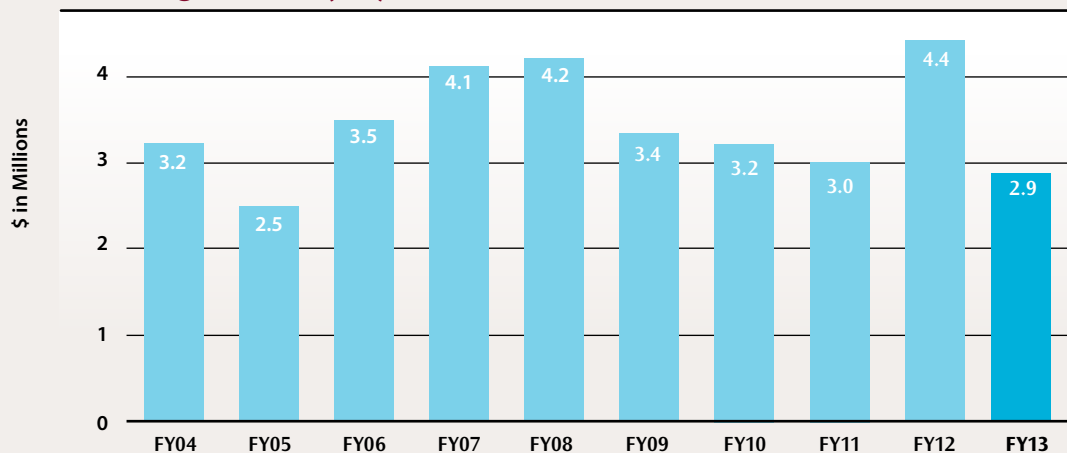


## Licenses

### Licenses



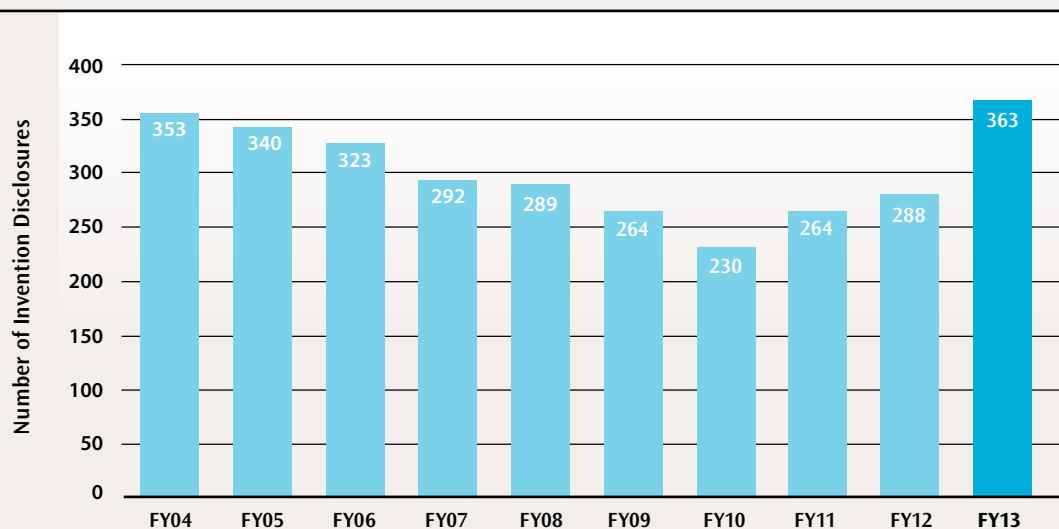
### Licensing Income (\$M)



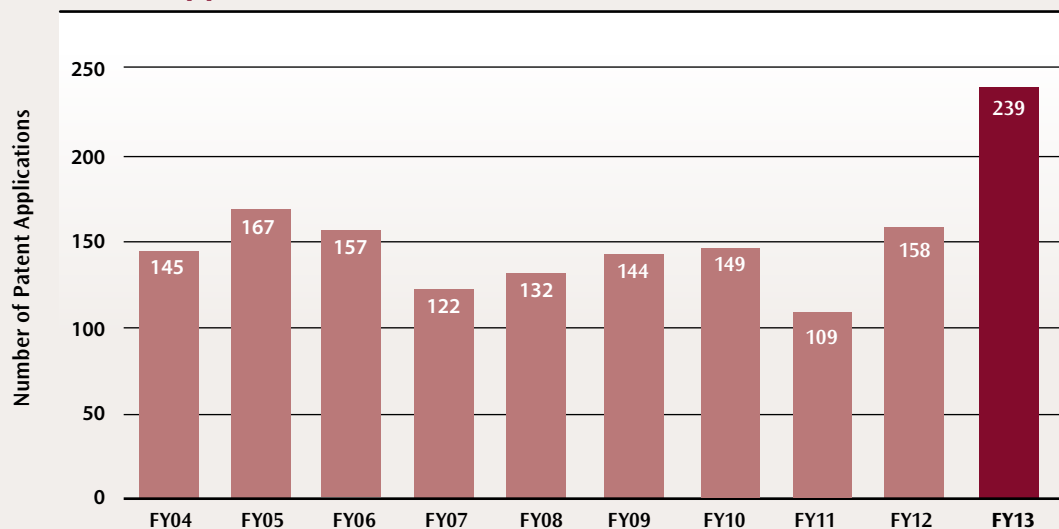


## Patent Activity

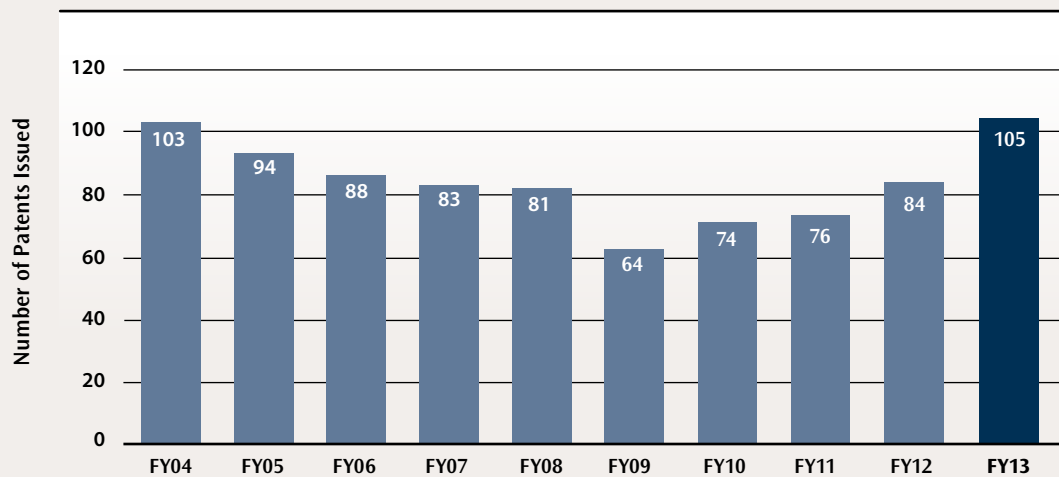
### Invention Disclosures



### Patent Applications



### Patents Issued

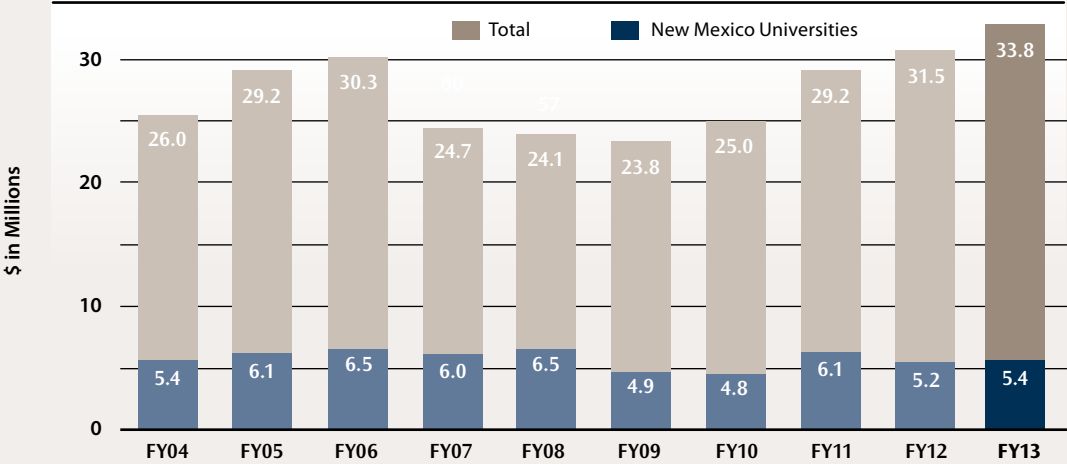


# University Partnerships

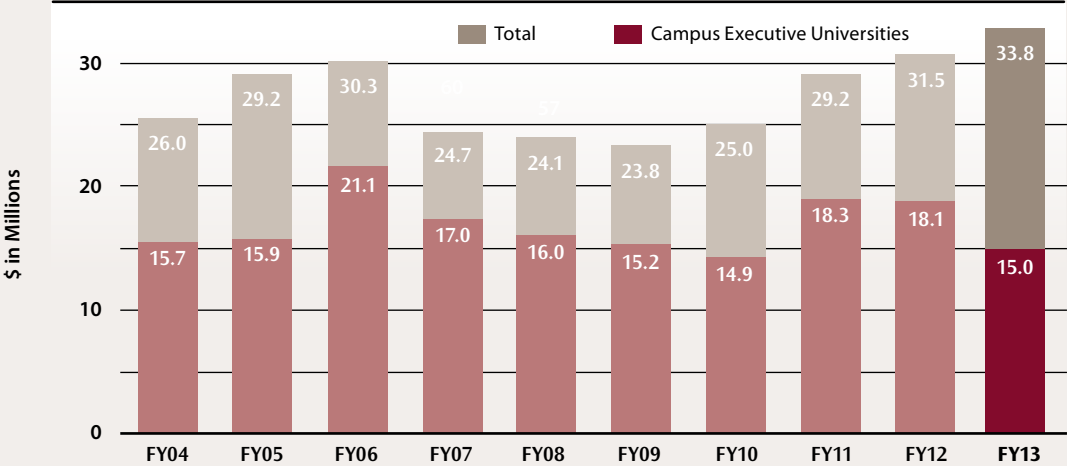
Sandia National Laboratories has traditionally contracted for university research to expand its science and technology base. Both Sandia and universities share a need to accelerate the creation of world-class research, produce scientists and engineers, and grow competencies and new businesses.

Today, Sandia partners with key universities to achieve three major objectives: conduct world-class science, hire world-class scientists and engineers, and develop strategic collaborations in focused research challenge areas. The University Partnerships Office, under the leadership of the Chief Technology Officer, serves as the point of contact for university research issues and implements those processes that enable university partnerships.

## Investments in University Research



## Investments in University Research







## Sandia Science & Technology Park (SS&TP)

### Results

Companies and Organizations .....	36
Employees .....	2414
Buildings .....	25
Available Space (out of 1.1 Million sq. ft.) .....	84,986
Available Land (out of 340 acres) .....	215
Funds-In to Sandia from Park Companies* .....	\$17.7M
Contracts from Procurement to Park Companies* .....	\$408M
Contracts Between Park Companies* .....	\$10.4M
Public Investment in the Park* .....	\$89M
Private Investment in the Park* .....	\$269M
Total Investment in the Park* .....	\$358M
Average Salary of Full-time Jobs in Park .....	\$75K
Average Salary of Full-time Jobs in Metro Albuquerque .....	\$42K

\*Since Park opened in 1998.

## New Mexico Small Business Assistance (NMSBA) Program

In 2013 the state of New Mexico, along with Los Alamos and Sandia, invested over **\$4.6M** to help **354** small businesses in **29** counties solve technical challenges.

**2000 - 2013**

**New Mexico Small Businesses Assisted** ..... 2195

### Rural vs Urban Businesses

Rural (65%) .....	1431
Urban (35%) .....	764
Combined .....	2195

**Dollar Amount of Assistance** ..... \$39M

**2000 - 2012**

**Return on Investment (ROI)** ..... 1.17

(ROI is Based on Salaries of Jobs Created and Retained)

### Economic Impact

Small Business Jobs Created and Retained .....	3510
Mean Salary .....	\$39K
Increase in Revenue .....	\$172.5M
Small Business Decrease in Operating Costs .....	\$79M
Investment in NM Goods/Services .....	\$56.4M
New Funding/Financing Received .....	\$59.6M

## Entrepreneurial Separation to Transfer Technology (ESTT) Program

**Companies Affected by ESTT** ..... **99**

Start-up Companies .....	49
Expansion Companies .....	50

**Sandia Scientists and Engineers Who Left on ESTT** ..... **145**

To Start up a Business .....	62
To Expand a Business .....	83



# PARTNERSHIP SUCCESS STORY VIDEOS

Sandia National Laboratories has produced a series of videos that bring to life the visions of companies that are using Sandia technology to better the world. These are stories of commitment, partnerships, and real people solving real problems. The stories are told in the words of the Sandia principal investigators, industry partners, and entrepreneurs who worked together to achieve a common goal. Each story strikes a powerful chord highlighting the various Sandia programs and partnership opportunities.

## Cleaning contaminated water at Fukushima: a Sandia and UOP partnership



Crystalline Silico Titanates (CSTs) are synthetic zeolites designed by Sandia scientists to selectively capture radioactive cesium and other group I metals.

They are being used for cleanup of radiation-contaminated water at the Fukushima Daiichi nuclear power plant in Japan.



[Watch YouTube Video](#)

## EMCORE's location in the SS&TP helps facilitate partnerships with Sandia



EMCORE Corporation, a leading provider of compound semiconductor-based components and subsystems for the fiber optic and solar power

markets, established its photovoltaics business at the Sandia Science & Technology Park (SS&TP) in 1998 through a technology transfer of multi-junction solar cell technology from Sandia. The company employs approximately 300 people in the SS&TP. EMCORE's story illustrates how one publicly traded company used Sandia technology to grow and prosper in a global economy.

## Kids with disabilities inspire a musical instrument anyone can play



The Midiwing is a musical instrument that unites music and computer technology for those who lack the experience, physical ability, or

maturity to play music with traditional instruments. To create the instrument, Dan Daily, Director of Musiccode Innovations, reworked and recoded Musical Instrument Digital Interface (MIDI) technology and introduced ergonomic design. He applied to the New Mexico Small Business Assistance (NMSBA) Program to receive help when he discovered the microcontroller he used was being phased out. Daily and Kent Pfeifer, an engineer at Sandia and musician himself, partnered to create a new state-of-the-art design.



[Watch YouTube Video](#)



[Watch YouTube Video](#)

## Successful company thrives thanks to Sandia's wavefront technology and entrepreneurial program



Former Sandian Dan Neal started his company, WaveFront Sciences, based on wavefront sensing metrology technologies licensed from Sandia and

taking advantage of its Entrepreneurial Separation to Transfer Technology (ESTT) program. Abbott Medical Optics since acquired WaveFront and estimates that one million patients have improved the quality of their vision thanks to its products.



[Watch YouTube Video](#)

**For general questions and comments, contact [partnerships@sandia.gov](mailto:partnerships@sandia.gov).**

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*Founded in 1993 by Lockheed Martin, Technology Ventures Corporation's charter is to facilitate the commercialization of technologies developed at Sandia, other laboratories, and research universities.*





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[www.sandia.gov/partnerships](http://www.sandia.gov/partnerships)

To learn more about licensing and technology transfer at Sandia, please contact us at:

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Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.  
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