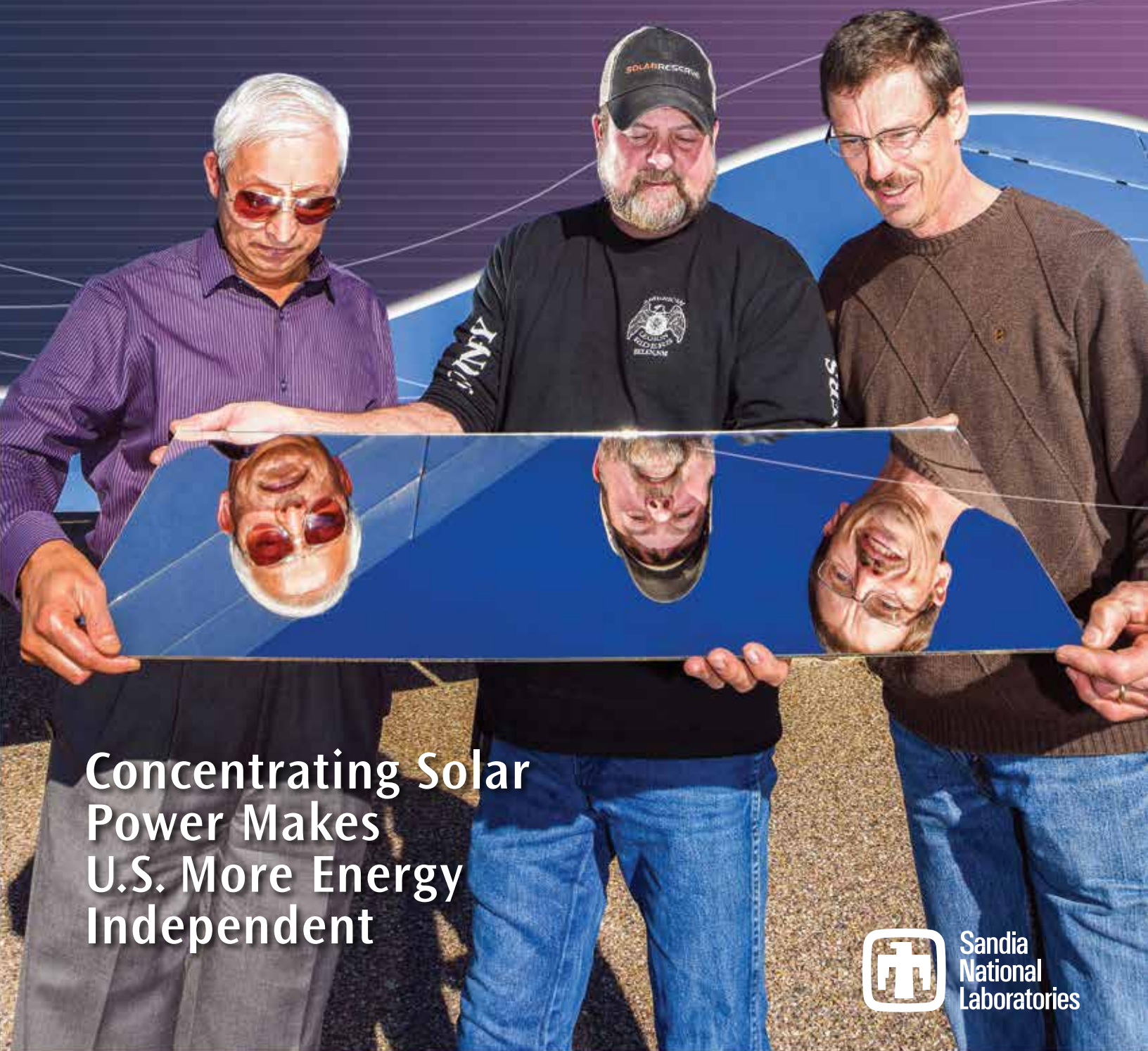


SANDIA NATIONAL LABORATORIES

# Partnerships

ANNUAL REPORT FY2015



Concentrating Solar  
Power Makes  
U.S. More Energy  
Independent



Sandia  
National  
Laboratories



“DOE is committed to nurturing the innovation ecosystem at our national labs. Sandia is a key partner in that effort, and its efforts in technology transitions strengthen our security, energy, and environmental missions.”

— **Jetta Wong**

*Director, Office of Technology Transitions  
U.S. Department of Energy (DOE)*



“Collaborations with industry, universities, government agencies, and other national laboratories enable the development of technical solutions for a broad spectrum of national security needs.”

— **Dan Sanchez**

*DOE Technology Partnerships Manager  
NNSA Sandia Field Office*



“Scientists and engineers drive technological change through discovery, innovation, and real-world application. Sandia’s technologies and their application are vital to national security, and moving them swiftly to the marketplace advances U.S. economic competitiveness. Sandia is committed to strategic partnerships with industry and universities to strengthen and accelerate technology transfer.”

— **Jill Hruby**

*President and Laboratories Director  
Sandia National Laboratories*

# ► Table of Contents

## INDUSTRY PARTNERSHIPS

### 2 Introduction

*Synergistic Relationships Let Us Accomplish More Than We Could Alone  
LDRD Program Benefits Partnerships*

### 4 EyeTracking

*Better Ways to Collect and Analyze Data from Dynamic Imagery*

### 6 Integrated Deposition Solutions

*User Friendly Direct Write System Provides Easy 3D Electronic Printing*

### 8 Peregrine Turbine Technologies

*sCO<sub>2</sub> Brayton Technology to Bring Power Production Benefits*

### 10 Red and White Fleet

*Hydrogen-Powered Ferries Could Improve Air and Water Quality*

### 12 Spectral Sciences

*SuperPixels Move Hyperspectral Imaging to the Mainstream*

### 14 Wakefield-Vette

*Breakthrough Heat Exchanger Changes Cooling Landscape*

## UNIVERSITY PARTNERSHIP

### 16 The University of Texas at Austin

*Research at Z Facility Improves Understanding of White Dwarf Stars*

## HOT TECHNOLOGY

### 18 SolarReserve

*Concentrating Solar Power Makes U.S. More Energy Independent*

## WORLD-CLASS FACILITIES

### 20 Kauai Test Facility

*Launching Rockets to Support Research and Defense*

### 21 MESA Facility

*Microfabricated Surface Traps Advance Quantum Computing Potential*

## LOCAL/REGIONAL PARTNERSHIPS

### 22 Sandia Science & Technology Park

*Entrepreneur Exploration a Part of Region's Startup Ecosystem*

### 23 New Mexico Small Business Assistance

*Semiconductor Lasers Part of Automotive Technology Revolution*

### 24 Entrepreneurial Separation to Transfer Technology

*Company Commercializes Tiny, Flexible Solar Cells*

### 25 Sandia Technology Showcases

*Events Shine a Spotlight on Technologies and Products*

### 26 Small Business Vouchers Pilot

*Sandia Selected for Clean Energy Business Assistance Program*

### 27 Technology Ventures Corporation

*Small Chemical Reactors Improve Fertilizer and Energy Production*

### 28 Academic Alliance

*Collaboration Attracts Talent, Enhances Research and Tech Transfer*

### 29 LabCorps

*Wind Energy Technology Accelerated by Entrepreneurial Program*

### 30 Recognition

### 31 Awards

### 32 Scorecard

#### About the cover:

Sandia Manager Subhash L. Shinde, SolarReserve Test & Calibration Lead Roger Buck, and Sandia Operations Lead/Test Engineer Bill Kolb stand in front of a SolarReserve 96-square-meter heliostat studying a new highly reflective mirror.

See story on page 18.

“Sandia performs research in the national interest, working out answers to serious and complicated issues. Collaboration with external partners allows the Labs to leverage the nation’s research investment and amplify its impact by moving beneficial technology to the marketplace.”

— **Rob Leland**

*Vice President and  
Chief Technology Officer  
Sandia National Laboratories*

“Collaborative research helps Sandia achieve bold scientific breakthroughs that enhance national security and spur economic development. To achieve mission success, these breakthroughs must be engineered to meet real world demands. Working this entire process is a Sandia strength.”

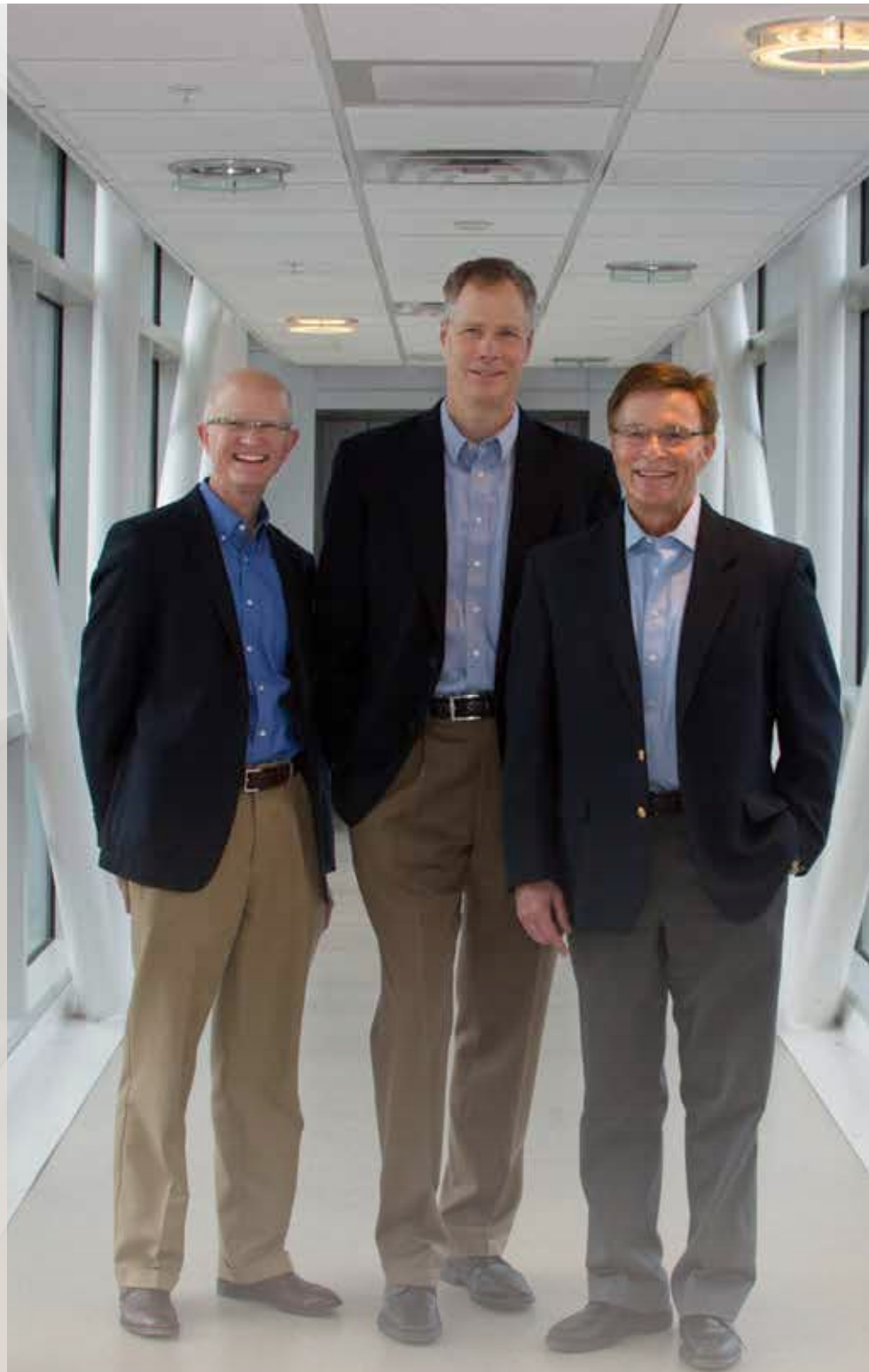
— **Andy McIlroy**

*Director  
Research Strategy & Partnerships  
Deputy Chief Technology Officer  
Sandia National Laboratories*

“Sandia is an incredible national resource because of our talented staff and the exceptional service they do in the national interest. This report describes a few of the many partnerships that have benefited greatly by their contributions.”

— **Pete Atherton**

*Senior Manager  
Industry Partnerships  
Sandia National Laboratories*



► **Andy McIlroy, Rob Leland, and Pete Atherton.**



# Synergistic Relationships Let Us Accomplish More Than We Could Alone

Strategic partnerships are essential to Sandia National Laboratories' mission success. Working with partners in industry, academia, and government benefits both the Labs and collaborating organizations in equal measure. Together with our partners, we can accomplish much more than we could alone.

Sandia's collaborative endeavors help the Labs further develop capabilities that are vital for delivering on all of its missions. Partnerships also facilitate technology transfer, moving new products into the marketplace, where they can benefit the public and help grow the nation's economy.

In fact, partnership and collaboration are indispensable parts of Sandia's Science & Technology Division strategy. Leaders at the Labs are moving to assess and increase productive collaborations, and enable a highly collaborative environment. That's because they have witnessed how everything from individual capabilities to mission outcomes are enhanced by partnership and collaboration.

In the stories you'll read in this annual report, you'll see some examples of the hundreds of partnerships Sandia engages in each year. Here you'll learn about how, together, Sandia and its partners are developing and deploying technology for mutual benefit and to serve the public good.

Stories in this year's report include:

- ▶ Advancing concentrating solar power technology with energy storage to increase the use of renewable energy
- ▶ Using experimental science and pulsed power to learn more about white dwarf stars and the universe than observation alone allows
- ▶ Commercializing a new type of energy-efficient, air-cooled heat exchanger that has multiple applications
- ▶ Creating a simple, inexpensive solution for printing of electronic circuitry

Synergistic relationships enhance the Labs. They make bold scientific outcomes possible, advance Sandia's capabilities, and deploy new technology for the public good—all while energizing our talented staff who see their innovations benefiting society.

## LDRD Program Benefits Partnerships

Research conducted within the Laboratory Directed Research and Development (LDRD) program is essential to maintaining the vitality of Sandia's mission-critical science, technology, and engineering capabilities. The LDRD program has benefited Sandia's work in all of its national security mission areas, including nuclear security, energy security, and global security.

A large number of Sandia LDRD research projects include strategic collaborations with partners in industry, academia, and other government agencies. The Labs and its strategic partners gain from collaborative research results, and many technological breakthroughs originating from, or improved through the LDRD program are later transferred to industry, commercialized under licensing agreements, and brought to market for the U.S. public good.



Look for the LDRD logo in this report to discover which technologies grew out of the LDRD program.

To learn more, visit [www.sandia.gov/lldr](http://www.sandia.gov/lldr)



## ► EyeTracking

- Sandia Researcher Mike Haass demonstrates how an eye tracker under a computer monitor is calibrated to capture his eye movements on the screen.



# Better Ways to Collect and Analyze Data from Dynamic Imagery

“With Sandia’s knowledge of national security applications and the cognitive demands of working with advanced sensors, and EyeTracking’s flexible hardware and analysis systems, we have the right combination of expertise to advance the state of the art.”

— James Weatherhead

President  
EyeTracking, Inc.

## ► CHALLENGE

Analysts must rapidly sift through huge numbers of satellite images, looking for anomalies. Radiologists review CAT scans quickly, searching for medical problems. And airport security officers view images of luggage zipping by, watching for danger within.

Experienced professionals, whether in security or medicine, are great at pattern recognition and spotting irregularities, but can be overwhelmed by the volume of data, especially in rapidly changing and high-stress environments.

## ► COLLABORATION

Sandia National Laboratories is teaming up with EyeTracking, a small company based in San Diego, CA, to work on how to help people glean meaningful information from large data sets, allowing them to do their jobs more efficiently.

While the company has software and hardware for data collection, Sandia has the knowledge of what is needed to make eye tracking work in dynamic workflow environments. Together they are working to develop a system for collecting, integrating, and analyzing information about human interactions with dynamic image content.

Eye tracking has been used for years in the lab to measure where the eye is looking on a computer screen, but usually the images are static and the subjects aren’t manipulating the images as they would in their regular jobs. When people are interacting with dynamic data sources, it is more complicated to capture their cognitive processes and strategies.

## ► SOLUTION

By better understanding how specialists evaluate and interact with images, the partners hope to find ways to help people get more meaningful information from visual data. Research findings can be used to create more effective training programs and inform new hardware and software system designs for use at specialized data analysis jobs.

Together, Sandia and EyeTracking are working to create tools that make the most of human expertise and intelligence while capitalizing on computer capabilities. If a computer can automate some steps, like screening the high volume of data, separating the most meaningful information from the “noise,” then that will free people to do what they do best, and keep an overabundance of data from overwhelming them.

## ► IMPACT

An improved understanding of how people interact with dynamic imagery is expected to lead to new systems and training that would make experts who we depend on to analyze images better at their jobs. For example, more accurate analysis of medical scans would lead to faster and more precise diagnoses. Efficient screening of luggage at airports would make air travel smoother and safer. Plus better analysis of satellite imagery would help make the world safer from nuclear proliferation.

**PARTNERSHIP TYPE:** Cooperative Research and Development Agreement (CRADA)

**GOAL:** Gaining more meaningful data from high-volume dynamic image analysis



► Sandia Researcher Dave Keicher, IDS Technician Veronica Wells, and UNM Mechanical Engineering student and Sandian Shaun Whetten in front of a Microjet system.

## User Friendly Direct Write System Provides Easy 3D Electronic Printing

“The collaboration between Sandia and IDS has made possible the development of aerosol-based additive manufacturing technologies to provide stable, production-level 2D and 3D printing platforms.”

— Marcelino Essien

*President  
Integrated Deposition  
Solutions, Inc.*

### ► CHALLENGE

The rapidly growing industry of additive manufacturing, or 3D printing, has expanded to include Direct Write Electronics (DWE), but many commercially available manufacturing platforms are not user-friendly or production-ready.

DWE commonly uses conductive nanoparticle silver ink to create printed circuits for components such as embedded sensors and antennas for mobile devices. With current technologies, focusing a distribution of aerosol particles or ink droplets to the well-defined point needed to form a circuit's fine features is difficult. The DWE systems presently available are prone to extraneous material deposition and clogging, and don't offer reliability and repeatability sufficient for production-level applications.

### ► COLLABORATION

Integrated Deposition Solutions (IDS), a small New Mexico-based business, is working with Sandia National Laboratories to overcome many of the problems associated with particle-based DWE. IDS is licensing and adapting a 1999 Sandia patent to reach the goal of stable and well-defined electronic printing.

The Sandia technology was originally designed for Cold Spray coating applications in the early days of additive manufacturing; however, the invention was not developed for commercial use. Recently a Sandia project required maskless printing with more accuracy than was previously possible. Working together, the IDS and Sandia team members repurposed the unused intellectual property for the present-day need.

In the course of the Sandia-IDS collaboration, new developments have spurred the filing of a number of patent applications pertaining to focused printing and digital print control.

### ► SOLUTION

IDS is building a modular system called Microjet™ which includes an integrated interface, process controls, aerosol printer, vision module, and part alignment module. Sandia is currently using the systems for some internal applications, and IDS is moving to commercialize the product.

The MicroJet uses a series of aerodynamic lenses to focus a distribution of particle sizes, making this process capable of printing features down to approximately 25  $\mu\text{m}$  in width and up to several microns thick. The first MicroJet systems can be operated continuously for up to four hours without user intervention, with product improvements being planned to increase unassisted run-time to eight hours.

### ► IMPACT

There's a worldwide need for a cost-effective, user-friendly DWE system such as the MicroJet, which provides a stable platform for small- or large-scale manufacturing of electronic and optoelectronic circuitry. Furthermore, the MicroJet technology could also be expanded to 3D printing applications involving fabrication of ceramic and metal components, applications in medical and biotechnology fields, and printing on curved and other non-planar surfaces.

**PARTNERSHIP TYPE:** License

**GOAL:** Creating a simple, inexpensive solution for printing of electronic circuitry

Microjet is a trademark of Integrated Deposition Solutions, Inc.

► Sandia sCO<sub>2</sub> Researchers Jim Pasch and Darryn Fleming investigate a turbine and compressor inside a test facility at Sandia.



## sCO<sub>2</sub> Brayton Technology to Bring Power Production Benefits

“The team at Sandia has laid fabulous groundwork for us to commercialize sCO<sub>2</sub> technology. Experience gained through experimentation is a valuable resource for us to capture lessons learned and avoid the pitfalls of early technology development.”

— David Stapp

CEO/CTO  
Peregrine Turbine  
Technologies, LLC

### ► CHALLENGE

Over the next 10 years, distributed energy is expected to grow to be a \$20 billion market for power generators between 1 and 20 MWe. Yet smaller turbines are currently less efficient than the giant ones used in large-scale power production. Sandia National Laboratories is looking to take supercritical carbon dioxide (sCO<sub>2</sub>) Brayton cycle technology and apply it to smaller distributed energy systems located closer to users.

Sandia has been developing sCO<sub>2</sub> Brayton cycle technology for six years. It offers cleaner, more efficient electricity production, but to be ready for commercialization, systems must also demonstrate functionality and manufacturability.

### ► COLLABORATION

Sandia and Peregrine Turbine Technologies are working together to design, test, and qualify Peregrine's design for a high efficiency power generator for the distributed energy market. Peregrine is leveraging Sandia's lessons learned and testing expertise.

While Peregrine provides engineering and design, Sandia can use its one-of-a-kind Brayton lab as a test and development platform and leverage its capabilities and experience in sCO<sub>2</sub> Brayton research. Together, the company and the Labs will demonstrate Peregrine's 6-megawatt turbine engine that can be powered by natural gas or biofuel to generate electricity.

An MOU and CRADA allow the partners to work easily together to accomplish similar goals: advancing the commercialization readiness of the sCO<sub>2</sub> Brayton cycle technology, providing world-class testing and analysis, and encouraging the establishment of U.S.-based, high-value technology and manufacturing jobs.

### ► SOLUTION

Improving power generation technology is part of Sandia's mission to strengthen national energy security. The sCO<sub>2</sub> Brayton cycle can replace steam systems in a smaller size with higher efficiency, lower cost, lower emissions, and with distributed power generation, reducing the burden on the national power grid.

The Peregrine power generation “Maverick” gas turbine engine, combined with a series of “cores” that use sCO<sub>2</sub> as a working fluid, could be 30%-60% more fuel efficient than current technology. By combining expertise from Sandia with technology from Peregrine, the partners hope to increase the efficiency of the thermal conversion of fuel to energy, effectively doubling the amount of energy produced by the same amount of fuel.

### ► IMPACT

sCO<sub>2</sub> Brayton technology could bring about large-scale improvements in production across most energy sectors, especially solar, nuclear, and gas turbine. Potential economic and environmental benefits include reduced fuel consumption and emissions, and the ability to generate power from a variety of sources, even landfill waste.

**PARTNERSHIP TYPE:** Memorandum of Understanding (MOU) and Cooperative Research and Development Agreement (CRADA)

**GOAL:** Increasing energy efficiency by applying sCO<sub>2</sub> Brayton cycle technology to distributed power generation

- A Red and White Fleet ferry boat passes beneath the Golden Gate Bridge in San Francisco.



# Hydrogen-Powered Ferries Could Improve Air and Water Quality

“We are looking forward to working with Sandia on Phase II and Phase III of the project, which will be the final design and operation of the high-speed ferry. We are extremely pleased with the professionalism, depth of knowledge, and openness of the entire team.”

— Tom Escher

*President  
Red and White Fleet*

## ► CHALLENGE

In San Francisco, transportation takes place on land and at sea, as ferries crisscross the Bay. We've all heard about reducing emissions from cars and buses, but how do you do it with boats? A new project is designed to tackle this question.

Called SF-BREEZE (San Francisco Bay Renewable Energy Electric vessel with Zero Emissions), the project's concept is to design, build, and operate a high-speed hydrogen fuel cell passenger ferry and hydrogen refueling station. The boats must be both fast and affordable. Success will require a boat specially designed to accommodate hydrogen fuel and fuel cells. Existing ferries can't be easily retrofitted.

## ► COLLABORATION

The U.S. Department of Transportation's Maritime Administration is funding a feasibility study to examine the technical, regulatory, and economic aspects of the SF-BREEZE project concept.

Sandia National Laboratories is leading the study in partnership with Red and White Fleet, the American Bureau of Shipping (ABS), the U.S. Coast Guard (USCG), and naval architect Elliott Bay Design Group. Being a part of this collaboration is providing the USCG and ABS with information needed to develop regulations for the use of hydrogen-powered vessels in maritime environments, helping to bring such boats into the mainstream.

Having lots of stakeholders take part gives the feasibility study a rock-solid foundation, ensuring that its conclusions are accurate.

## ► SOLUTION

Hydrogen fuel cells have several advantages over the diesel engines that power most passenger ferries — no harmful exhaust, higher energy efficiency, quiet operation, and no risk of fuel spills. Replacing diesel engines with hydrogen fuel cells will greatly improve air and water quality in harbor areas.

The high-speed passenger ferry would use about 2,200 kilograms of hydrogen per day. To put this in perspective, an average hydrogen fuel cell car might use less than 5 kilograms of hydrogen per week. To support the ferry and other potential users, the refueling station would have a capacity of 2,500 kilograms a day — about three times the size of the largest hydrogen refueling station in the world today.

## ► IMPACT

The hydrogen refueling station is planned to serve fuel cell electric cars, buses and fleet vehicles in addition to the ferry and other boats. Economy of scale could boost the local hydrogen fuel cell marketplace, and drive down hydrogen costs as more people adopt fuel cell-powered transportation.

For Red and White Fleet company president Tom Escher, emissions-free ferry boats will enable him to continue the tradition of leadership and environmental stewardship his grandfather began when he established the company in 1892.

**PARTNERSHIP TYPE:** Cooperative Research and Development Agreement (CRADA)

**GOAL:** Eliminating emissions from ferry boats while remaining competitive with other forms of transportation

► Sandia Optical Engineer Amber Dager displays an early iteration of a thin film superpixel array.

# SuperPixels Move Hyperspectral Imaging to the Mainstream

“We knew Sandia scientists had the technology and expertise to attack this problem. Our partnership has provided us a great opportunity to produce an exciting new product.”

— **Marsha Fox**  
Vice President  
Spectral Sciences, Inc.

## ► CHALLENGE

Thermal hyperspectral imaging (HSI) has been around for a while but the sensors are currently too large, heavy, and expensive for use in many military and commercial applications where it could be helpful

Where thermal imaging sees heat, HSI divides thermal light into many bands, like a rainbow in comparison to the red, green, and blue a “regular” visible light camera sees. This means thermal HSI makes it easier to distinguish between similar materials like asphalt and concrete or types of vegetation, from very long distances, at night, and through dust and smoke.

Creating a compact, lightweight, and less expensive “snapshot” thermal HSI video camera—one that can collect a full set of high resolution data with each frame, instead of requiring multiple frames—would make many HSI applications more practical.

## ► COLLABORATION

Sandia National Laboratories invented a “superpixel” technology which can help make faster, easier, and less expensive thermal HSI systems possible. Superpixels are tiny arrays of 5-10 filters on a side. Each filter in the superpixel transmits a separate thermal color band and is matched to one camera pixel. Arrays of superpixels are fabricated with exacting thin film techniques and require precise microlithographic etching. Sandia is adapting its original superpixel technology with new thin film materials and processes to be more versatile and manufacturable.

Sandia partner Spectral Sciences is designing the processes that form the hyperspectral image. The company is developing a thermal HSI video camera concept using the superpixel array, and algorithms and software to turn two dimensions of data into three-dimensional HSI data for analysis. This new system will be faster, more compact and affordable than thermal HSI systems currently available.

## ► SOLUTION

Using the superpixel technology, Sandia and Spectral Sciences have found a way to replace the bulky front end optics currently used for thermal HSI systems with a thin filter array that will mount directly to the camera sensor. This will make the HSI system smaller, lighter, and easier to operate.

Spectral Sciences is also working to commercialize the superpixel filter technology in partnership with a long-wave IR camera manufacturer attracted by the prospect of gaining a commercial advantage with this unique upgrade for HSI.

## ► IMPACT

A new, compact system means thermal hyperspectral imaging can be used for more applications, and finally live up to its promise. Not only military remote sensing, but also commercial resource management, mineral exploration, and environmental monitoring can be performed more easily and economically.

**PARTNERSHIP TYPE:** Strategic Partnership Projects (SPP) Agreement

**GOAL:** Creating a filter that will make a lower cost, more compact and lightweight hyperspectral imaging system possible



► Wakefield-Vette Vice President David Stone and Engineering Manager Mark Pelillo, holding a prototype cooler, by their CNC Control board.

## Breakthrough Heat Exchanger Changes Cooling Landscape

“Licensing Sandia Cooler technology allows us to solve customer issues we couldn’t solve before. This new technology will expand the repertoire of tools we have to help overcome problems we’re presented with every day.”

— David Stone

Vice President Sales,  
Marketing, and Engineering  
Wakefield-Vette, Inc.

### ► CHALLENGE

Heat generated by electronics requires thermal management solutions. In some applications, the traditional fan and heat sink are just too large, too energy hungry, or too noisy. For other applications, air cooling does not provide enough heat transfer, and liquid or refrigerated cooling solutions need to be employed. But those add expense and risk. Nobody wants to chance having liquid leak from a cooling system into computers or high-powered electronics.

### ► COLLABORATION

Wakefield-Vette has over 50 years’ experience in thermal management. As a design, engineering, and manufacturing company, they create custom products for customers, helping them solve their cooling challenges. When the company learned that Sandia National Laboratories had invented a new type of air-cooled heat exchanger, they realized this technology could help them overcome some of today’s pressing thermal management issues and gain a competitive edge.

The company appreciates the development work Sandia has done up front, shortening the time to market for what will be several new products based on Sandia Cooler technology. Sandia will share knowledge to further accelerate the technology transfer through future collaborations. Wakefield-Vette has the manufacturing facilities and applications engineers needed to produce the products and customize them for various customer needs.

### ► SOLUTION

The Sandia Cooler is a breakthrough air-cooled heat exchanger with a novel design offering many advantages over existing products. It’s on its way to dramatically altering the air-cooling landscape in computing and microelectronics, and has many other potential applications.

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 by combining the fan and heat sink into a single rotating component. It is smaller than the current state-of-the-art alternatives, exceptionally quiet, and energy efficient.

### ► IMPACT

New products based on Sandia Cooler technology have multiple applications in industrial and commercial markets. For example, medical equipment used in hospitals and medical labs require cooling methods that are not just efficient, but also quiet.

The Cooler technology saves cost and infrastructure by expanding the upper temperature limits of air-cooled solutions for systems that produce a lot of heat and now require liquid cooling. For every application, it saves energy.

Because air cooling is used in everything from computers and refrigerators to HVAC systems and lasers, and because the Sandia Cooler uses less energy, Sandia researchers say the technology has the long-term potential to decrease overall electrical power consumption in the U.S. by 1 or 2%.

**PARTNERSHIP TYPE:** License and Strategic Partnership Projects (SPP) Agreement

**GOAL:** Commercializing a new type of energy-efficient, air-cooled heat exchanger that has multiple applications

Sandia National Laboratories and The University of Texas at Austin have a broad and strong relationship that has persisted for decades. The partnership spans collaborative research in novel battery technologies, advanced computational methods, environmental and energy applications, and advanced manufacturing and materials. A number of the collaborations include other institutions, such as the National Science Foundation-sponsored center with the University of New Mexico addressing nanomanufacturing systems.

► UT Austin graduate student Ross Falcon, now a Sandia postdoc, assembling a component of the white dwarf experimental hardware for Z.

## Research at Z Facility Improves Understanding of White Dwarf Stars

“Collaboration with Sandia has helped move astrophysics from an observational science to an experimental science.”

— Don Winget

Harlan J. Smith Centennial  
Professor in Astronomy  
The University of  
Texas at Austin

### ► CHALLENGE

Astronomers need to determine the mass and temperature of white dwarf stars accurately to learn about the fate of stars like our Sun and to estimate the age of the universe.

### ► COLLABORATION

In 2009 a Sandia National Laboratories scientist, Jim Bailey, visited UT Austin, which has one of the largest astronomy departments in the U.S. UT Austin astronomers have studied white dwarfs for many years and, in fact, observing them was one of the main reasons to construct UT Austin’s McDonald Observatory 76 years ago.

Astronomy professor Don Winget and Bailey realized that the extreme temperatures and densities created in the Z pulsed power facility were close to those in white dwarfs. A year later, Sandia and UT Austin began a collaboration to develop a better understanding of these hot, dense stars, which have masses about that of the Sun but are about the size of Earth and have exhausted their nuclear fuel.

Under a collaborative research agreement, UT Austin students and faculty have access to data from Z, the most powerful laboratory source of x-rays on Earth.

### ► SOLUTION

Z can create macroscopic quantities of matter, uniformly heated to extreme temperatures. Four experiments can typically be conducted on each shot with the platform Sandia developed over a 10-year period to study the properties of celestial objects. The emitted radiation on Z provides diagnostic signatures in the form of spectra that can be interpreted and then compared with spectra observed from the photospheres (surfaces) of actual white dwarfs.

Studying the spectra of white dwarf stars allows scientists to infer their mass and temperature and, as a result, to estimate the age of the universe based on the oldest of these stars and to develop theoretical models for the formation of the spectral lines as a function of density and temperature.

### ► IMPACT

Using Z has been transformational for astronomy. For the first time, scientists are able to measure the conditions in white dwarf plasma from just a few centimeters away, rather than at a distance of light years.

Research suggests the inferred masses of tens of thousands of white dwarfs may be systematically underestimated and does not agree with the mean inferred mass deduced through other methods. A leading hypothesis is that the spectral line broadening for hydrogen and helium is inaccurately modeled at the relevant densities.

In addition to achieving high impact results, partnerships with UT Austin and other academic institutions provide a conduit to attract and retain top scientific talent for Sandia’s future workforce. Several new researchers in Sandia’s Pulsed Power Sciences Center have doctoral degrees in astronomy.

**PARTNERSHIP TYPE:** Collaborative Research and Academic Alliance  
**GOAL:** Using pulsed power to infer the masses of white dwarf stars, which are a marker for constraining the age of the universe

# Concentrating Solar Power Makes U.S. More Energy Independent

“The independent evaluations Sandia supplies using its unique capabilities and tools are very valuable. These assessments provide credibility in the industry and help the company develop heliostat solutions that deliver leading performance at a competitive price point.”

— **Tim Connor**

*Vice President, Engineering & Technology  
SolarReserve, LLC*

## ► CHALLENGE

Two main challenges that renewable energy faces in order to be competitive with energy from traditional sources are intermittency and cost. Concentrating solar power (CSP) plants with integrated energy storage solve intermittency issues; while a large part of the cost is for the heliostats that reflect the sun's energy onto a receiver, which then captures the energy and stores it in molten salt to produce electricity day or night.

SolarReserve, a developer of utility-scale solar power projects and advanced solar thermal energy storage technology, has been working on improving structures, optical performance, and control systems. They've been performing research with Sandia National Laboratories since 2009 to find ways to make CSP more efficient and competitive.

## ► COLLABORATION

Currently, SolarReserve and Sandia are improving the performance of heliostats while cutting costs. One approach being developed is to reduce the amount of steel used in the structure that supports the reflective glass while maintaining the structure's strength.

By working at the National Solar Thermal Test Facility (NSTTF), SolarReserve has access to the only test facility of its type in the U.S. and the expertise of Sandia scientists and technicians. Operated by Sandia for the Department of Energy (DOE), the NSTTF provides engineering support and data for components and systems in solar thermal electrical plants.

SolarReserve brings new designs to the NSTTF facility, and the staff helps fabricate, test, and evaluate them. The company benefits by receiving industry-recognized independent assessments. Sandia gains by expanding site capabilities and staff experience.



- Sandia Manager Subhash L. Shinde, SolarReserve Test & Calibration Lead Roger Buck, and Sandia Operations Lead/Test Engineer Bill Kolb look into a new SolarReserve 96-square-meter heliostat tested at the NSTTF. The Sandia Solar Tower and heliostats can be seen in the reflection.

### ► SOLUTION

The performance reports from Sandia are recognized in the energy industry as a valuable source of independent data. They give credibility to new designs and can make the difference in companies like SolarReserve garnering support for new power plants.

Made possible by DOE loan guarantees, SolarReserve's 110 MW Crescent Dunes solar energy plant with 12 hours of energy storage is now fully operational in Nevada. Using technology based on the Crescent Dunes project, SolarReserve received environmental approval from the Chilean government to develop one of the world's largest solar projects with energy storage. The company has also received a commitment of \$400 million in debt financing from the Overseas Private Investment Corporation (OPIC) to support the planned Redstone CSP project in South Africa.

### ► IMPACT

With more utility-scale CSP projects getting approval and coming online, Sandia and SolarReserve are contributing to renewable energy projects worldwide. The impact is that in generations to come, the energy market will be more heavily weighted to renewable sources rather than fossil fuels, making the U.S. and other countries more energy independent.

**PARTNERSHIP TYPE:** User Facility Agreement

**GOAL:** Advancing concentrating solar power technology with energy storage to increase the use of renewable energy

## Launching Rockets to Support Research and Defense



Co-located on the Navy's Pacific Missile Range Facility (PMRF) on the westernmost end of the magnificent island of Kauai, Hawaii, Sandia National Laboratories' Kauai Test Facility (KTF) has a rich history of supporting national security programs. In recent years, KTF has been the premier location for Missile Defense Agency (MDA) work and a variety of research rocket missions—including weapons research and development, operational training, and technology development.

► Staff working details of a mission from inside KTF's Launch Operations Building.

KTF's partnerships with MDA and PMRF are critical to the work done in support of the United States' missile defense mission. The facility works with a steady stream of missions for MDA which include launching targets that simulate enemy offensive systems. MDA is then able to test their missile interceptor capabilities—sometimes working with simultaneous launches. KTF has supported more than 75 missions for MDA.

Additionally, KTF is ideally located to support satellite launches into polar orbits and is also set up to support maritime directed energy testing, and military operational energy technologies. KTF operates several launchers, four assembly buildings, and a launch operations building. The facility also has unique operational access to a rail launcher installed by the University of Hawaii on PMRF's newest launch pad. This one-of-a-kind relationship requires close coordination between KTF, the University, and PMRF for management, safety, and operations.

Customers consistently laud the exceptional support they receive at KTF—from the on-site expertise, machine shops, and facilities to the experienced, dedicated staff. Eric Hedlund, test director of the Aegis Ballistic Missile Defense Program, says, "Without the facility, the instrumentation, and especially the people and expertise here, we would not have been a successful program." Customers choose to partner with KTF in part because of its location, but they choose to stay due to the service they receive while onsite.

## Microfabricated Surface Traps Advance Quantum Computing Potential

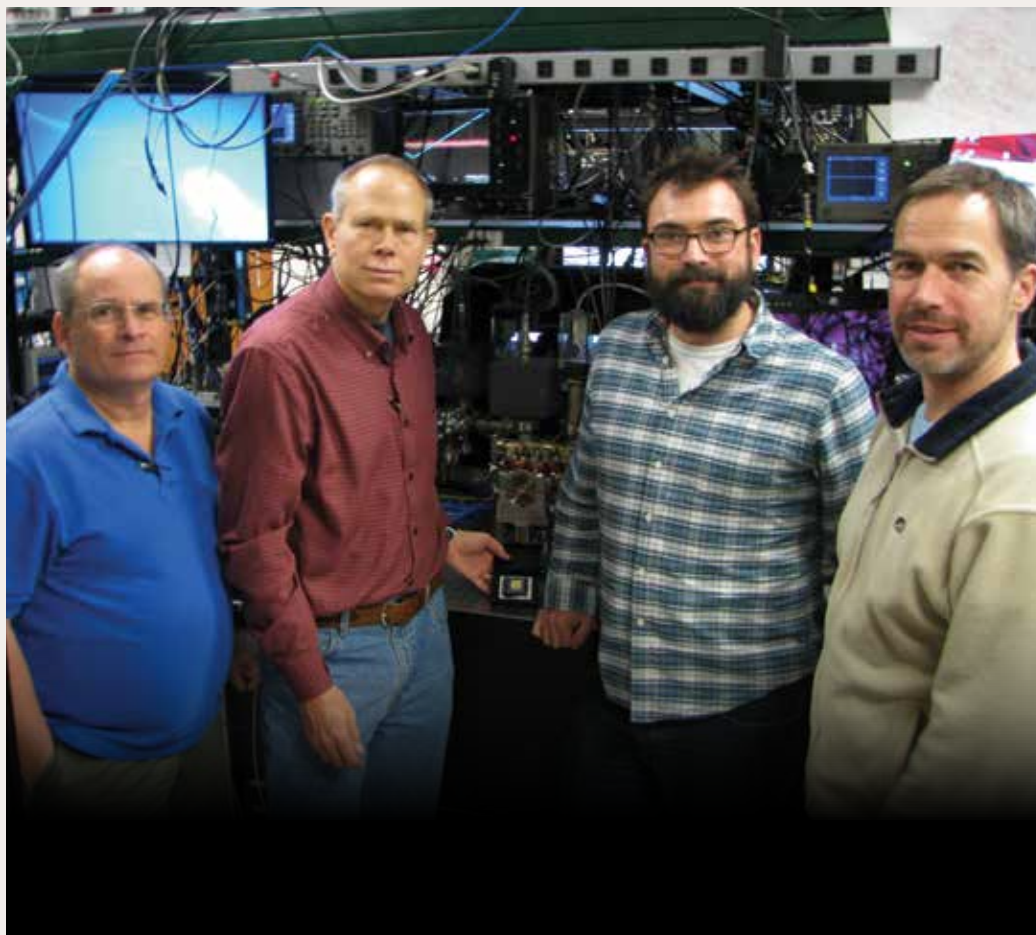
For decades researchers have endeavored to unlock the potential of quantum computing by utilizing the quantum mechanical properties of physical multi-level systems such as photons, electrons, or atoms. One such system is trapped ions, where two or more physical ions can serve as quantum bits, i.e. qubits, and be entangled by virtue of their motional state.

Ion traps have been in use for many years for applications such as spectroscopy, but computing applications cannot use the traditional macroscopic traps these applications often employ. Starting in 2004, Sandia National Laboratories researchers Matthew Blain and Chris Tigges investigated the use of Sandia's Microsystems and Engineering Sciences Applications (MESA) facility for fabricating two-dimensional surface ion traps that could be designed for future quantum information systems. The MESA fabrication facility develops and delivers integrated microsystems components that industry can't, won't, or shouldn't provide, to support mission goals in meeting national needs.

Blain and Tigges partnered with the Intelligence Advanced Research Projects Activity (IARPA) to develop this capability and enable the advancement of quantum information science. As part of its mission to address some of the most difficult challenges in the intelligence community, IARPA sponsors several applied research programs that explore the potential in quantum computing.

Through IARPA's Multi-Qubit Coherent Operations (MQCO) program, Sandia has designed and fabricated advanced surface ion traps and delivered them to IARPA's research partners around the world.

Additionally, Sandia scientists Peter Maunz and Daniel Lobser have demonstrated a two qubit entangling gate with a fidelity of 99.5% using Sandia's latest surface trap design.



► Sandians Chris Tigges, Matthew Blain, Daniel Lobser, and Peter Maunz with the surface ion trap (held by Matt) and the experimental apparatus (on the table behind) used to demonstrate the current benchmark for fidelity.

## Entrepreneur Exploration a Part of Region's Startup Ecosystem



Monthly programs at the Sandia Science & Technology Park (SS&TP) inspired businesspeople and would-be entrepreneurs as the Entrepreneur Exploration program was launched in 2015. One-on-one advice, presentations, and training sessions helped participants refine their business goals and learn how to commercialize technology.

In 2015 over 400 Sandians, SS&TP leaders, New Mexico Small Business Assistance (NMSBA) Program participants, and community leaders participated in Entrepreneur Exploration programs. Events included Office Hours, Roundtables, and Bootcamps.

During Office Hours, business experts and serial entrepreneurs offered personalized assistance, answered challenging startup questions, and helped businesses outline their action plans and define critical milestones.

At Roundtables, industry leaders provided overviews of specific startup topics and then answered questions from the audience.

In Bootcamps, mentors taught the fundamentals of Lean Startup methodology and worked with entrepreneurs to outline their business model in an interactive format.

Entrepreneur Exploration is the first new program for the Center for Collaboration and Commercialization (C3) initiative, which will include a facility planned for the SS&TP. Currently, Entrepreneur Exploration programs are being held at the National Museum of Nuclear Science & History, also located in the SS&TP. The permanent C3 multi-tenant building will serve as a public face for Sandia, dedicated to increasing Sandia's collaboration and commercialization activities and building linkages with the community. It will be a place where Sandians and their partners can interact easily and freely, outside the gates.

► **Sandia Vice President and Chief Technology Officer Rob Leland (fifth from the left) discussed his vision for Sandia entrepreneurs at a July Entrepreneur Roundtable.**

To find out about upcoming Entrepreneur Exploration program events, visit [www.sstp.org/C3](http://www.sstp.org/C3)



## Semiconductor Lasers Part of Automotive Technology Revolution

The current revolution in the automotive world is all about driver assistance. Today's vehicles require numerous sensors and TriLumina's semiconductor lasers help make exciting new car features possible. TriLumina's laser arrays are critical components of Light Detection and Ranging (LiDAR) for Advanced Driver Assistance Systems, bringing the company lots of recent recognition and funding.

TriLumina took part in the New Mexico Small Business Assistance (NMSBA) Program to help them optimize an existing laser array submount assembly. NMSBA gave them access to the expertise and facilities they required, but that were only available at Sandia National Laboratories. The project led to the invention of a new way to connect the small lasers to the submounts by the two Sandians working on the project, with the technology assigned to TriLumina.

The year 2015 was very busy for TriLumina. Since the completion of the NMSBA project, the company won an award from the Los Angeles Auto Show's Connected Car Expo as one of its Top Ten Automotive Startups. They were also listed in EE Times Silicon 60: 2015's Startups to Watch. Plus, TriLumina closed on \$8.5 million in Series A funding from investors Stage 1 Ventures, Sun Mountain Technology Fund, and Cottonwood Capital; and received an investment from Caterpillar Ventures.

An upcoming NMSBA project will look at matching lasers to electrical pulses. This second round of technical assistance from Sandia is expected to help TriLumina enable improvements in both the cost and size of LiDAR components, broadening the potential applications for their Light Engine technology beyond the automotive industry, to areas including other industrial applications of LiDAR sensors, and natural user interfaces.



► TriLumina Director of Technology Mial Warren holding a wafer of laser array submounts like those studied in the NMSBA project.

To learn more about NMSBA, visit [www.NMSBAprogram.org](http://www.NMSBAprogram.org)



## Company Commercializes Tiny, Flexible Solar Cells



Murat Okandan helped develop microsystems enabled photovoltaics (MEPV) at Sandia National Laboratories and now he's bringing the technology to the marketplace. He's one of the founders of mPower Technology, a company that has an option to license MEPV technology, and is working to build upon the original intellectual property to solve customer needs.

Okandan is taking part in Sandia's Entrepreneurial Separation to Transfer Technology (ESTT) program, which permits Sandia employees to leave the Labs to start up or expand technology companies. Entrepreneurs are guaranteed reinstatement for up to two years if they choose to return to the Labs.

The company is commercializing MEPV as Dragon SCALES™ and Dragon Cell™. Dragon SCALES are small, lightweight, and flexible, so they can fit into any device, including wearable devices or sensors of any shape or size, to collect energy to power the device. They can be integrated into satellites and unmanned aerial vehicles (UAVs), biomedical, or consumer electronics applications, and can be folded like a sheet of paper for easy transport, yet provide a lightweight, reliable and high-efficiency power source. Dragon Cell is targeted for standard solar panels, and provides higher voltage, greater reliability, and ultimately lower energy costs (\$/kWh) than currently available photovoltaic cells.

The goal for Okandan is to have MEPV become a cheap, reliable energy source that can power positive change in the world. Through mPower Technology's partnership with Sandia, and the growing interest and excitement around renewable energy—especially solar, Okandan hopes to be able to deliver on that vision.

Dragon SCALES and Dragon Cell are trademarks of mPower Technology, Inc.

► **mPower Technology**  
**Founder Murat Okandan**  
**talks about his company's**  
**technology developed**  
**at Sandia.**

## Events Shine a Spotlight on Technologies and Products

**The Medical and Biotech Innovations Showcase**, held in Pleasanton, CA, in February, provided potential investors and licensees a close look at eight ready-to-license technologies in medical diagnostics, biosurveillance, and therapeutics and drug discovery.

Technologies presented included rapid lab-on-a-chip biodetection systems, a microliter-based digital microfluidic platform, a wearable, noninvasive diagnostic and delivery device, and novel drug-carrying nanoparticles.

For the showcase, Sandia National Laboratories used the commercialization know-how of local organizations: Life Science Angels, an angel investment group focused on healthcare; Tri-Valley Capital, a firm that invests in start-up and established technology ventures and operator of Innovate Pleasanton; i-GATE Innovation Hub, an incubator specialized in growing technology startups; and Innovation Tri-Valley Leadership Group, a collaborative of industry leaders building a robust ecology of innovation.

**The STC.UNM and Sandia 2015 Fall Technology Social and Showcase**, held in Albuquerque, NM, in September, was co-hosted by Sandia and STC.UNM, the University of New Mexico's (UNM) tech transfer office that nurtures innovation for UNM. Company representatives, investors, and entrepreneurs with an interest in and experience with commercializing university inventions attended.

The event presented jointly developed research and technology opportunities as well as start-up companies. Presentations in the morning were of four technologies in Life Sciences including two biosensor devices, microneedles, and semiconducting nanopores. Afternoon presentations were about Engineering and Physical Sciences technologies and included cell-based composite materials, CO<sub>2</sub> capture, encapsulated polymer nanocomposites, and metal phosphide nanomaterials.

Local entrepreneurs and investors ("sharks") took part in a question and answer session, and there was a panel discussion with three companies commercializing jointly owned UNM and Sandia technologies.



► UNM Chemist Diane Dickie and Sandia Chemist Bernadette Hernandez-Sanchez present jointly developed research and technology to those interested in collaborating with and licensing intellectual property from both organizations.

For more information about Showcases, visit [sstp.org/showcase](http://sstp.org/showcase)



## Sandia Selected for Clean Energy Business Assistance Program



Sandia National Laboratories was selected as one of five leads in a new pilot program that gives small, clean-energy companies access to national laboratory expertise and resources. The office of Energy Efficiency and Renewable Energy (EERE) at the Department of Energy (DOE) launched the Small Business Vouchers (SBV) Pilot in the summer of 2015. SBV, which invites small companies to apply for vouchers worth \$50,000 to \$300,000 in assistance from national laboratories, is similar in many ways to the long-running New Mexico Small Business Assistance (NMSBA) Program, but focuses on clean energy technologies and offers larger amounts of assistance than NMSBA.

Sandia is the lead in three of the nine SBV clean energy technical areas: solar, wind, and geothermal, and has \$2.75 million in vouchers to allocate. The first round of submissions has been reviewed, and work started on selected projects in February 2016. Two more rounds of submissions are scheduled for 2016.

Across the entire SBV program in the first round, there were over 450 requests for assistance from businesses in more than 22 states, representing businesses in various stages of the commercialization pipeline. For example, over 80% of requestors have demonstrated the feasibility of the technology in a lab, and 77% of requestors have already created and tested a prototype. Additionally, over 30% of requestors have achieved sales and 52% have demonstrated the technology in an initial pilot.

SBV is the latest element in a technology transfer strategy that seeks to deploy the results of Sandia's publicly funded research and development for the U.S. public good.

► **iBeam Materials**  
**President Vladimir**  
**Matias whose company**  
**is one of the small**  
**businesses with a project**  
**selected for SBV.**

To learn more about the  
SBV Pilot, visit [www.sbv.org](http://www.sbv.org)



## Small Chemical Reactors Improve Fertilizer and Energy Production

When he retired from Sandia in 2011, Milton Vernon wasn't thinking about the nested flow technology he had co-invented at Sandia National Laboratories in 2004. It was originally developed as a way to produce hydrogen without using natural gas, at a time when the price of gas was high. Yet now his company, BayoTech, has licensed the technology for new applications, including distributed fertilizer manufacturing and solid oxide fuel cells (SOFC).

Nested-flow reactors improve efficiency, greatly reducing production cost and environmental impact. These reactors have a 35%-50% lower capital cost than the current type of chemical reactors used to reform natural gas into hydrogen and subsequently urea in a two-stage process.

Today, one-third the cost of fertilizer is for transportation. The U.S. imports 50% of the urea, a common source of nitrogen, used for fertilizer and other industrial purposes. By utilizing BayoTech's modular plants, fertilizer can be made much closer to where it is needed. Since they are much smaller, the plants cost less and can be easily set up anywhere.

BayoTech presented their technology to potential investors at the 2015 Technology Ventures Corporation (TVC) Deal Stream Summit. TVC was formed by Lockheed Martin Corporation as part of the management contract for Sandia. Its goals: job creation, business formations, and equity funding. The annual Deal Stream Summit showcases promising technology companies originating from the Department of Energy laboratories and other research institutions.

Vernon is now hopeful that BayoTech's small reactors can make a difference. Besides being used in the U.S., he envisions that in underdeveloped countries, they could improve farming operations and quality of life. The reactors could take waste from farm animals, and exploit the methane produced to create both urea for fertilizer and hydrogen for energy.



► The BayoTech team collaborating with an industry partner.

## Collaboration Attracts Talent, Enhances Research and Tech Transfer



Sandia National Laboratories has established partnerships with a number of universities to nurture talent, collaborative research, and technology deployment. As an extension of its long-running Campus Executive program, which includes relationships with 23 leading schools, Sandia has begun an Academic Alliance, a more strategic engagement model focused on 5 of these universities.

Sandia formed the Academic Alliance to bring together the Labs' status as a Federally Funded Research and Development Center and the know-how of major national research universities. The goal of the Academic Alliance is to advance science and engineering to enhance our national prosperity and security by providing opportunities for students and faculty to experience research work at a national lab; engaging in joint recruiting of top graduate students, postdoctoral fellows and faculty; increasing transfer of technology from Sandia and universities to the private and federal sectors; and collaborating to address nationally significant problems.

Academic Alliance universities are working closely with Sandia on mutually beneficial research projects. Science and engineering students and faculty have the opportunity to gain access to the expertise and specialized facilities of the Labs to further their studies. Collaboration between the universities and Sandia also increases awareness among science and engineering students of career opportunities at the Labs, helping to attract top candidates.

By fostering collaboration between Sandia and the five prominent national research universities, the Academic Alliance takes a multidisciplinary approach to solving big national problems. A key goal is to engage early-career researchers at both institutions to work on complex problems of practical importance. Collaboration will also lead to more jointly held intellectual property, and more opportunities for technology transfer for the public good.

The universities currently taking part in the Academic Alliance are Georgia Tech, Purdue University, University of Illinois Urbana-Champaign, University of New Mexico, and The University of Texas at Austin.

► **Sandia Senior Manager Marcey Hoover, Sandia President and Laboratories Director Jill Hruby, Purdue University Executive Vice President for Research and Partnerships Suresh Garimella, Sandia Manager Purdue Partnerships William Hart, and Purdue University Chief Scientist and Executive Director of Discovery Park Tomás Díaz de la Rubia.**

## Wind Energy Technology Accelerated by Entrepreneurial Program

In April 2015, Sandia National Laboratories' Twistact team of researchers, led by Jeff Koplow, was selected to take part in the first cohort of the LabCorps program. Launched by the Department of Energy (DOE), Energy Efficiency and Renewable Energy (EERE) Office, LabCorps was created to accelerate the transfer of innovative clean energy technologies from DOE's national laboratories into the marketplace.

Researchers were chosen after attending a series of seminars and entrepreneurship training sessions to prepare them for a competitive pitch of their technology to a selection committee. Each LabCorps team selected is paired with an industry mentor and an entrepreneurial lead. The team works together to map out the most promising pathways for commercialization of the new technology.

The program aims to better train and empower national lab researchers to successfully transition their discoveries into high-impact, real-world technologies in the private sector. By participating in LabCorps, the Twistact team gained access to a suite of commercialization resources, including market validation/testing, techno-economic analysis, and other incubation services.

The patented Twistact design is an enabling technology that could bring more wind energy to the grid by increasing reliability and decreasing cost. The technology was invented to eliminate the need for expensive and heavy rare earth magnets and high-maintenance brush/slip-ring components currently used in wind turbines, allowing more cost-effective wind power.

By participating in LabCorps, the Twistact team discovered through customer interviews a beachhead market in replacement brush/slip-ring modules for wind turbines with the current standard generator architecture. This differs a bit from the originally targeted application, so the team will now seek an experienced partner such as an operations and maintenance firm to perform field testing. Discussions with customers taught them that such testing will greatly improve the chances of Twistact technology gaining acceptance and being commercialized.



► Sandia Researcher Jeff Koplow holding a simple version of Twistact.

## NMSBA Innovation Celebrations



► Taos Mountain Energy Foods CEO and Founder Kyle Hawari and President and Founder Brooks Thostenson.

The New Mexico Small Business Assistance (NMSBA) Program held events in counties throughout the state to recognize the success of small businesses that received assistance from NMSBA.

In addition to honoring NMSBA participants, the six local sessions provided an opportunity for small businesses, local economic development representatives, elected officials, and community leaders to network and learn about what NMSBA offers to help businesses grow. Panel discussions allowed company owners to share the positive impact they experienced as a result of their NMSBA projects. NMSBA project managers were also on hand to answer questions about the program.

At the Santa Fe celebration, Taos Mountain Energy Foods received the “Honorable Speaker Ben Luján Award for Small Business Excellence” for demonstrating the most economic impact. U.S. Congressman Ben Ray Luján presented this special award.

NMSBA assists for-profit small businesses in New Mexico with access to experts at Sandia National Laboratories and Los Alamos National Laboratory. These experts help businesses gain knowledge and solve challenges utilizing the labs’ cutting-edge technologies.



## Innovation and Intellectual Property Celebration

The sixth annual event was held in June at the Sandia Golf Club Event Center in Albuquerque to honor the innovative culture and intellectual property generated by Sandia National Laboratories’ scientists, engineers, and technologists.

At the celebration, 146 Patent Inventors and 34 Copyright Authors were recognized. Also receiving awards were 32 Director-nominated Up & Coming Innovators who were recognized for their technical excellence in support of innovation and intellectual property generation, and entrepreneurial talent.

For the first time this year, 130 Sandians gained recognition as Mission Innovators, an award for those whose technical expertise and innovative contributions support delivery of Sandia’s national security mission.

The first Entrepreneurial Hall of Fame Inductee, Hong Hou, was also announced at the event. Hou is a former Sandian who left the Labs to expand semiconductor and solar company, EMCORE, which was commercializing products that stemmed from technology he helped develop at Sandia. He is credited with building the company into one of the world’s leading manufacturers of high efficiency solar cells and solar panels for space power applications.

Sandia National Laboratories won a number of awards again this year. These awards recognize achievements in technology development, technology transfer, and technology partnerships.

## R&D 100 Awards

Widely recognized as the “Oscars of Invention,” the R&D 100 Awards identify and celebrate the top 100 technology products of the year spanning industry, academia, and government-sponsored research.

### CO<sub>2</sub> Memzyme



An ultra-thin membrane that is the first cost-effective technology for carbon-dioxide separation and capture to meet and exceed the Department of Energy’s targets, the CO<sub>2</sub> Memzyme also won the Green Technology Special Recognition Gold Award.

### LED Pulser

Light-emitting diodes are used instead of expensive lasers to provide high brightness, rapidly pulsed, multicolor light for scientific, industrial or commercial uses.

### Integrated Circuit Identification



Authenticates integrated circuits, detects counterfeit electronics, and verifies individuals’ identities and their transactions using a unique device signature and cryptographically secure challenge-response protocol.

### Lightweight Distributed Metric Service



Monitoring software that provides detailed awareness of the systemwide performance of high-performance computers and applications in production environments.

### 6.5kV Enhancement-Mode Silicon Carbide JFET Switch

A low-loss power switch based on a novel silicon carbide junction field-effect transistor that will improve the efficiency of next-generation power conversion systems used in energy storage, renewable energy and military applications, as well as data center power distributions.



## FLC Awards

The Federal Laboratory Consortium (FLC) Awards Program annually recognizes federal laboratories and their industry partners for outstanding technology transfer efforts.

### FLC National Awards

#### Excellence in Technology Transfer BaDx



A “lab-in-a-pocket” device used to sample, sense, and diagnose anthrax, BaDx uses no power, refrigerated storage, or lab equipment and keeps handlers safe.

### FLC Mid-Continent & Far West Region Awards

#### Excellence in Technology Transfer Decontamination Technology for Chemical and Biological Agents



This technology is being used for a growing number of applications ranging from battling toxic mold to disinfecting healthcare facilities and agricultural packing plants.

#### Notable Technology Development Dynamic Prosthetic Socket System

This system is aimed at helping prosthetic limbs fit better by automatically accommodating changes in body fluid.

#### Outstanding Technology Development Twistact



Twistact can eliminate the need for expensive rare earth magnets and brush/slip-ring components, enabling more cost-effective wind power.

#### Technology Transfer Professional of the Year Bianca Thayer

Ms. Thayer was recognized for her exceptional contributions to the transfer of technologies developed at Sandia.

## Popular Science Award

### Best of What’s New, Security

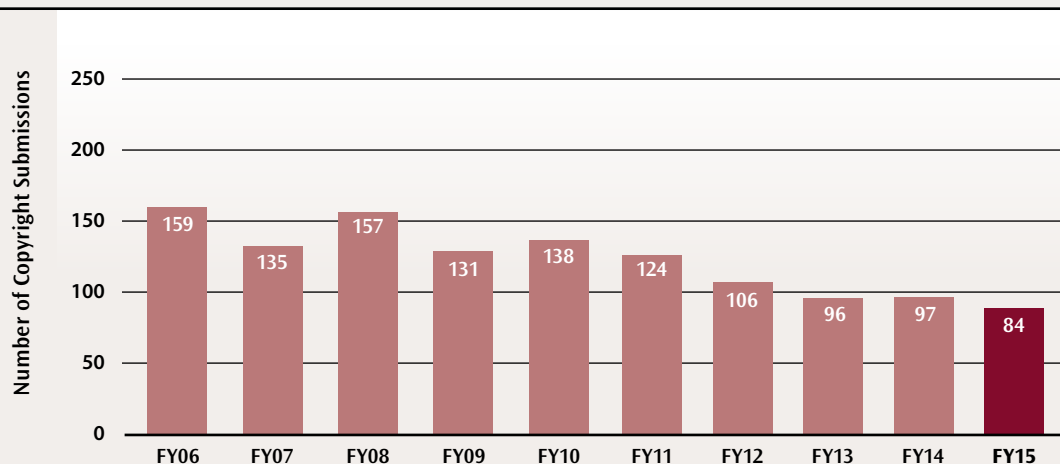


BaDx and Sandia partner Aquila, which is manufacturing the product, were recognized for developing and distributing this small, safe anthrax detector, and its potential to be adapted for other bacteria.

- FLC Mid-Continent Region Director Jack James, Sandia Principal Member of Staff Jason Wheeler, and Sandia Technology and Economic Development Department Manager and FLC Mid-Continent Region Deputy Director Jackie Kerby Moore.

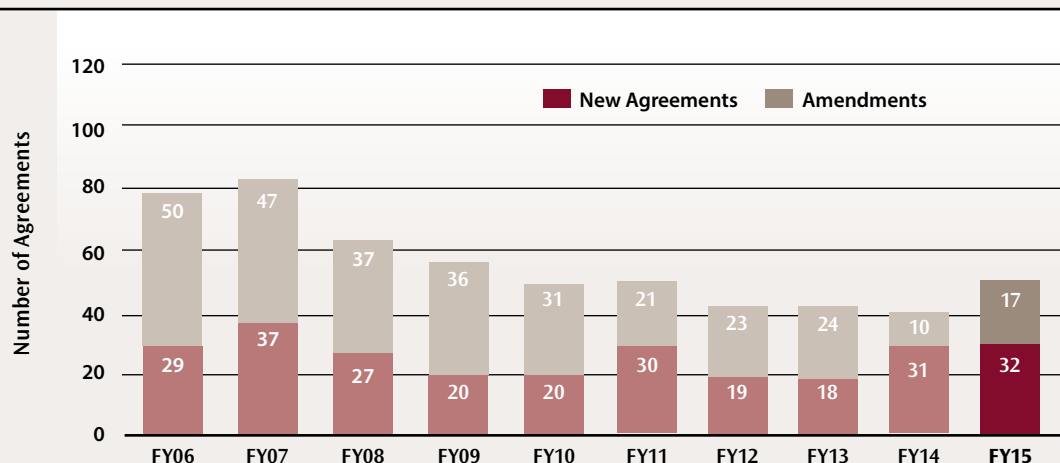
## Copyrights

### Copyright Submissions

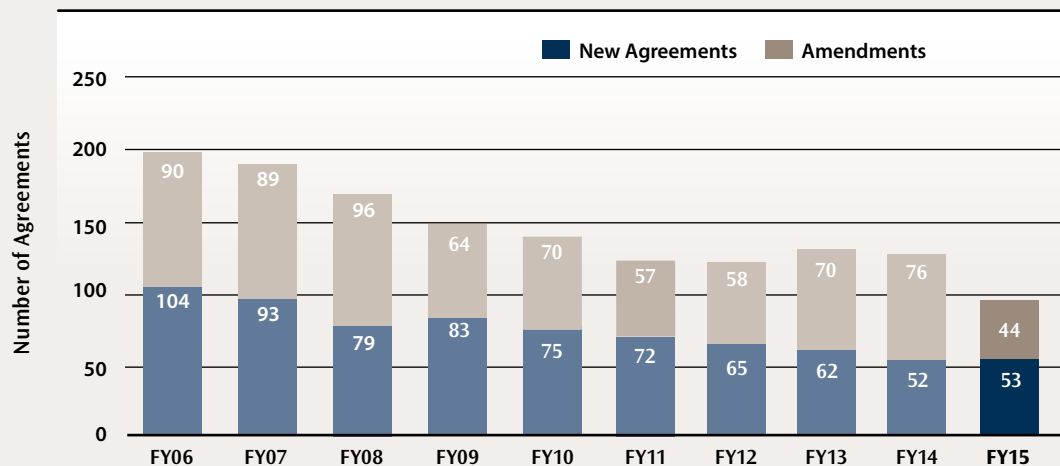


## CRADAs and SPP/NFE Agreements

### Cooperative Research and Development Agreements (CRADA)



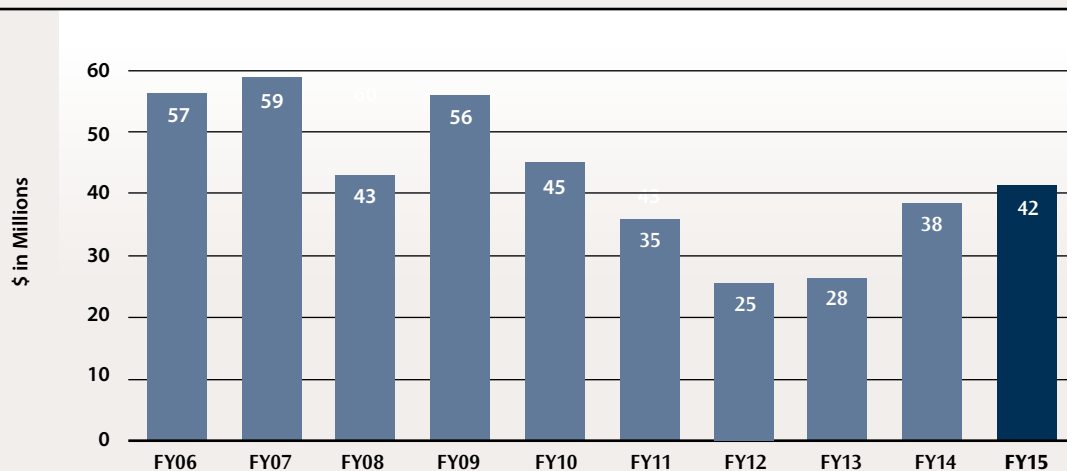
### Strategic Partnership Projects, Non-Federal Entity (SPP/NFE) Agreements



## Industry Funds-In

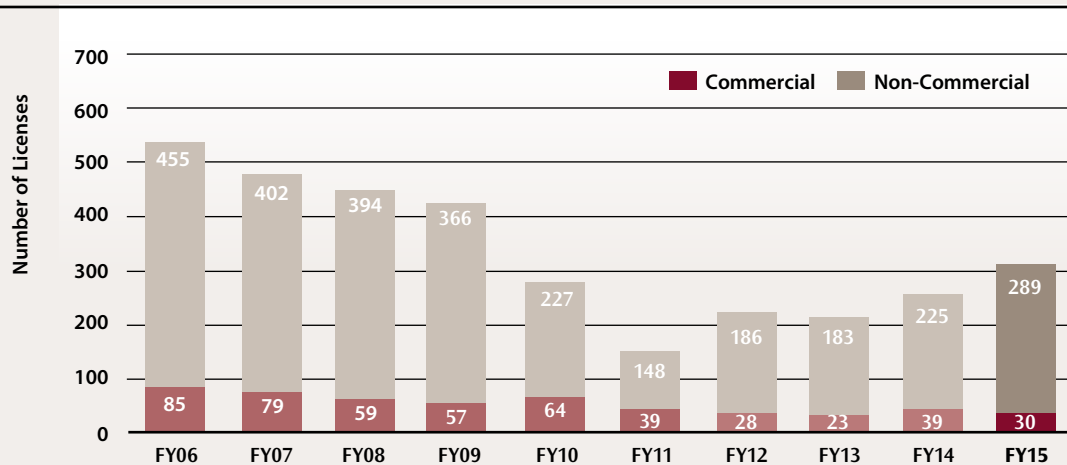
### Industry Funds-In to Sandia (\$M)

Values represent Funds-In for CRADAs, SPP/NFE Agreements, and Licensing Income.

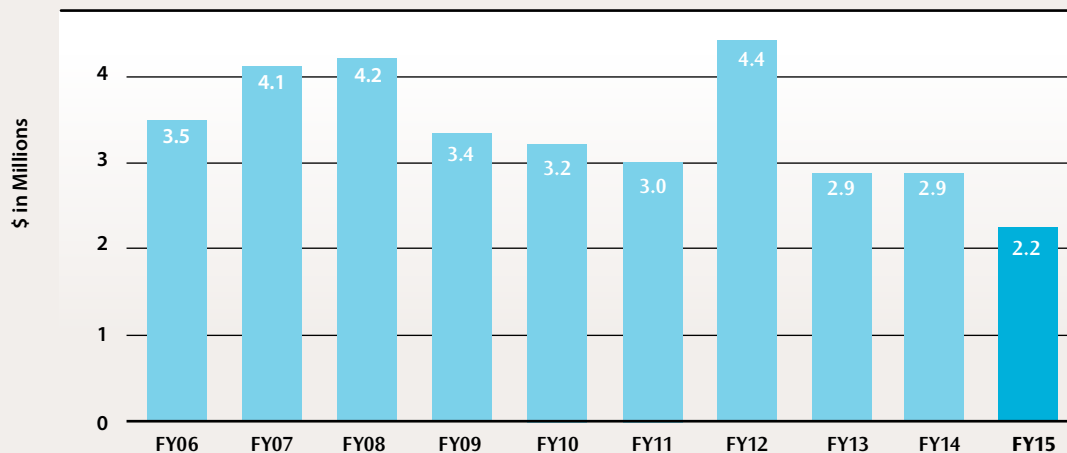


## Licenses

### Licenses

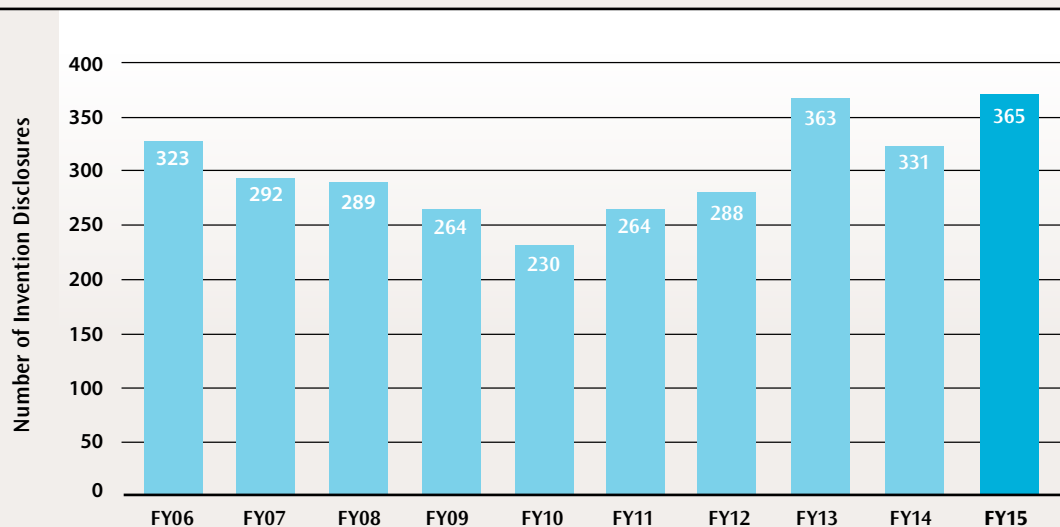


### Licensing Income (\$M)

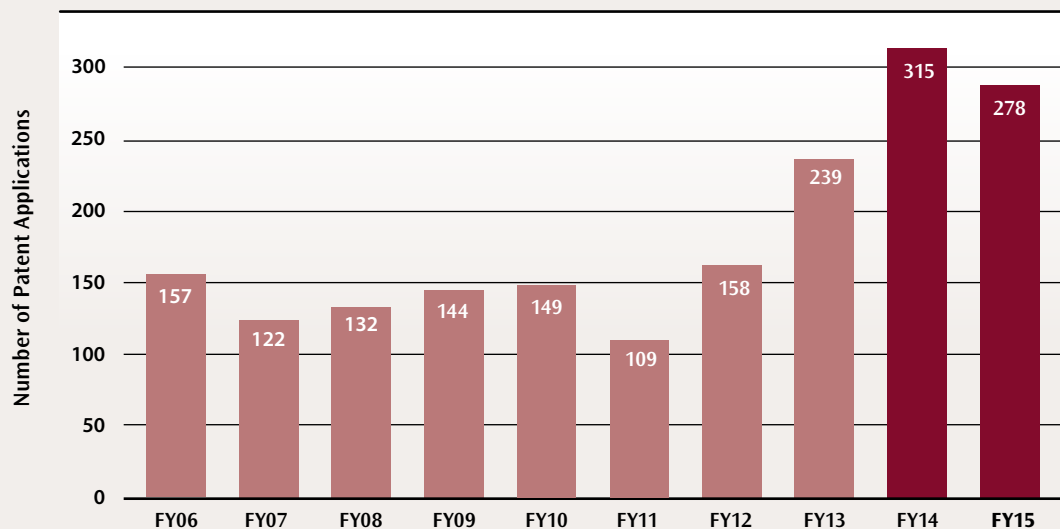


## Patent Activity

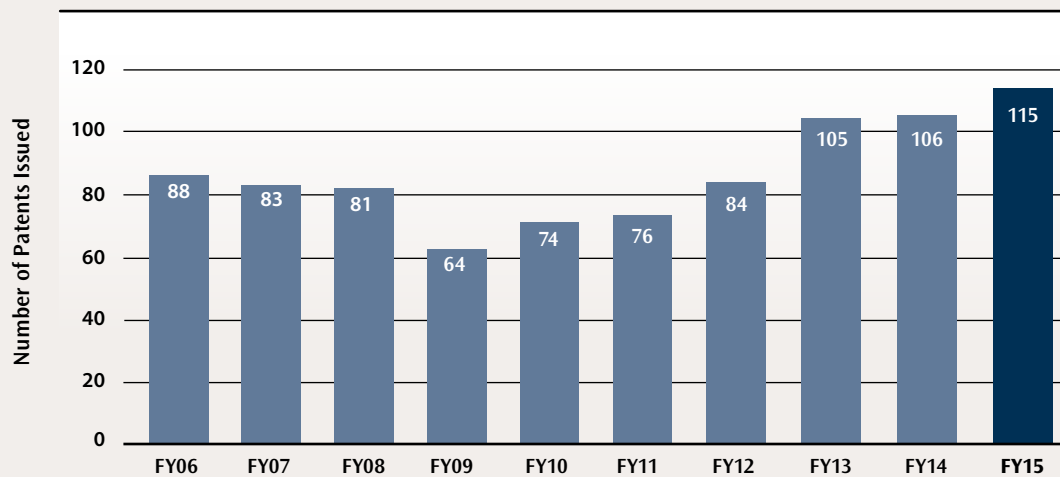
### Invention Disclosures



### Patent Applications



### Patents Issued

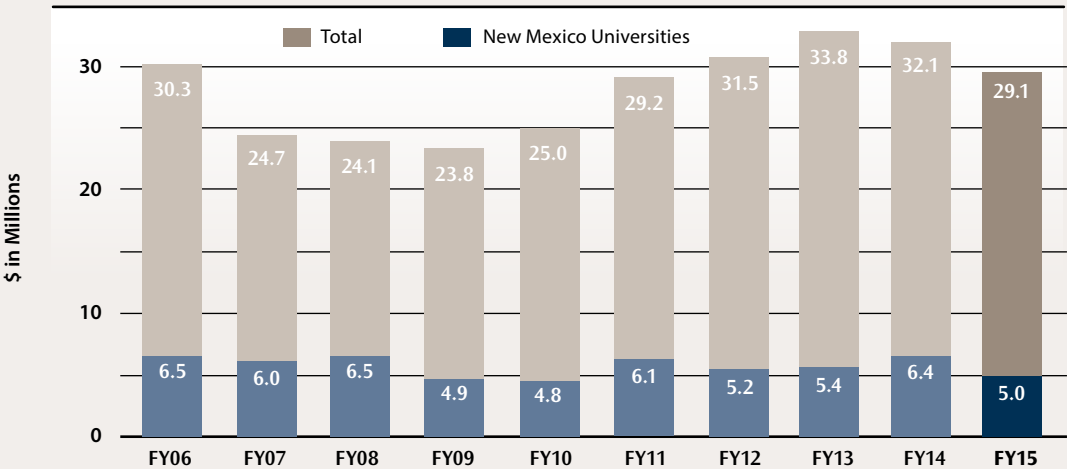


# University Partnerships

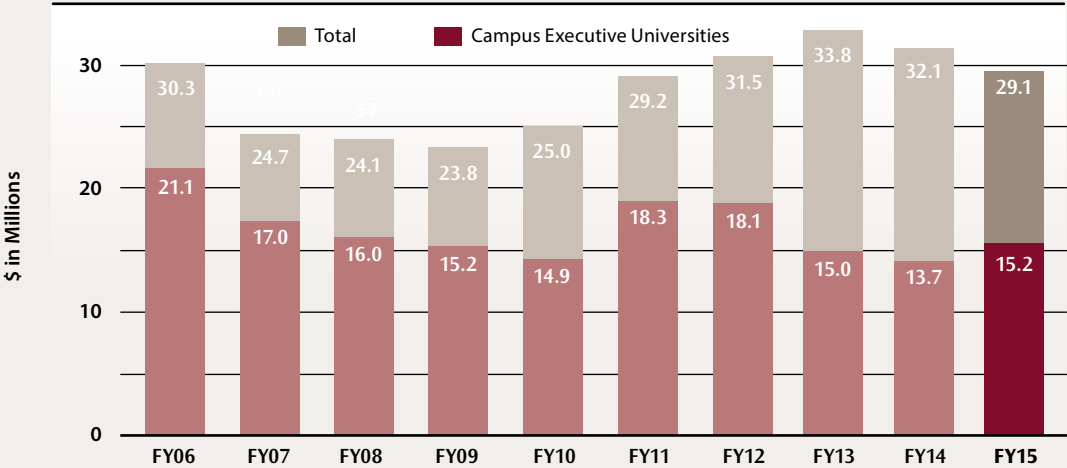
Sandia National Laboratories has traditionally contracted for university research to expand its science and technology base. Both Sandia and universities share a need to accelerate the creation of world-class research, develop scientists and engineers, and grow competencies and new businesses.

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 Research at New Mexico Universities



## Investments in Research at Campus Executive Program Universities



The Campus Executive Program pairs Sandia executives with university officials at schools that share research interests and capabilities.



**2015:** Four new companies and organizations moved into the SS&TP: Innovative Reasoning, LLC; Qynergy Corporation; Stone Lion Environmental, LLC; and Technology Leadership High School.

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

### Results

|                                                             |          |
|-------------------------------------------------------------|----------|
| Companies and Organizations .....                           | 40       |
| Employees .....                                             | 2155     |
| Buildings .....                                             | 25       |
| Funds-In to Sandia from Park Companies* .....               | \$17.8M  |
| Contracts from Sandia to Park Companies* .....              | \$459M   |
| Contracts Between Park Companies* .....                     | \$12.5M  |
| Public Investment in the Park* .....                        | \$89M    |
| Private Investment in the Park* .....                       | \$286.5M |
| Total Investment in the Park* .....                         | \$375.5M |
| Average Salary of Full-time Jobs in Park .....              | \$83K    |
| Average Salary of Full-time Jobs in Metro Albuquerque ..... | \$42K    |

\*Since Park opened in 1998



**2015:** Sandia invested \$2.4M helping 205 small businesses in 18 counties throughout New Mexico. There were 81 Sandia principal investigators across 63 departments that supported NMSBA.

## New Mexico Small Business Assistance (NMSBA)

In 2015 the state of New Mexico, along with Los Alamos and Sandia national laboratories, invested over **\$4.77M** helping **366** small businesses in **24** counties.

**2000 - 2015**

**New Mexico Small Businesses Assisted** ..... 2495

### Rural vs Urban Businesses

|                   |      |
|-------------------|------|
| Rural (65%) ..... | 1620 |
| Urban (35%) ..... | 875  |
| Combined .....    | 2495 |

**Dollar Amount of Assistance** ..... \$48.5M

**2000 - 2014**

**Return on Investment (ROI)** ..... 1.9

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

### Economic Impact

|                                                  |        |
|--------------------------------------------------|--------|
| Small Business Jobs Created and Retained .....   | 4863   |
| Mean Salary .....                                | \$39K  |
| Increase in Revenue .....                        | \$236M |
| Small Business Decrease in Operating Costs ..... | \$105M |
| Investment in NM Goods/Services .....            | \$98M  |
| New Funding/Financing Received .....             | \$87M  |



**2015:** Six employees left on ESTT, five to start up a company and one to expand an existing company.

## Entrepreneurial Separation to Transfer Technology (ESTT)

**Sandians Who Left on ESTT\*** ..... **152**

|                             |    |
|-----------------------------|----|
| To Start up a Company ..... | 67 |
| To Expand a Company .....   | 85 |

**Companies Affected by ESTT\*** ..... **104**

|                           |    |
|---------------------------|----|
| Start-up Companies .....  | 52 |
| Expansion Companies ..... | 52 |

\*Since ESTT began in 1994

**For general questions and comments, contact [partnerships@sandia.gov](mailto:partnerships@sandia.gov).  
For information about specific partnership areas, contact the following:**

### **Industry Partnerships**

Andy McIlroy, 505-844-1071, [amcrlr@sandia.gov](mailto:amcrlr@sandia.gov)

### **Business Development and IP Management**

Mary Monson, 505-844-3289, [mamonso@sandia.gov](mailto:mamonso@sandia.gov)

### **Strategic Partnership Agreements and CRADAs**

Samuel Felix, 505-284-3225, [ssfelix@sandia.gov](mailto:ssfelix@sandia.gov)

### **Business Development and Partnerships**

Rene Sells, 505-844-2882, [rmgonza@sandia.gov](mailto:rmgonza@sandia.gov)

### **Industry Partnerships and Technology Transfer (California)**

David Gibson, 925-294-6905, [dwgibso@sandia.gov](mailto:dwgibso@sandia.gov)

### **Technology and Economic Development**

Jackie Kerby Moore, 505-845-8107, [jskerby@sandia.gov](mailto:jskerby@sandia.gov)

### **Technology Ventures Corporation**

John Freisinger, 505-246-2882, [john.j.freisinger@lmco.com](mailto:john.j.freisinger@lmco.com)

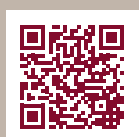
*Founded in 1993 by Lockheed Martin, Technology Ventures Corporation's charter is to facilitate the commercialization of technologies developed at Sandia, other laboratories, and research universities.*



### **Partnerships National Reach**

Explore our interactive data map which illustrates the amazing breadth of work Sandia National Laboratories does with industrial, university, government, and lab partners around the U.S.

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



### **Partnerships Annual Report Team**

#### **Sandia National Laboratories**

Jackie Kerby Moore, *Manager*

Michael Vittitow, *Designer*

Randy Montoya, *Photographer*

Michael Bejarano, *Photographer*

Thomas Hamilton, *Photographer*

#### **Akima Infrastructure Services, LLC**

Linda von Boetticher, *Project Manager  
and Photographer*

#### **Contractors**

Ellen Cline, *Copywriter*

Norman Johnson, *Photographer*

Lonnie Anderson, *Photographer*

Dino Vournas, *Photographer*

*Photos courtesy of Department of Energy;  
Colonel Jim Pringle, U.S. Army; Red and White  
Fleet; Wakefield-Vette, Inc.; Sandra Valdez, Los  
Alamos National Laboratory; BayoTech; Nicole  
Kingma, Purdue University Discovery Park; and  
Stephen Crutchfield, SPAWAR Systems  
Center Pacific.*



To learn more about industry or university partnership opportunities with Sandia, visit [www.sandia.gov/partnerships](http://www.sandia.gov/partnerships) or contact us at [partnerships@sandia.gov](mailto:partnerships@sandia.gov)



To learn more about licensing and technology transfer at Sandia, visit <https://ip.sandia.gov> or contact us at [ip@sandia.gov](mailto:ip@sandia.gov)

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. SAND2016-3314 M

