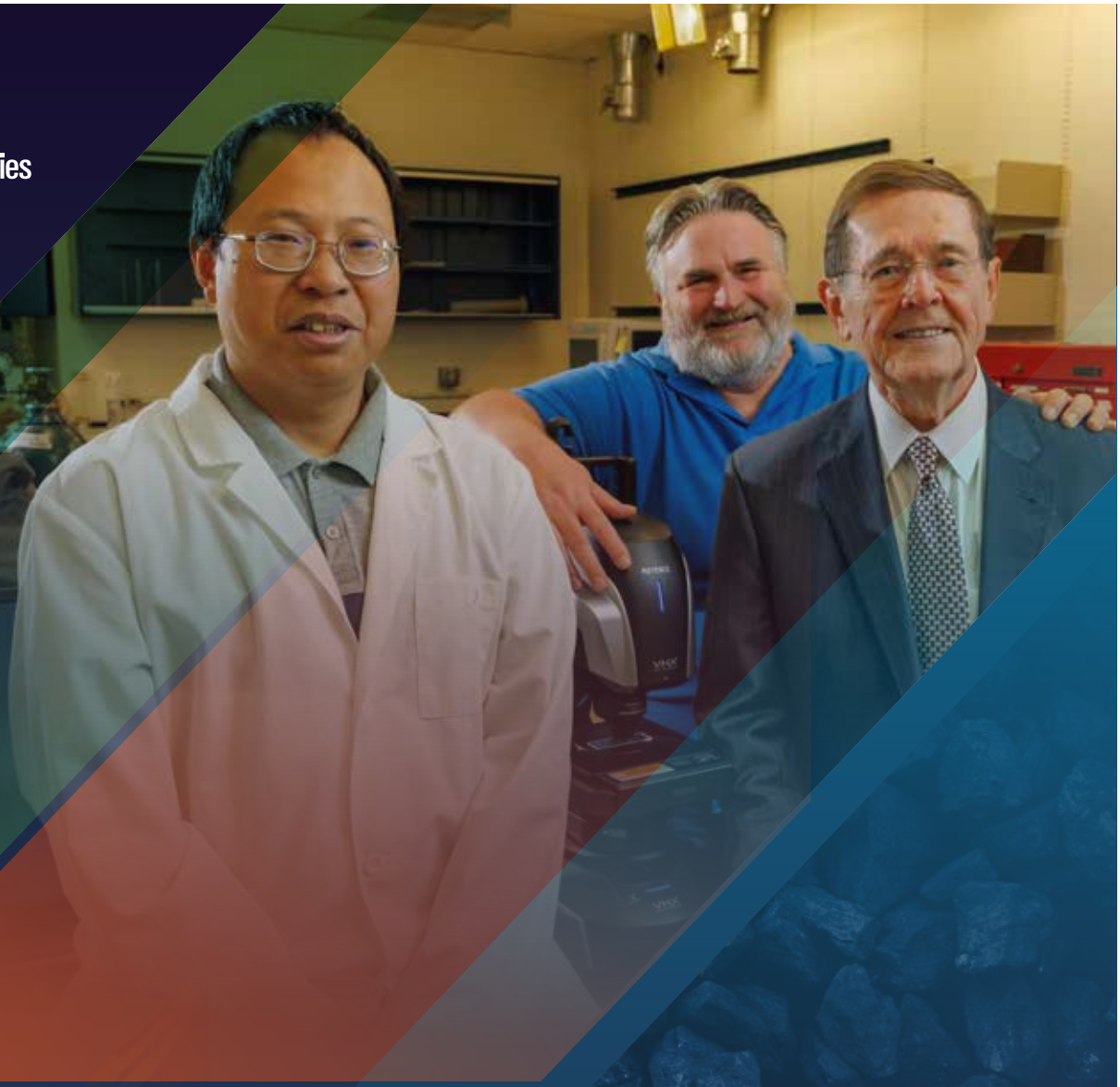
Sandia National Laboratories



TECHNOLOGY Partnerships

ANNUAL REPORT
FY2022

Technology Converts Coal Ash from Trash to Treasured Strategic Metals

"In 2022, Sandia continued its proven track record of driving innovation and the commercialization of lab technologies through their impressive repertoire of partnerships and programs. This report highlights why Sandia is a key part of DOE's commercialization ecosystem and how their daily work delivers for the American people."

— Dr. Vanessa Z. Chan

Chief Commercialization Officer
Director, Office of Technology Transitions
US Department of Energy (DOE)

"Sandia's partnerships are supporting the maturation and deployment of mission-inspired discoveries and inventions, enabled by strategic investments in research and development. These partnerships continue to support our national security missions, inclusive of technology transfer, through the commercialization of innovative technologies that benefit our nation's security."

— Dan Sanchez

DOE Technology Partnerships Manager
National Nuclear Security Administration (NNSA)
Sandia Field Office

"The Sandia Partnerships Program ensures that innovative technologies developed at the Labs reach the marketplace to strengthen national security and build US economic prosperity and competitiveness. We are proud of and committed to the partnerships with industry, academia, and government that make technology transfer possible. We will continue to broaden the Labs' impact through tech transfer and improve the quality of Americans' lives."

— James S. Peery

Laboratories Director
Sandia National Laboratories

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About the cover:

Sandia researchers are working with startup Critical Materials to optimize technology that will lessen reliance on overseas sources for strategic metals.

See story on page 20.

"New initiatives in technology commercialization are bolstering both mission fulfillment and the national economy. Partnerships and technology transfer ensure that scientific developments resulting from Sandia R&D can be utilized for all potential applications, whether for national security,energy security, or economic growth."

— Susan Seestrom

Associate Laboratories Director & Chief Research Officer
Advanced Science and Technology
Sandia National Laboratories

"We've expanded our relationships with universities across the nation to bring in more diversity in research partnerships and hiring. The new Sandia University Partnerships Network (SUPN) is helping us to cultivate enduring strategic and mutually beneficial relationships with a focused set of schools beyond our previous Academic Alliances."

— Basil Hassan

Director and Deputy Chief Research Officer
Chief Research Office
Sandia National Laboratories

"We're breaking down barriers and amplifying our engagement with industry to increase tech transfer. Our new TCF technology partnership projects are making it easier for businesses to engage with Sandia and multiple national laboratories while speeding up the technology transfer process."

— Mary Monson

Senior Manager
Technology Partnerships & Business Development
Sandia National Laboratories

Strengthening US Security, Manufacturing, and Supply Chains

New federal initiatives are focused on expanding US manufacturing while strengthening supply chains and national security. In addition to the CHIPS and Science Act of 2022, the DOE funded an over $18 million Technology Commercialization Fund (TCF) opportunity accelerating the labs' transfer of clean energy technologies to the marketplace. Sandia National Laboratories is leading three of the seven projects that received awards.

While the Sandia-led projects are part of a nationwide push, they also focus on the regional economy, and build upon the myriad Partnerships Programs Sandia already has in place.* Sandia partnerships with industry, universities, and other national laboratories continue to bring new technologies to market, creating a vibrant economy.

Here are just a few of the Sandia partnerships highlighted in this annual report that are promoting clean energy, manufacturing, and national security.

- Commercializing a new way to source essential rare earth elements domestically, in an economical and environmentally friendly way
- Increasing the amount of solar energy produced with active automated tracking of concentrating solar power heliostats
- Developing non-fogging plastic scintillators that are now being manufactured for threat detection
- Advancing pH sensor technology for integration into a downhole tool that can enhance geothermal energy production

Sandia is already a leader in partnership programs that benefit local businesses and the national economy. The new TCF projects will leverage Sandia's expertise by promoting rapid deployment of clean energy through new ventures aimed at regional energy challenges, with a focus on underserved communities.

*See the TCF story on page 32 for more details.

LDRD Program Essential to Mission Capabilities

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.

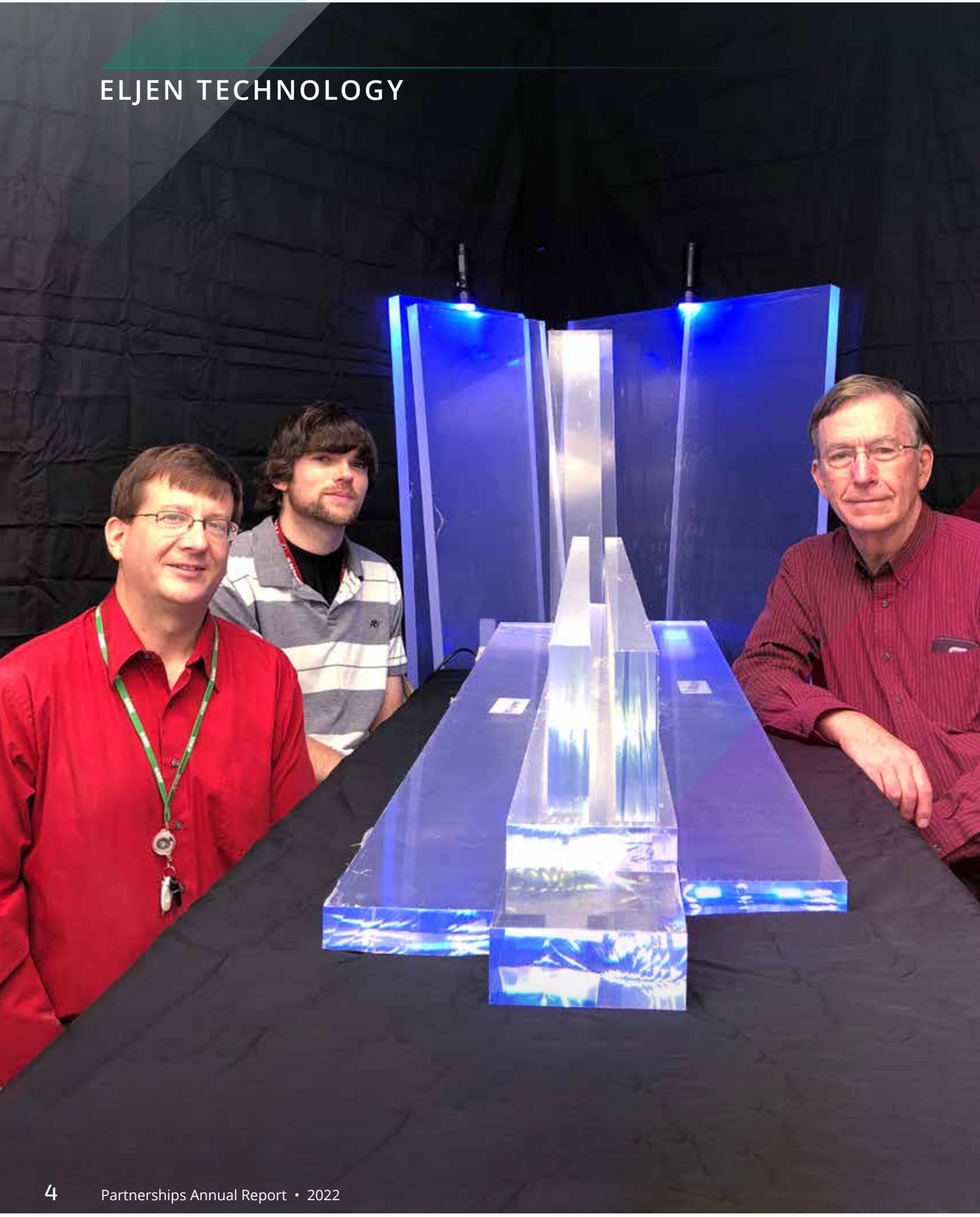
The Labs and its strategic partners gain from collaborative research results. Many technological breakthroughs originating from, or improved through, the LDRD program are later transferred to industry, commercialized under licensing agreements, and brought to market for the US public good.

LDRD
LABORATORY DIRECTED RESEARCH & DEVELOPMENT

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/ldrd

ELJEN TECHNOLOGY



Non-Fogging Plastic Scintillators Improve Threat Detection

"This very successful collaboration had a number of very satisfying aspects including open and free-ranging discussions with the Sandia researchers and amicable and honest teamwork to achieve the best result possible."

— Charles Hurlbut

General Manager
Eljen Technology

CHALLENGE

The Department of Homeland Security (DHS) maintains a network of radiation detection portals at the borders. These function to monitor cargo passing between the US and its neighbors, and are designed to detect radiological materials that could be used to create nuclear weapons or dirty bombs.

The large plastic scintillators in these detection systems have a high sensitivity in order to detect radioactive materials passing in front of them. But these scintillators are exposed to blazing heat, torrential rain, and freezing temperatures 24/7. So even when enclosed in hermetic boxes, over time, moisture creeps in. Eventually, the plastic scintillator becomes foggy, causing the detector to not function as well. This increases the chance that dangerous cargo could enter the US.

COLLABORATION

Sandia National Laboratories has extensive experience with scintillators as part of its national security mission. Sandia scientists, along with those from other DOE laboratories, were funded by the DHS Countering Weapons of Mass Destruction Office to look into updating plastic scintillator technology to overcome the fogging issue.

Eljen Technology, a manufacturer of organic scintillation material, worked to fine-tune a non-fogging formulation developed and patented by Sandia. The company wanted to develop a manufacturing process for the large scintillators, 2 inches thick and 6 to 8 feet high, required by their customers for radiation portal monitor detectors and other applications.

SOLUTION

Once they knew why the original plastic scintillators were failing, Sandia researchers came up with a new formula to overcome the stresses on the material caused by temperature changes and humidity. These stresses were causing the material to crack and become cloudy, and once that happened, less light could pass through the scintillator, impairing its function.

Eljen took the Sandia formula and gradually scaled up the process at their manufacturing facility from the small scintillator prototypes Sandia produced in the lab, to larger and larger plates of material. The company figured out processes that enabled them to efficiently and repeatedly manufacture the large scintillators. Then Eljen worked on the polymer structure to keep the large sheets of material flat. Eljen is now selling non-fogging plastic scintillators to its customers that perform well, last longer, and don't require hermetic enclosures.

IMPACT

The non-fogging plastic scintillators will keep working effectively for years longer than previous plastic scintillators. This improves national security, and ensures the reliability of the monitoring network, helping the DHS detect radiological threats.

Eljen Special Projects Engineer Terry O'Brien, Chem Lab Manager Kyle Shipp, and General Manager Charles Hurlbut with samples of their EJ-200NF non-fogging plastic scintillators used for testing.

PARTNERSHIP TYPE: *License*
GOAL: *Developing non-fogging plastic scintillators that could be manufactured at a large scale for threat detection*

New Method Makes Biofuel and Bioproducts Industry More Sustainable

"Sandia is an excellent partner. They provided data on the fundamental chemical composition of materials that directed our application efforts. With this structure-function relationship, and working in partnership, we developed a feedback loop with Sandia creating new prototypes that fit the design criteria better."

— Thomas Sisson

Sr. Director, Technology
Ingevity Corporation

CHALLENGE

The DOE's Bioenergy Technology Office (BETO) wants to enable the biomass industry to produce both fuels and chemicals profitably. In order to do this, the industry needs to be able to better use the approximately 20% of biomass that is lignin.

Lignin is a complex carbon-containing material that doesn't have a regular structure, is hard to break down, and is not very hydrophilic, or compatible with water. It is often burned for heat or energy, but this is a low-value use for what is now generally a waste product. If a higher value use for the lignin left after biofuel production were found, it would help make biofuel more affordable.

COLLABORATION

Ingevity is the world's largest producer of kraft lignosulfonates, producing a range of lignin products for agriculture, battery, and textile markets. Currently the lignin they use comes from the kraft process in the pulp and paper industry. The company is looking for better ways to create their current products and for potential new products that can be derived from the large quantities of lignin that will be produced by biorefineries as they come on line.

Sandia National Laboratories develops technology to address pressing national needs in energy security. Sandia is also a partner of the DOE-sponsored Joint BioEnergy Institute, which focuses on conversion of lignocellulosic biomass into transportation fuels.

Joint research between Ingevity and Sandia is focused on lignin from pulp and paper processing, a current business area of Ingevity, as well as biorefinery lignin, which is a potential future business area for Ingevity.

SOLUTION

Sandia came up with an oxidative methodology that uses small amounts of iron and hydrogen peroxide to convert the lignin waste from biorefineries into valuable products. The technology provides an economically viable single-step process that can chemically transform polymeric lignin into commercial dispersants, materials for nutrient delivery or water purification, or for other applications.

IMPACT

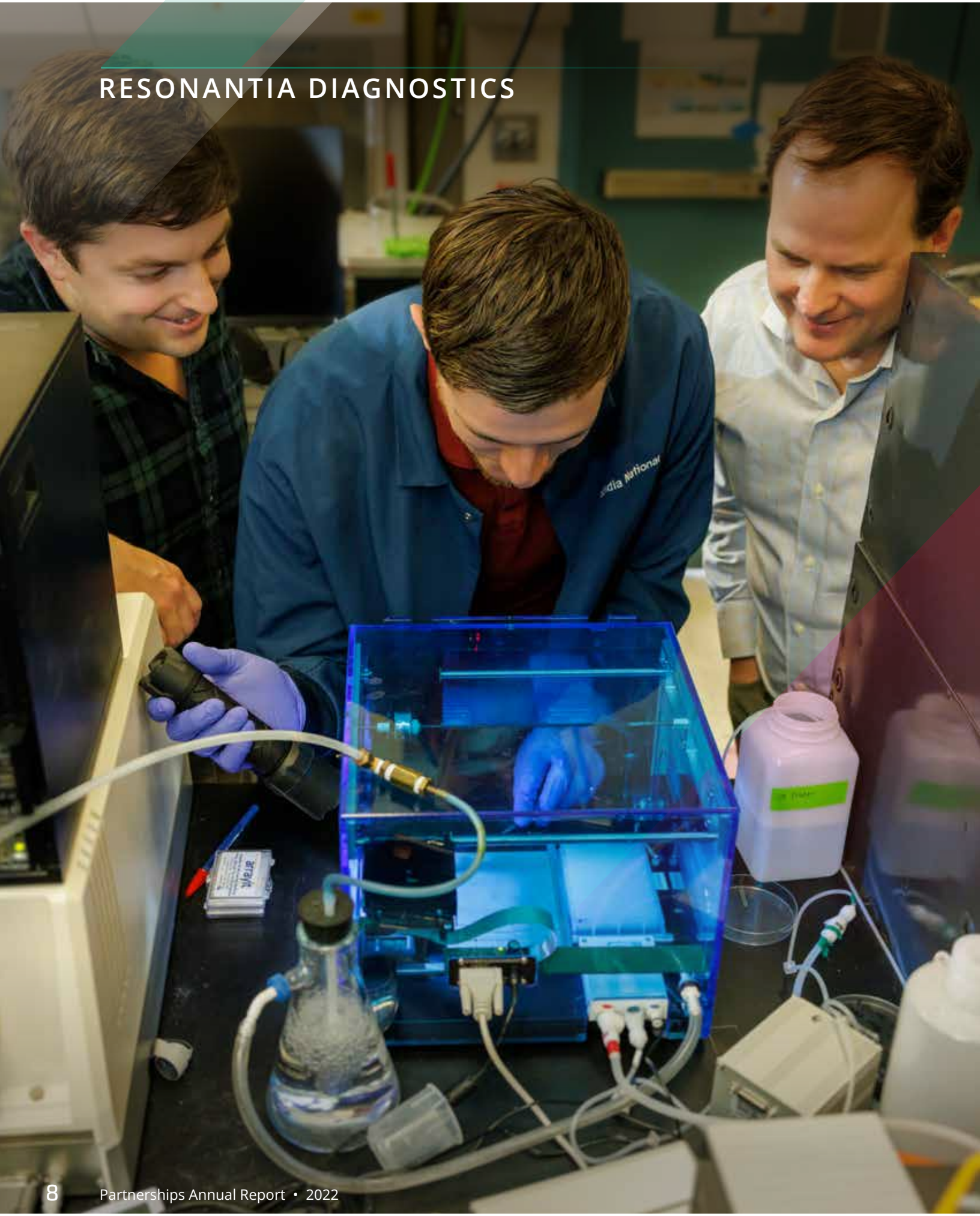
Currently, sulfonation of lignin is used to generate water-soluble polymers from kraft lignin. The new method could allow Ingevity to use lignin from an additional source, lignocellulosic biorefineries, and, at the same time, enable the company to create new materials and products and enter new markets.

Supporting a sustainable domestic biofuel and bioproducts industry enhances Sandia's energy security mission. It also supports broader US efforts to ensure future energy security by lowering greenhouse gases to mitigate climate impacts.

Ingevity Lead Chemist Kim Tran and Analytical Chemist Preet Khayat in their lab, shown with one of Ingevity's plants located in Warrington, England.

PARTNERSHIP TYPE: *Collaborative BETO-funded research*
GOAL: *Enabling the biomass industry to create not just fuels and chemicals, but also valuable polymeric products from the lignin portion of biomass that is now generally a waste product*

RESONANTIA DIAGNOSTICS



Acoustic Technology Speeds Diagnoses and Improves Patient Outcomes

"Working with Sandia we have the ability to access a tremendous amount of resources and world-class talent on an as-needed basis; something that would be prohibitively expensive if we tried to go at it alone."

— Matt Jones
CEO
Resonantia Diagnostics, Inc.

CHALLENGE

Bacterial and fungal infections greatly increase the cost of treating patients. They also cost lives. Current testing methods are slow and laborious, meaning that patients might not be given the best antibiotic or antifungal medicine to treat their condition for days. While waiting, their condition may worsen and their time in the hospital can increase. To improve patient outcomes and decrease healthcare costs, the testing process needs to be sped up.

COLLABORATION

Sandia National Laboratories and Resonantia Diagnostics are collaborating on the development of an end-to-end rapid bacterial and fungal identification and antimicrobial susceptibility testing platform leveraging two pieces of acoustic technology. The partners began working together with a FedTech project in 2020 focused on Sandia's micro acoustic lysis (mALS) technology. Now, through a CRADA, they are combining mALS with a Sandia-developed acoustic-based susceptibility sensor to create a complete testing instrument.

Resonantia is consulting with its scientific advisory board, including a clinical microbiologist and infectious disease doctor, to ensure that the testing system being developed will meet the needs of doctors who treat bacterial and fungal infections.

SOLUTION

The combination of two technologies into one platform creates an end-to-end system with the ability to first identify the infection, and then determine how best to treat it.

mALS technology is 3 times more effective and 97% faster than comparable methods at gaining access to genetic content. After identification, the susceptibility assay leverages the acoustic sensor to determine what treatment the infection will be susceptible to and what concentration is needed. The acoustic-based sensors measure the mechanical and electrical changes in the bacteria or fungi, discovering the impact of antibiotics at the cellular level. They are 48 times faster than traditional methods.

An instrument with a touchscreen and various test cartridges is being developed. It may first be used at hospitals and labs, and later, smaller versions might be used at doctor's offices. The new testing platform is able to get results much faster than existing systems, in part because mALS rapidly releases viable DNA or proteins without chemicals that must be removed later.

IMPACT

Originally developed for Sandia's national security mission, now the technologies can be used to improve patient outcomes in general medical settings. With this testing platform, targeted therapies, such as the most appropriate antibiotic or antifungal, can be prescribed faster, decreasing patients' time in the hospital, cutting healthcare costs, and saving lives.

Resonantia CEO Matt Jones and Sandia Researchers Adam Bolotsky and Darren W. Branch observe the printer depositing DNA primers to create the sensor matrix which detects the presence of bacterial DNA.

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

GOAL: *Developing a faster viral, bacterial, and fungal identification platform using acoustic technology to improve patient outcomes and lower healthcare costs*

SHÁNDÍÍN AND SKYSUN

Better Tracking Increases Concentrated Solar Production

"Having access to the solar tower at Sandia, the only facility of its kind in the US, as well as to the Sandia staff with their expertise in solar energy, gives credibility to the heliostat active tracking technology we're developing."

— Julius Yellowhair
Founder
Shándíín, LLC

CHALLENGE

Throughout each day the sun is moving across the sky, and as the seasons change, its path shifts. To maximize concentrating solar power (CSP) performance, heliostats need to track the sun so they are accurately focusing the light from their mirrors on a receiver. The collected energy heats a high temperature fluid, and this thermal energy can be used to generate electricity.

Current passive tracking methods use the calculated position of the sun, which can be limited in accuracy. The mechanical structure of the heliostats can also shift over time, compounding aiming errors. Heliostat operators have to tweak algorithms and manually adjust the heliostats' azimuth and elevation to keep them focused. Utility scale developers are seeking efficiency gains and cost reductions to maximize return on investment (ROI) and improve the levelized cost of energy (LCOE). A better way to improve aiming accuracy is needed since the current inaccuracies mean CSP plants are not producing as much energy as they could be.

COLLABORATION

Sandia National Laboratories scientists worked with Julius Yellowhair of Shándíín, LLC and Jim Clair of Skysun, LLC to test a prototype for an active heliostat tracking system. Their concept was for a sensor system that would adjust heliostats throughout the day automatically to improve optical efficiency. They wanted to increase the technology readiness level by building and testing a prototype sensor, including optical and mechanical components, along with required software.

Shándíín brought optical engineering and analysis expertise that helped move Skysun's concept to the prototype stage. With expertise in CSP and the National Solar Thermal Test Facility (NSTTF) as an ideal site for testing, Sandia developed software to work with the companies' prototype tracking system. Two sets of field tests were run at the NSTTF with the sensor prototype.

SOLUTION

The Heliostat Active Tracking System is an active autonomous heliostat tracking controller utilizing artificial vision and machine learning to provide constant and real-time heliostat aiming control. The technical advances that resulted from this CRADA and research are now in the patent process, with the two companies and Sandia as co-inventors. The companies are looking into commercializing a product based on the collaborative research.

IMPACT

Increasing optical and receiver efficiency through more accurate tracking will increase the amount of solar power generated by CSP plants. Increased clean energy production helps to offset the use of fossil fuels, tying to Sandia's climate security mission.

Sandia Researchers Guillermo Anaya and Aaron Overacker, Project Principal Investigator Ken Armijo, and Researcher Ansel Blumenthal at the Sandia NSTTF where they tested the Heliostat Active Tracking System. The system is designed to improve CSP efficiency as well as lowering the LCOE.

PARTNERSHIP TYPE: *Cooperative Research and Development Agreement (CRADA)*
GOAL: *Increasing the amount of solar energy produced with more accurate, active automated tracking of concentrating solar power heliostats*

THERMOCHEM

pH Sensor Takes the Heat to Lower Geothermal Energy Costs

"Commercializing the Sandia-developed sensors will enable us to provide better insight into downhole well chemistry which will help guide production and drilling strategies."

— Joe Henfling

R&D and Instrumentation Engineer
Thermochem, Inc.

CHALLENGE

The pH of geothermal fluid is a fundamental measurement of reservoir chemistry. One or more feedzones in a well can be acidic but could be masked at the surface by zones that are neutral. Once geothermal wells are in production, the chemistry of these feedzones can change over time. The changes must be monitored to prevent corrosive fluid from damaging downhole casing, surface piping, and power plant equipment. Corrosive fluid can also be a serious safety issue for personnel working near the geothermal wellheads and piping.

Current downhole well tools can collect a sample at one depth only before returning to the surface. In order to get a vertical profile of the pH in a borehole, downhole samples must be collected at multiple depths. A sensor is needed that can withstand the high temperatures and pressures of geothermal wells while making continuous pH measurements.

COLLABORATION

Sandia's Geothermal Department is working with Thermochem to integrate a Sandia-developed high-temperature, high-pressure pH sensor package into the Thermochem Downhole Sampler (DHS) tool. Sandia's geothermal research is part of the Labs' energy security mission.

The partners are collaborating to make sure the pH real-time sensor is small enough to fit into the DHS tool and robust enough to withstand high temperatures at high pressures (300°C and 345 bar), and rapid heat-up and cool-down cycles. They are also optimizing the internal components to ensure the probes can be fabricated at a commercially viable cost.

SOLUTION

The team analyzed the Sandia prototype's components and replaced Teflon used in the initial design with ceramic to better protect the sensors from higher pressures and temperatures. The partners are also enhancing the packaging before conducting downhole field tests.

With the new sensors, real-time measurements of high-temperature geothermal fluids can be performed continuously. This new downhole tool with an integrated pH sensor will provide the geothermal industry with critical data that would otherwise not be obtainable.

IMPACT

Knowledge about the pH of fluids in geothermal wells can potentially lengthen the life of the wells and surface facilities through early warning of corrosive chemistry, allowing mitigation measures to be implemented before damage occurs. This enhanced data can help assure more production and lower production costs, making geothermal more attractive as an alternative energy source that will help the US achieve energy security and resiliency.

Thermochem Engineer Joe Henfling and Sandia Engineer Andrew Wright holding the next generation of high-temperature, high-pressure pH sensors for geothermal well evaluation.

PARTNERSHIP TYPE: License and Cooperative Research and Development Agreement (CRADA)
GOAL: Advancing pH sensor technology to enable integration into a downhole tool that can monitor and enhance geothermal energy production

TOTALENERGIES

Acoustic Technology Tapped for Carbon Storage Well Monitoring

"This collaborative project between TotalEnergies and Sandia was initiated thanks to their expertise in acoustic telemetry, their facilities, and their downhole tools that were already existing and available. We are pleased to work together on this new technology that will help us to achieve our carbon storage goals."

— Maria Perez-Fernandez

CCS Containment & Wells R&D Leader
TotalEnergies S.E.

CHALLENGE

Carbon storage is a key factor to achieve carbon neutrality. As projects utilizing the geological storage of carbon dioxide (CO_2) increase, new methods of monitoring the integrity of these wells are needed. It is essential to prove that there are no leaks of CO_2, a greenhouse gas, for many years to come. Current instrumentation methods include wired pipe, which is expensive and can degrade over time. Other technologies, like fiber optics, can be used separately from the pipe, but their route down the well can introduce a leakage pathway for the CO_2.

COLLABORATION

TotalEnergies is a major energy player that produces and markets fuels, natural gas, and low-carbon electricity. The company is developing industrial projects for carbon capture, transport, and storage (CCS) as part of its ambition of developing storage capacity of 10 million metric tons of CO_2 per year by 2030. TotalEnergies first learned of Sandia's research at the Advanced Energy Consortium. Collaboration was born from a shared vision and technical strategy.

Sandia's research focused on communicating with electronics near the drill bit in exploration wells using acoustic waves, or vibrations. Now TotalEnergies and Sandia are working together to develop this technology further so it can be used for self-powering, two-way communications in a permanent monitoring tool for CO_2 storage wells.

SOLUTION

Acoustic waves are transmitted through a well's steel production casing for wireless downhole power and communications. A prototype downhole acoustic transceiver and energy harvesting tool is being built by Sandia engineers. A wellhead transmitter will generate a high amplitude acoustic waveform which will travel through the casing and be converted to electrical power by the downhole tool. For communications, the downhole tool will generate an electrical signal which will be converted to an acoustic signal and propagated through the casing to the wellhead transmitter.

Sandia is currently working on proving the feasibility of this method. Future work would aim to optimize the design for full-scale applications. This work, which was originally conducted as part of Sandia's energy security mission, is now being developed to combat the effects climate change can have on national security, another Sandia mission.

IMPACT

Geological storage of carbon dioxide is a method that can be used worldwide to store huge quantities of CO_2 as a way to combat climate change. Monitoring the storage wells with reliable, self-powered sensors will ensure that CO_2 is not escaping into the environment far into the future.

Sandia Engineers Alfred Cochrane and Melanie Schneider installing wellhead transmitters behind the prototype downhole acoustic transceiver and energy harvesting tool.

PARTNERSHIP TYPE: *Cooperative Research and Development Agreement (CRADA)*
GOAL: *Creating a reliable solution for monitoring well integrity, ensuring that the wells used for carbon storage are safe for the long term*

LOS ALAMOS NATIONAL LABORATORY

Scintillating Nanoguide Sharpens Nuclear Threat Imaging

"Sandia's Nanoguides have the potential to break with the paradigm that thicker and therefore more efficient neutron detectors can only happen at the cost of lower resolution—Nanoguides will greatly improve our neutron imaging beam lines."

— Sven Vogel

Staff Scientist
Los Alamos
National Laboratory

CHALLENGE

X-ray imaging is used widely in material characterization. For dense materials such as lead, more energetic X-rays could be used but they wouldn't "see" less dense parts of an object made out of lighter materials, such as plastic. A new type of detector needs to be developed that uses neutrons to image through dense objects to do things like determine the contents of a thick lead container and identify potential defects or threats.

COLLABORATION

While Sandia National Laboratories and Los Alamos National Laboratory are both DOE labs with a national security mission, they each have different types of expertise and facilities. Through collaboration, they can leverage each lab's strengths and unique capabilities.

Sandia developed organic glass scintillator material that is optimized to convert detected neutrons into light which can then be captured by special cameras. It can be a very effective way to detect nuclear threats, and can also be used to develop optical waveguides for neutron detection.

Los Alamos has expertise in high-energy neutron characterization and operates the Los Alamos Neutron Science Center (LANSCE), a national user facility where one of the nation's most powerful linear proton accelerators produces short intense neutron pulses. Materials produced by Sandia and processed by Incom, Inc. to become optical waveguides are tested at LANSCE for advanced neutron radiography applications.

SOLUTION

Incom supports researchers and instrument makers in areas including homeland security and defense with advanced material processing technologies. One of the company's products is Nanoguides, which are optical elements used in neutron detection and other applications. Incom is configuring and processing the Sandia organic glass scintillator material to turn it into a Nanoguide waveguide. Nanoguides use quantum mechanical effects to act as waveguides for the light, channeling it towards the imaging camera. Without a waveguide, light spreads and the resulting neutron image can be blurry. The Nanoguide approach leads to an effective way to detect hidden threats like uranium inside a shielded container.

IMPACT

This technology will provide higher resolution neutron detection, meaning potential threats can be detected faster and with more confidence. The scintillating Nanoguide's applications include the detection of radiological threat objects, but it can also be used in applications such as nondestructive evaluation, nuclear physics, and medical imaging. This research to refine the scintillating Nanoguide composition will lead to a product which can be included as a drop-in component in commercial neutron radiography systems or state-of-the-art neutron imaging beam lines at large-scale neutron user facilities worldwide.

Los Alamos Staff Members Daniel Eigelbach, Danielle Schaper (front row), Alexander Long, Sven Vogel, and Cort Gautier (back row) are the team testing the Nanoguide scintillators.

PARTNERSHIP TYPE: *Collaborative Research supported by the DOE/NNSA NA-22 near-field detection program*

GOAL: *Improving detector efficiency for neutron imaging without sacrificing spatial resolution*

GEORGIA INSTITUTE OF TECHNOLOGY

Sandia has collaborated with Georgia Tech on research and development projects and hired talented GT alumni for decades. This partnership allows Sandia and Georgia Tech to work together for mutual benefit in research areas such as materials science, hypersonics, electrical grid resilience, nanotechnology, microelectronics, cybersecurity, climate, and robotics. Projects in these areas benefit our nation's security and engage the next generation of scientists and engineers.

Tools to Fingerprint Intercepted Radioactive Materials

"Modeling radiation and aging effects in materials is challenging as the process occurs over long time and length scales. The collaboration between Georgia Tech and Sandia has enabled the development of a new methodology to study extended-time radiation effects at the atomistic scale."

— Chaitanya Deo

Professor
George W. Woodruff School of Mechanical Engineering
Georgia Institute of Technology

CHALLENGE

Nuclear forensics uses analytical techniques to examine nuclear and other radioactive materials in order to investigate and improve nuclear security practices. Experts may use nuclear forensics methodologies to gain insight into the process history or origin of radioactive materials. Knowing the history of material samples collected or intercepted by inspectors can help in tracing the source of the material and inferring its intended use, such as if it was created for commercial or weapons applications.

But how do you fingerprint these materials to find the clues hidden in the microstructure caused by processing and storage conditions over time?

COLLABORATION

Sandia National Laboratories Researcher Remi Dingreville and Georgia Tech (GT) Professor Chaitanya Deo have a long track record of working together, ranging from co-advising students, some of whom later become postdocs and staff members at Sandia, to successful joint research, with 14 published peer-reviewed papers. The collaboration is possible because GT is an Alliance partner in Sandia's University Partnerships Network, an initiative Sandia has formed with universities to promote collaborative research and attract top talent to work on tough problems.

SOLUTION

In a joint research project funded by the Department of Homeland Security, Sandia and GT are developing a suite of computational tools augmented with experimental characterization and data science tools to predict forward and reverse relationships between material storage conditions and measurable microstructural characteristics. These will then be applied toward understanding the influence of environment and processing on actinide alloys that are of interest to nuclear forensics. The new methodology provides unique insight on atomistic features that may develop in materials subjected to prolonged energetic particle radiation.

As part of this project, two graduate student fellows and two undergraduate students will be trained in characterization and simulation methods and will spend significant time interacting with Sandia scientists. This will provide valuable research experience.

IMPACT

The goal of this research project is to improve nuclear forensics science by producing a new capability. This will also enhance national security, one of Sandia's missions. Joint research with GT has already resulted in significant output in the form of method development, research publications, and graduate student theses in the fields of corrosion and radiation damage in nuclear materials. This project is leveraging the long-standing partnership with GT that provides training to up-and-coming scientists, including those from under-represented groups, and serves as a pipeline for promising students to become Sandians.

Former GT Graduate Student and current Sandia Postdoc Daniel Vizoso and Sandia Staff Scientist Remi Dingreville are developing computational materials and data science tools to address materials reliability and materials forensics questions.

PARTNERSHIP TYPE: Sandia University Partnerships Network
GOAL: Developing a new a suite of atomistic and mesoscale computational tools to improve nuclear forensics and national security

"The Sandia critical material separation technology represents a significant business opportunity with strategic importance to the US. We started Critical Materials in New Mexico to forge a close working partnership with the Sandia inventors to advance this technology towards commercialization."

— Robert Happeny

CEO
Critical Materials, LLC

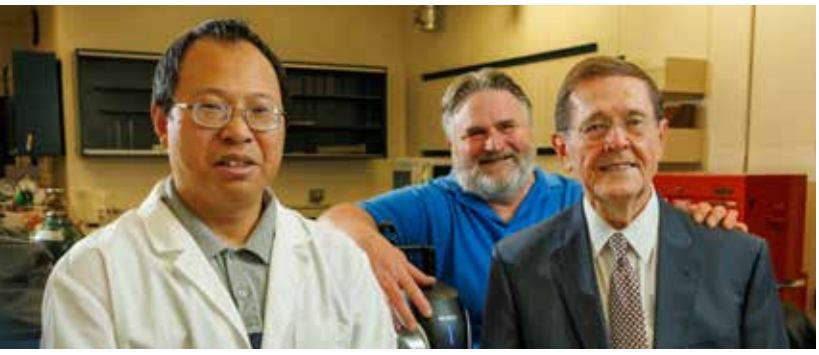
Technology Lessens Reliance on Foreign Sources for Strategic Metals

CHALLENGE

The US imports 100% of many of its strategic metals, including rare earth elements (REE). Much of our REE supply is imported from China, in part due to their lower labor costs and relaxed environmental regulations. Yet these metals are vital for a variety of high-tech equipment from magnets in wind turbines to smartphones and even fighter jets and submarines. They're essential to the green energy and electronics industries, as well as our nation's defense.

COLLABORATION

Great Plains Partners is a venture capital group focused on identifying and licensing promising technologies developed at DOE national laboratories, and then developing companies to move them towards commercialization. After learning about a patent-pending technology from Sandia National Laboratories that utilizes CO_2, water, and an environmentally friendly complexing agent to efficiently mine strategic metals from coal ash solid waste, they started a company, and licensed the technology.



Sandia Researchers Guangping Xu and Mark Rigali with Critical Materials CEO Robert Happeny in the Sandia Geochemistry Lab.

Sandia Geochemist Guangping Xu examines coal ash using a Raman microscope.

As a New Mexico-based company, Critical Materials found that it was eligible to take part in the TRGR Technology Readiness Initiative, where Sandia scientists can partner with the company's staff to mature, optimize, and scale lab-developed technology in order to elevate the technology readiness level and assess commercial viability. With the TRGR Project underway, the company is applying for a DOE Small Business Innovation Research (SBIR) grant to further advance research efforts.

SOLUTION

Sandia scientists invented an efficient technology that utilizes a supercritical CO_2- H_2O-chelator solvent to extract critical metals, including REEs, from coal ash waste as part of the Labs' national security mission. Coal ash is generated from coal-burning power plants, and one-third of that ash is not reused; leaving it to occupy numerous sites across the US while posing a substantial environmental hazard.

The Sandia process extracts rare earth metals and other valuable strategic materials from coal ash without the environmentally harmful chemicals used in current mining methods. In addition, the extraction process does not generate new waste and makes the residual coal ash cleaner to reuse for applications like manufacturing cement. The coal ash disposed of in ponds and landfills can damage the environment and could cost up to $50 per ton in cleanup fees.

IMPACT

Sandia's technology reduces mining costs and environmental impact for REEs and other critical metals. Commercialization of the Sandia technology will lessen reliance on overseas sources for these essential materials, and will create an economically viable resource in the US.

PARTNERSHIP TYPE: *License and TRGR Technology Readiness Initiative*

GOAL: *Commercializing a new way to source essential rare earth elements domestically, in an economical and environmentally friendly way*

Incubator Offers Specialized Space for Deep Tech Startups

For hard tech startups, finding lab space can be a struggle. Daybreak Labs, an incubator offering space for life science and deep tech startups, is helping companies overcome this obstacle. Their new facility just opened in Livermore, California, thanks to a partnership between the city of Livermore, Sandia National Laboratories, and Lawrence Livermore National Laboratory (LLNL).

Companies can rent benches and desks in shared lab and office space for a reasonable cost at Daybreak Labs, with labs certified for biological and chemical work. They also gain access to business resources and entrepreneurial activities provided by the i-GATE Innovation Hub, a nonprofit dedicated to building a thriving startup community sponsored by the Tri-Valley cities of Livermore, Pleasanton, Dublin, and the town of Danville, as well as LLNL and Sandia.

The new 7,000-square-foot Daybreak Labs facility is close to Sandia, making it convenient for budding entrepreneurs from the Labs or other organizations in the area to attend networking events held there. The facility and activities there help promote Sandia's technology transfer mission. The companies currently using the facility include a mix of diagnostics, med tech, and climate tech startups.

Early-stage biotech or deep tech startups are encouraged to apply to the Daybreak Labs residency program. In addition to access to funding and expertise, startups accepted into the residency program receive space at Daybreak Labs at no cost for six months to one year.

This business ecosystem, including specialized space and services, is helping to grow an emerging innovation hub that is already home to a number of successful biotech and deep tech startups. It's also a way to keep startup companies in the Tri-Valley area near Sandia California from having to move to an incubator in South San Francisco, Berkeley, or the peninsula.

Daybreak Labs Executive Director Yolanda Fintschenko and Operations Manager and Biosafety Officer Meryem Rqibate discuss the exciting work companies are performing at the incubator as Phil Belgrader, Francesca Pearson, and Don Masquelier of LabSimply, Inc. prepare reagents in the Daybreak Labs shared lab space.

To learn more about Daybreak Labs, visit http://daybreaklabs.io

BATTERY ABUSE TESTING LABORATORY

Electric Vehicle Battery Safety Hot Topic for BATLab

The Battery Abuse Testing Laboratory (BATLab) at Sandia National Laboratories is an internationally recognized leader in energy storage system safety research that serves the national interest. The facility has unique capabilities and participates in partnerships supporting research for industry, other DOE offices such as the Office of Electricity's Vehicle Technologies Office, and US government agencies including the Department of Defense (DOD), NASA, and Department of Transportation/National Highway Traffic Safety Administration (DOT/NHTSA).

The BATLab has conducted research over the past 20 years to enable new electric vehicle (EV) technologies, which relates to Sandia's energy security mission. BATLab's battery safety experts, Loraine Torres-Castro and Alex M. Bates, are working with the DOT/NHTSA and other organizations on safety and reliability issues for EVs.

Early Detection for Intervention is a research partnership with the DOT/NHTSA, which identifies potential failures in EV batteries before they cause a fire or other safety hazard. With the implementation of diagnostic devices in vehicles, drivers can be warned of issues, giving them time to get to safety before something dangerous happens. Sandia scientists are studying and comparing the performance of different sensors in determining overheating or electrical failure of batteries. Research results can be used to develop onboard diagnostics that could be included in future EVs.

Another topic that BATLab researchers are addressing with the DOT/NHTSA regarding EV safety is the issue of stranded energy. This is a big issue for emergency responders who arrive at an accident and are unsure how to deal with an EV's lithium-ion batteries, which might have been damaged. There is a high risk of fire or electrical shock from the stranded energy in the batteries. This research could provide guidelines for emergency responders at EV accident scenes, giving them the knowledge they need to stay safe when dealing with EV batteries.

Sandia Technologists Jerry Quintana, Lucas Gray, and Jill Langendorf from the Power Sources Technology Group prepare to conduct a mechanical abuse experiment on a lithium ion battery pack. Instruments connected to the battery ensure data integrity and help control safety.

To learn more about the BATLab, visit https://energy.sandia.gov/keycapabilities/facilities/batlab

hCMOS Cofounders Marcos Sanchez and Matthew Dayton showing off packaged and tested Icarus sensors.

New Company Formed to Meet Demand for World's Fastest Camera

After years of work, the world's fastest digital camera, developed at Sandia National Laboratories, won an R&D 100 Award and was in use at national laboratory and government facilities to image the nation's premier high energy density and inertial confinement fusion physics experiments. The camera provides much higher-fidelity data to researchers than previous technology.

Sandia Researchers Liam Claus and Marcos Sanchez worked on the multiframe digital camera technology from its conception through its introduction at Sandia's Z machine and other national laboratory facilities. They took part in the DOE's Energy I-Corps tech transfer program, where they discovered that the high-speed imaging technology would also be desirable to other research customers.

Seeing that a steady supply of imagers would be needed at national laboratories to support their critical NNSA Stockpile Stewardship mission, as well as for new customers and applications, Claus and Sanchez thought about starting their own company. While Sandia could supply a limited number of imagers through its low-volume foundry, the technology would need to be commercialized to meet higher demand.

Claus and Sanchez learned about Sandia's Entrepreneurial Separation to Transfer Technology (ESTT) program. The program supports Sandia's technology transfer mission and allows employees to leave the Labs to start up or expand technology companies, with guaranteed reinstatement for up to two years.

The two Sandians, along with a third partner, Matthew Dayton from Lawrence Livermore National Laboratory, licensed the Sandia technology and formed Advanced hCMOS Systems, LLC. The company is already serving government customers, and is working on ramping up production and lowering the imager's cost through a DOE Phase I Small Business Innovation Research Grant and a TRGR Technology Readiness Initiative Project.

Efficiency Testing Bolsters Disinfecting Robots' Market Success

Formed in 2017 as a way to bring automation to industries that were not yet utilizing it, Build With Robots began working with a large paint company to create painting robots. When the COVID-19 pandemic hit, the Albuquerque-based company shifted to development of Breezy One, a fully automated disinfecting robot that could help with safely reopening facilities.

Build With Robots joined with a few other New Mexico companies—Painting Bots, Inc., FatPipe–Rio Rancho, and BioScience Center—to develop disinfection efficiency testing processes for the robots, which were already in use at airports and schools. To obtain analytical help, the companies reached out to the New Mexico Small Business Assistance (NMSBA) program, which paired them with Mark K. Kinnan and Cathryn Mayes at Sandia National Laboratories.

The Sandia team created and implemented a testing matrix from which they could select a range of equipment and protocols. These disinfection processes were tested in a mockup facility to evaluate the robot's efficiency in close-to-real-world scenario experiments. The processes that worked best were then set for real-world testing and validation.

Thanks to this work, the companies have secured $5 million in funding and have hired 30 new people. Based on these results, the project received the NMSBA's *Honorable Speaker Ben Luján Award for Small Business Excellence* for demonstrating the most economic impact. Breezy One is now in use in numerous facilities around the country where it is efficiently eliminating pathogens, allergens, and asthma triggers, in the air as well as on surfaces. Breezy Blue, a smaller Internet of Things (IoT) disinfecting device, is being launched for situations where the larger robot cannot easily fit.

Build With Robots Robotics Technician Marlene Trujillo swapping microresistors on a circuit board.

To learn more about NMSBA, visit www.NMSBAprogram.org.

QCaMP Introduces High School Students to Quantum Computing

The Quantum Systems Accelerator (QSA) is co-led by Sandia National Laboratories and Lawrence Berkeley National Laboratory (LBNL). Its purpose is to catalyze national leadership in quantum information science. This year, one of the events QSA organized was the Quantum Computing, Mathematics, and Physics (QCaMP) for high school students as part of its mission to train and inspire a diverse quantum-ready workforce that can advance the field's future. QCaMP was developed in collaboration with the non-profit Computer Science Alliance and the Institute of Electrical and Electronics Engineers (IEEE).

QCaMP ran two week-long cohorts for high school teachers and students in minority-serving, economically disadvantaged communities in New Mexico and California. A total of 20 teachers participated during QCaMP's first-week cohort and 32 students for the second, with most attendees being introduced to Quantum Information Science (QIS) for the first time.

Quantum researchers at QSA institutions, including LBNL, Sandia, the University of New Mexico, and collaborators at New Mexico State University, designed the program to be accessible to students without knowledge of advanced math or physics.

One of the participating teachers at QCaMP, Ray Tokuda, who has taught physics for over three decades, said of QIS, "It's like the Wild West where no one knows what's on the horizon, but it's a field where an interested student will have tremendous opportunities. As a physics teacher, you are doing your students a disservice if you don't mention this area in your class." Inspired by QCaMP, Tokuda is planning a quantum computing unit for his high school students.

"QCaMP gives students the opportunity to learn a topic not taught in high schools, and it will hopefully introduce a more diverse community to QIS careers," said Sandia's Megan Ivory, technical lead for QCaMP.

Sandia QCaMP Technical Lead Megan Ivory presents an Introduction to Quantum course to teachers in New Mexico to help drive engagement and interest in QCaMP.

To learn more about QSA, visit www.quantumsystemsaccelerator.org/

SANDIA SCIENCE & TECHNOLOGY PARK

BlueHalo Expands in the Park

With the opening of its new 73,000-square-foot research and development, manufacturing, and office facility on Gibson Boulevard on August 18 and the lease of a building on Eubank Boulevard, BlueHalo expanded in 2022 from its original footprint of about 50,000 square feet to over 200,000 square feet of space across three buildings in the Sandia Science & Technology Park (SS&TP).

The SS&TP is a 340-acre, master-planned technology community. Associated with Sandia National Laboratories and adjacent to Kirtland Air Force Base, it gives companies easy access to world-class facilities, technologies, scientists, and engineers.

BlueHalo currently employs 300 professionals on its SS&TP campus, including researchers, engineers, hardware and software developers, and security and intelligence experts. The new facility will create more than 70 additional jobs with an average salary of $90,000.

"We are fortunate to have strong partnerships with leaders from across New Mexico and the local Albuquerque community as we partner to transform the state into a hub of space technology," said BlueHalo Chief Executive Officer Jonathan Moneymaker.

The company provides capabilities in the domains of Space Superiority and Directed Energy, Missile Defense and C4ISR, and Cyber and Intelligence. BlueHalo has contracts with Sandia and the Air Force Research Laboratory's Directed Energy and Space Vehicles Directorates.

US Senator Martin Heinrich (D-NM) said, "It is no accident that New Mexico has become the national leader in a wide range of new and emerging defense technologies. The success of homegrown companies like BlueHalo is the direct result of strategic investments over many years in the sustained success of program management and acquisition entities housed within our state's national defense labs and military installations."

BlueHalo opened the doors to its new research and development, manufacturing, and office facility with a number of community leaders and dignitaries, including US Senator Martin Heinrich and Albuquerque Mayor Tim Keller, cutting the ribbon.

To learn more about the SS&TP, visit www.sstp.org

Rapid Testing for Viruses Moves Ahead with TRGR

At the height of the pandemic in 2020, a Florida-based company was setting the industry standard in rapid COVID-19 testing, helping the tourism industry, hospitals, state government, and large utilities with results in less than 24 hours. The New Mexico film industry took note and asked Applied InGENuity Diagnostics to take over their testing.

The company, founded by clinical geneticist Maulik Shah, quickly established an office in Albuquerque, connected with the local bioscience infrastructure, and set up a lab in record time. But Shah also envisioned creating a 30-minute rapid test that would improve access to diagnostic testing at the point-of-care, with results that would be just as reliable as polymerase chain reaction (PCR) tests. That's when his partnership with Sandia National Laboratories began.

Shah created a new company in New Mexico called QUASR Diagnostics, Inc., which licensed Sandia's QUASR technology. Originally developed by Sandia Researcher Robert Meagher to detect mosquito-borne viruses as part of the Labs' national security mission, QUASR can also be used to test for other pathogens, viruses, and diseases. By amplifying the signals from an RT-LAMP (reverse-transcription loop mediated isothermal amplification) testing platform, QUASR makes the results brighter and easier to read.

As a New Mexico company licensing Sandia technology, QUASR Diagnostics is able to take part in the TRGR Technology Readiness Initiative. TRGR enables Sandia and Los Alamos national laboratories to assist in turning transferred technology into viable products and services, helping to create more innovation and jobs in the state. The ongoing TRGR research and development project will lead to a more mature QUASR technology with improved sensitivity and performance, ready for market adoption in rapid tests for influenza, COVID, and other viruses.

Sandia Researcher Bryan Carson prepares newly designed isothermal nucleic acid amplification primers for testing. A lot of work goes into analyzing viral genome variability to ensure rapid point-of-care tests for infection can detect new variants of common respiratory viruses and guide health security decisions.

To learn more about TRGR, visit http://nmtrgr.org

ENERGY I-CORPS

Sandia Team Wins Prize for Chemical Sensor Technology

The nDETECT team from Sandia National Laboratories won the $25,000 Energy I-Corps Commercialization Award for their efforts to move their technology toward commercialization. The team will use the prize money towards building an nDETECT prototype.

Energy I-Corps' Cohort 14 had 16 national laboratory teams participating in the intensive two-month training program, including 4 from Sandia. In the program, which ties to Sandia's technology transfer mission, researchers define technology value propositions, conduct stakeholder discovery interviews, and develop viable market pathways for their national laboratory-developed technologies.

The winning team included Principal Investigator Mara Schindelholz, Business Management Professional Wendy Rue, and Industry Mentor Rob Delcampo from the University of New Mexico. The team is working to commercialize nDETECT sensor technology, which could be used to help munitions remain safe and reliable.

"Current chemical sensor technologies are expensive, have a short lifespan, and can require extensive maintenance," Schindelholz said. "Our chemically selective nanoporous-based electrical sensors are cost-effective and low power. They use one millionth the power consumption of current chemical sensors and require minimal maintenance."

"Although we focused on a military application path, we were exposed to other ideas for scaling up the technology for other use cases," Rue said. "We have a better idea of these opportunities now, including the diesel engine market and air quality or environmental monitoring."

Other Sandia teams that took part in Cohort 14 were ZAV, Zero-trust Application for Vehicles, which dynamically generates message-specific cryptographic keys as they are needed; CAML, computational modeling and machine-learning strategies to identify new reaction pathways in drug discovery; and Hydrogen Ships that would transfer wind-sail power to hydrokinetic power, which is then used to manufacture and store hydrogen.

nDETECT team members Mara Schindelholz and Wendy Rue are the winners and graduates of the most recent Energy I-Corps program.

To learn more about Energy I-Corps, visit https://energyicorps.energy.gov/

Sandia Technology Teams Explore Market Possibilities

Sandia Researchers Isaac Avina and Patrick Doty holding free-standing films of conjugated polymers with evaporated gold contacts, mounted for testing in a high energy proton beam.

In 2022, FedTech launched DOE Emerging Tech Studio, a dedicated program for DOE laboratories. In addition to building startups by connecting lab technologies and entrepreneurs, the program features TechTalks—a concise entrepreneurship training program for researchers that includes IP portfolio analysis. Two Sandia National Laboratories teams took part this year.

Virtual Power Plants (VPP) are designed to combine thousands of distributed energy resources (DER) to provide critical grid services. VPPs need fast and accurate controls so their grid services are both reliable and profitable. That's why Sandia Researcher Jay Johnson and his team developed the Virtual Power Plant Controller.

The technology includes a patented control algorithm that enables aggregations of DER such as solar, wind, and batteries to meet a target output power level for VPP applications to provide safe, stable electric grid operations. After taking part in FedTech, there were four potential use cases identified: wholesale markets, renewable energy customers, critical infrastructure and disaster recovery, and isolated, underserved rural communities.

The Electronic Polymer Dosimeter for Radiotherapy (EPDR) was invented by Sandia Researchers Isaac Avina and Patrick Doty. The technology helps doctors treat cancer with a precision dosimeter to more accurately administer radiation therapy to tumors, lowering costs and improving patient outcomes. EPDR is a disposable adhesive patch based on electronic polymer particle detectors. The patch can be applied to the patient's skin to precisely measure radiation intensity and spatial distribution.

EPDR reduces the need for restraints used to hold patients still during therapy, and the need for anesthesia, which can be expensive and cause side effects. This technology could be particularly useful in treating pediatric patients and patients with cancers where precision is especially important, like brain or prostate cancer.

To learn more about FedTech, visit www.fedtech.io

LAB PARTNERING SERVICE

Energy Storage Content Supports Commercialization

DOE's Lab Partnering Service (LPS) is a suite of online services providing access to people, projects, and patents from across the DOE national laboratories, including Sandia National Laboratories. It provides a conduit between innovators and potential partners.

Sandia continues to support the LPS website, both by partnering on site development efforts and by managing Sandia's content. By the end of FY22, Sandia had contributed a total of 172 experts, 200 success stories, 166 technology summaries, 69 facilities, and 2,375 patents to the LPS site since its inception, and fielded around 115 inquiries from users interested in engaging with the Labs.

This year, Sandia was tasked by the DOE's Office of Technology Transitions with conducting an Energy Storage Grand Challenge (ESGC) project relating to LPS. The ESGC is a comprehensive program to accelerate the development, commercialization, and utilization of next-generation energy storage technologies. ESGC content on the LPS website will help support the ESGC's Technology Transition Track.

Sandia and Oak Ridge national laboratories partnered to advance the ESGC Track's goals by broadening partner access to the labs' expertise and capabilities, and providing enhanced understanding of energy storage partnership gaps and opportunities.

The team developed a taxonomy to organize relevant LPS content by identifying key topics from the ESGC roadmap and coordinating with technical staff at different labs. The labs also expanded their respective content on the site. These activities enable improved access to the ESGC-related expertise, capabilities, facilities, and technologies across the national labs.

Under this project, the team also compiled partnerships data and created a framework that can be used to analyze energy storage partnership trends across the national laboratories to better understand energy storage R&D, partnerships, and commercialization.

Sandians Lauren Amagai and Jessica Knight discuss updates to the LPS website. Not pictured, project team member Janna Corro.

To learn more about LPS, visit www.labpartnering.org

Sandia Awarded Three Clean Energy Projects

A new DOE Technology Commercialization Fund (TCF) initiative prioritizes addressing commercialization challenges and collaboration across national laboratories to support demand for emerging clean energy sources. $18.4 million in funding has been awarded to seven national laboratory projects, including three led by Sandia National Laboratories.

Sandia's three projects include collaboration with multiple national lab partners and funds cost-shared by other project stakeholders including industry, communities, and the state of New Mexico. These TCF projects tie to Sandia's energy security and technology transfer missions.

One Sandia project, the *Collaboration, Communication, Co-location, Community (C-4) Partnering Model*, is creating a strong regional clean energy commercialization ecosystem in New Mexico for manufacturing. Sandia's second project, *Boost*, is facilitating interactions with the startup community at a new, larger scale by building ventures around actionable challenges identified by underserved communities. In its third project, Sandia is establishing a collaborative approach for moving the semiconductor sector and next-generation microelectronics from the lab to the market.

"I am thrilled that these awards will empower our national labs—including Sandia in New Mexico—to build strong partnerships with local private sector startup companies and grow commercialization and manufacturing ecosystems around promising clean energy technologies developed by DOE researchers," said US Senator Martin Heinrich (D-NM).

"DOE's national laboratories are stepping up to address the urgent need to develop solutions for expedited clean energy technology commercialization—from the time a product is researched, developed and patented to its widespread use," said US Secretary of Energy Jennifer Granholm.

TCF provides new flexibility to promote promising energy technologies. The first-of-its-kind *Core Laboratory Infrastructure for Commercialization* opportunity combined resources from nine DOE program offices to develop infrastructure for clean energy technology commercialization.

US Secretary of Energy Jennifer Granholm, center left, asks questions of Sandian Nathan Schroeder, right, while on a tour with others including Laboratories Director James Peery and US Representative Melanie Stansbury, center, at the National Solar Thermal Test Facility at Sandia.

To learn more about TCF, visit https://www.energy.gov/technologytransitions/technology-commercialization-fund

RECOGNITION

Innovation and Intellectual Property Celebrations

Sandia National Laboratories Integrated Partnerships Organizations hosted Innovation and Intellectual Property (IP) Celebrations in both New Mexico and California. The annual events recognize Sandia scientists and engineers whose work contributes to the Labs' innovative culture.

Along with IP inventors and authors, the events recognize Mission Innovators (Classified Innovation & Recognition Awards in California) for their technical and innovative contributions to Sandia's national security mission. Additionally, New Mexico recognizes Up & Coming Innovators as director-nominated inventors who display enormous potential for supporting impactful innovations, exhibit entrepreneurial talent, and develop unique solutions to complex scientific challenges.

In New Mexico, an in-person celebration was not held due to the COVID-19 pandemic, but in-home recognition and awards were presented to 109 patent inventors, 48 copyright authors, 15 Mission Innovators, and 13 Up & Coming Innovators. In California, a hybrid Innovation Award Open House was held, with both on-site and virtual components, to honor distinguished innovators: 27 patent inventors, 11 copyright authors, 14 Classified Innovation Recognition Award recipients, 3 FLC Award winners, 17 R&D 100 Award winners, and 1 DOE National Labs Pitch Competition winner.

NMSBA Innovation Celebration

The New Mexico Small Business Assistance Program (NMSBA) held the first Innovation Celebration since the onset of COVID-19 at Santa Fe Brewing. New Mexico small businesses and laboratory principal investigators that achieved outstanding innovations through NMSBA were recognized.

Three Sandia projects were showcased. ORC Tech achieved product development milestones faster than anticipated and secured over $100,000 in funding for their cellphone antenna booster thanks to Sandia's technical assistance. After Sandia evaluated various sensors for a new pain-assessment technology, the PainScan Leveraged Project improved their technology's performance, secured a Small Business Innovation Research award, and hired seven new employees.

The Disinfecting Robot Leveraged Project received the *Honorable Speaker Ben Luján Award for Small Business Excellence* for demonstrating the greatest economic impact, including securing $5 million in funding and hiring 30 people. The Breezy One disinfecting robot is now in use across the country.

NMSBA projects are also recognized each year in the program's *Perspectives* annual report.

R&D 100 Awards

The R&D 100 Awards celebrate the year's 100 most innovative technologies. Sandia National Laboratories competes with universities, corporations, and other government laboratories for these prestigious awards.

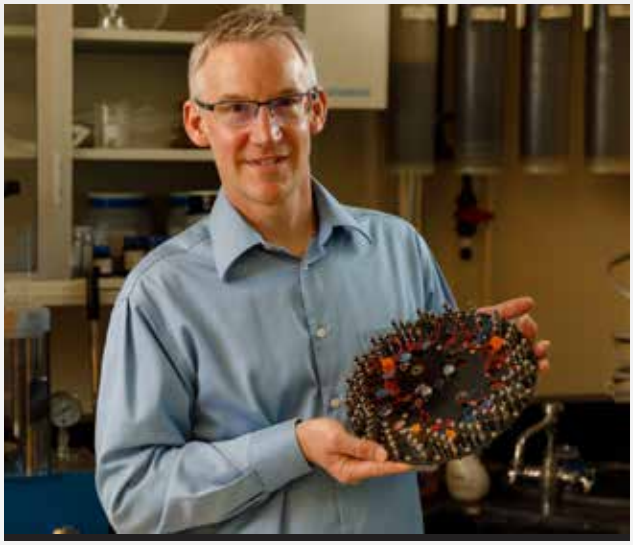
Individual Awards

Automated Threat Estimator for Networks and Applications (ATHENA)

Cyber analysts must quell repetitive cyberattacks and also keep up with threats from electronic entities that might not have existed an hour earlier. Cyber watchdogs can use ATHENA to model all possible adversarial paths through network architecture and device configurations. ATHENA fuses data collected from multiple sources to enable users to model and build virtualizations of their networks. This situational awareness tool provides a dynamic network view, updated continually, that can aid in path prediction and threat prioritization.

Iron Nitride Soft Magnetics

Because of iron nitride's high magnetization and resistivity, the soft magnetic alloy—capable of operating at high temperatures—is expected to increase the efficiency of smart grid electronics, transformers, and electric machines while reducing their size and weight by an order of magnitude. Modern devices and electric-based solutions for vehicles, aircraft, and ships require ultra-high-voltage power semiconductor devices to reduce energy loss. A reduction of even 1% of existing grid transmission and distribution losses through use of iron nitride would produce $500 million to $1 billion per year in savings.



Proactive Intrusion Detection and Mitigation System (PIDMS)

Energy generation through distributed solar resources is making an increasingly positive impact on the environment and the interconnected electric grid. But monitoring the security and protecting the operation of these grid-edge units raises its own problems. PIDMS is a solution developed to secure photovoltaic "smart" inverters and other equipment. PIDMS, deployed either as software or bump-in-the-wire hardware, provides real-time cyber-physical data analysis to detect malicious and abnormal events and deploy suitable mitigations to eliminate or reduce distributed energy system impact.

Ultra-Stable Thermally Excellent Advancements in Material Strength

Taking note of the strength demonstrated by the alternating layers of materials that form seashells, Sandia researchers alternated microscopically thin layers of common table sugar with silica, married them through heat, and came up with a coating stronger, lighter, and more cost-effective than those currently protecting US satellites in space. Because the new material is also relatively unaffected by high heat, it is being considered as a protective layer in fusion labs for instruments exposed to temperatures of hundreds of degrees.

Joint Award

Sandia researchers won an additional R&D 100 Award with partnering organizations.

More Situational Awareness for Industrial Control Systems (MOSAICS)

A comprehensive, integrated and automated cyberdefense capability for industrial control systems, MOSAICS was co-developed by researchers at Sandia, Idaho, and Pacific Northwest national laboratories and Johns Hopkins University Applied Physics Laboratory. It allows system operators to more quickly, easily, and effectively detect and characterize cyberattacks against critical infrastructure systems in real time and will eventually provide support for automated response actions. The objective for MOSAICS was the initial operational cyberdefense capacity to defend mission critical infrastructure.

Special Recognition Award

Market Disruptor – Products

SILVER: PIDMS
(see description on previous page)

FLC National Awards

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

Rookie of the Year

Kelli Howie has made waves throughout the federal laboratory complex in her less than three years at Sandia by creating programs to boost diversity in technology transfer activities. Howie's work to develop and advance women inventors was recognized.

DOE TTWG Awards

The Technology Transfer Working Group (TTWG) awards celebrate the exceptional work done by the 17 DOE national laboratories to support American competitiveness and security through a streamlined commercialization process.

Member of the Year

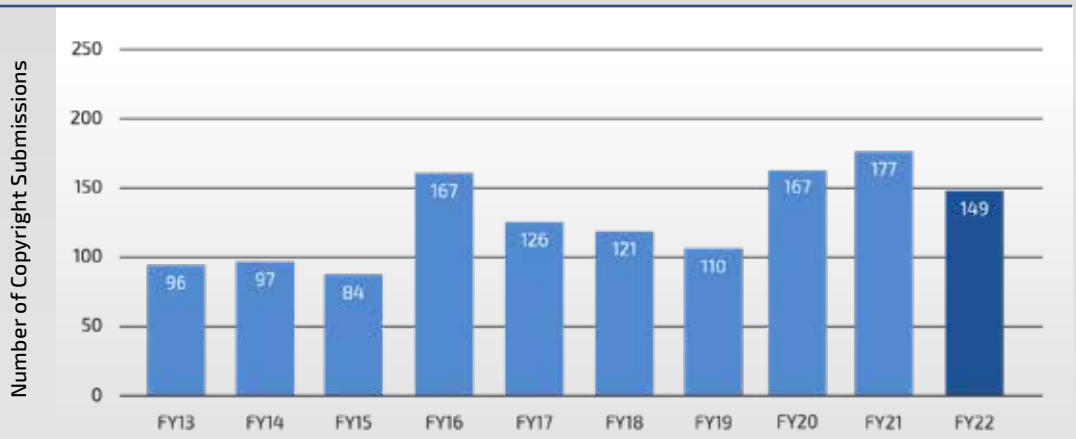
Joel Sikora was recognized for spearheading the TTWG Metrics Subcommittee return on investment project. He led a multi-laboratory team to develop recommendations for a framework to measure the return on investment for the technology transfer activities of DOE labs/sites requested by the Office of Technology Transitions (OTT).

Early Career Professional of the Year

Mason Martinez was recognized for his contributions to the COVID-19 Technical Assistance Program (CTAP 2.0), including overseeing partnership formation for multiple Sandia Principal Investigators to support organizations across New Mexico and increasing equitable investments in technology-based economic development initiatives.

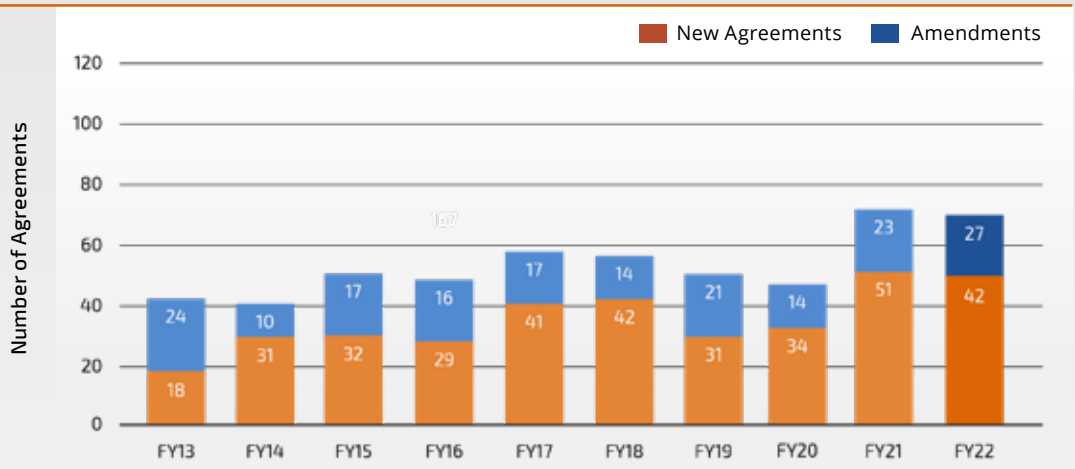
Copyrights

Copyright Submissions

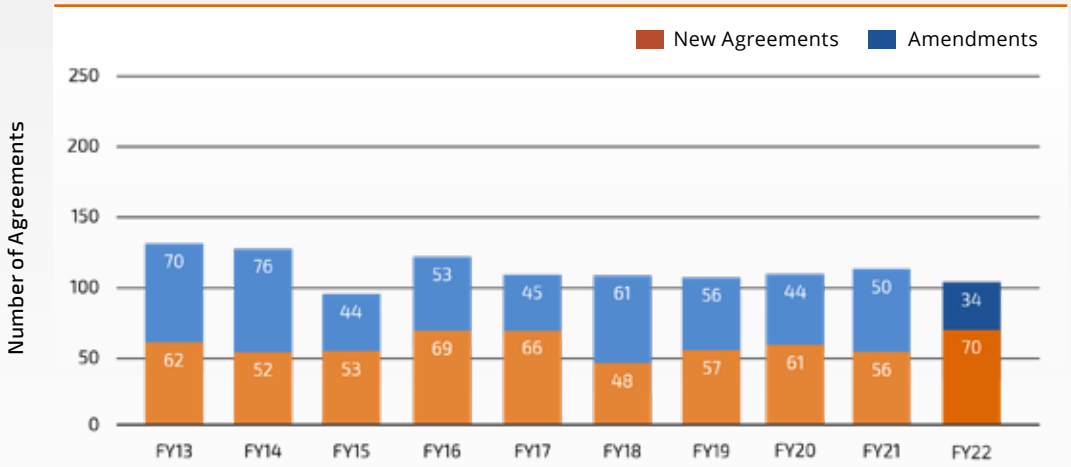


CRADAs and SPP/NFE Agreements

Cooperative Research and Development Agreements (CRADAs)

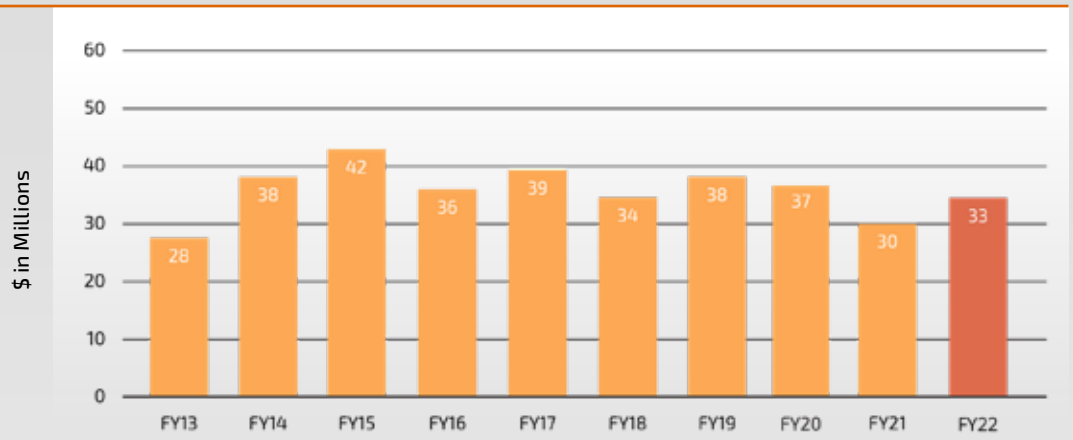


Strategic Partnership Project/Non-Federal Entity (SPP/NFE) Agreements



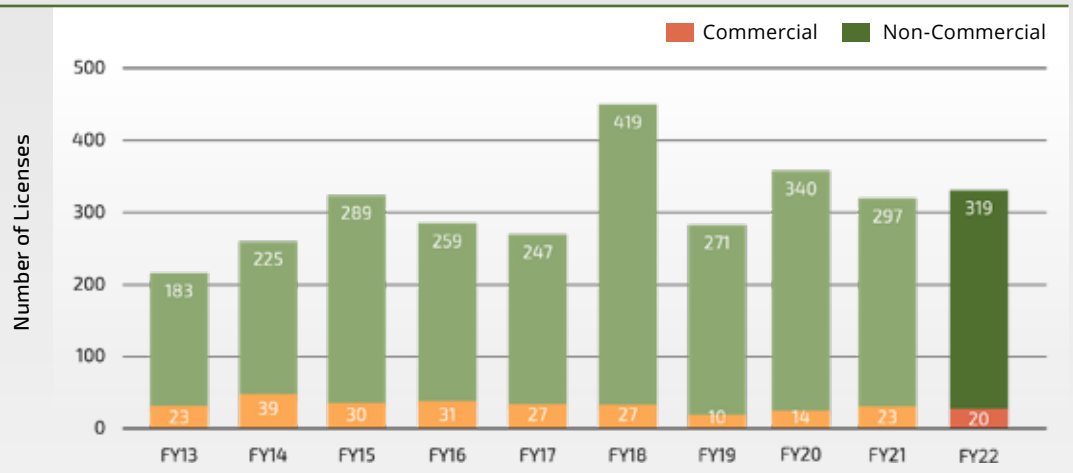
Industry Funds-In

Industry Funds-In to Sandia ($M)

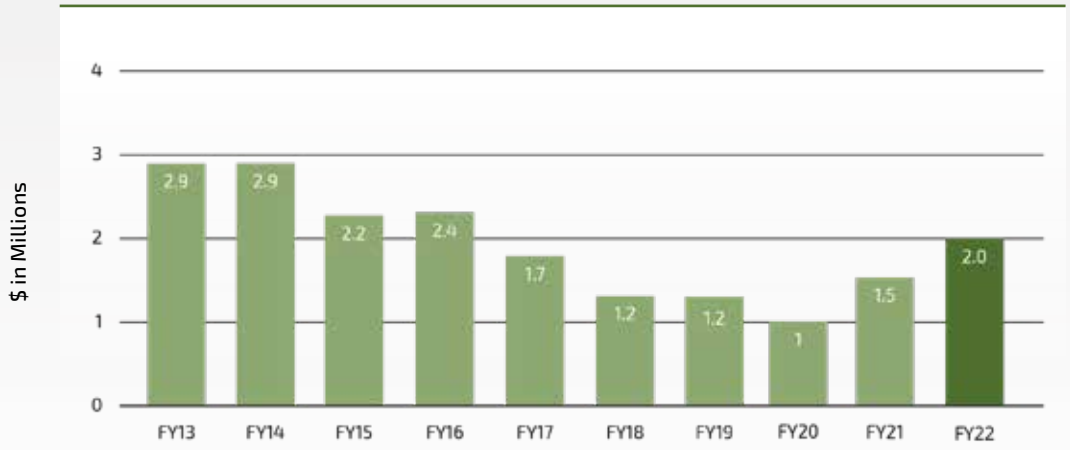


Licenses

Licenses

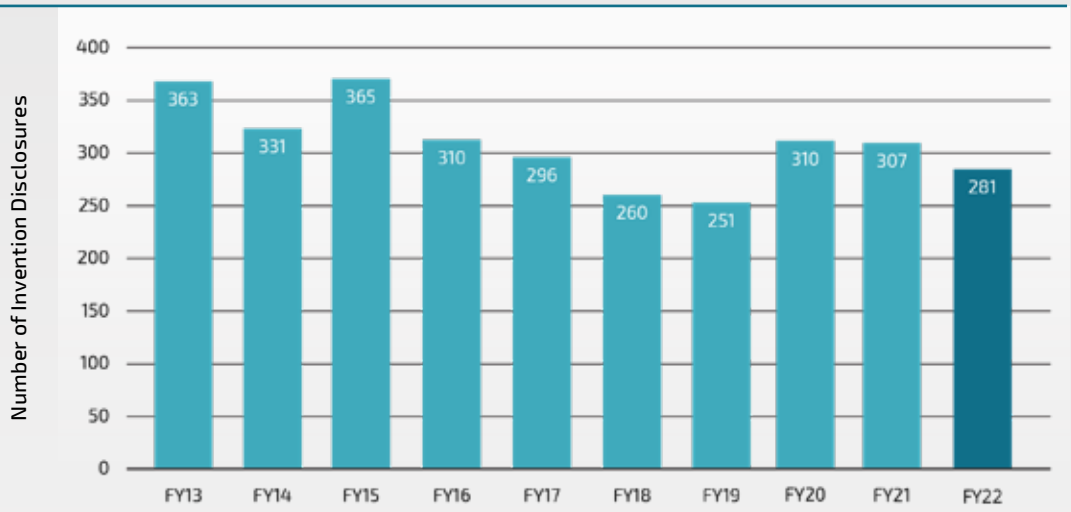


Licensing Income ($M)

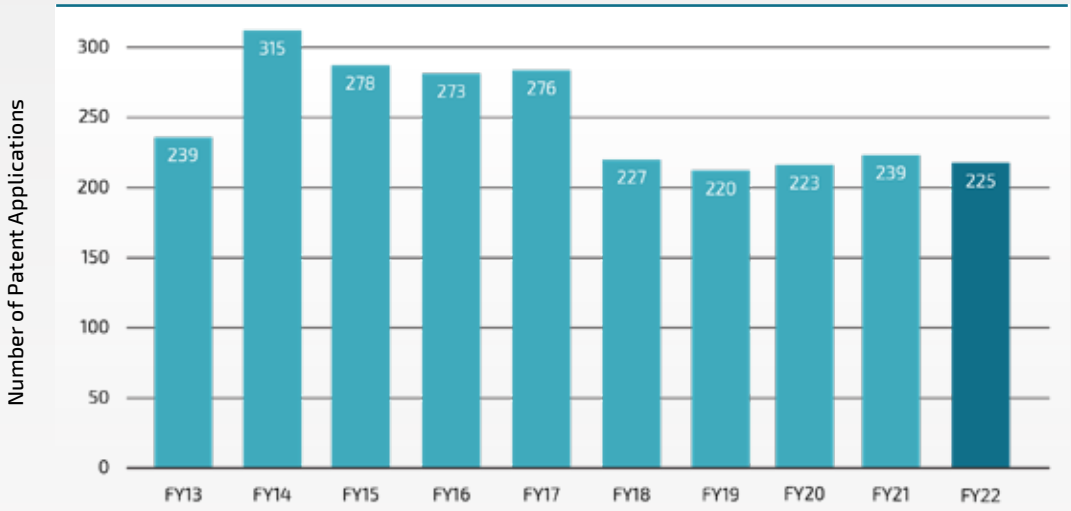


Patent Activity

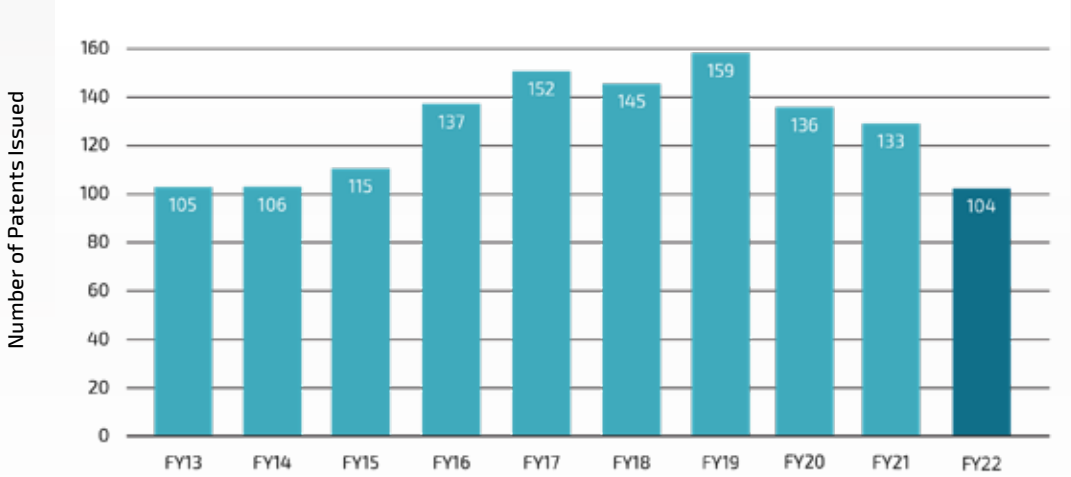
Invention Disclosures



Patent Applications



Patents Issued



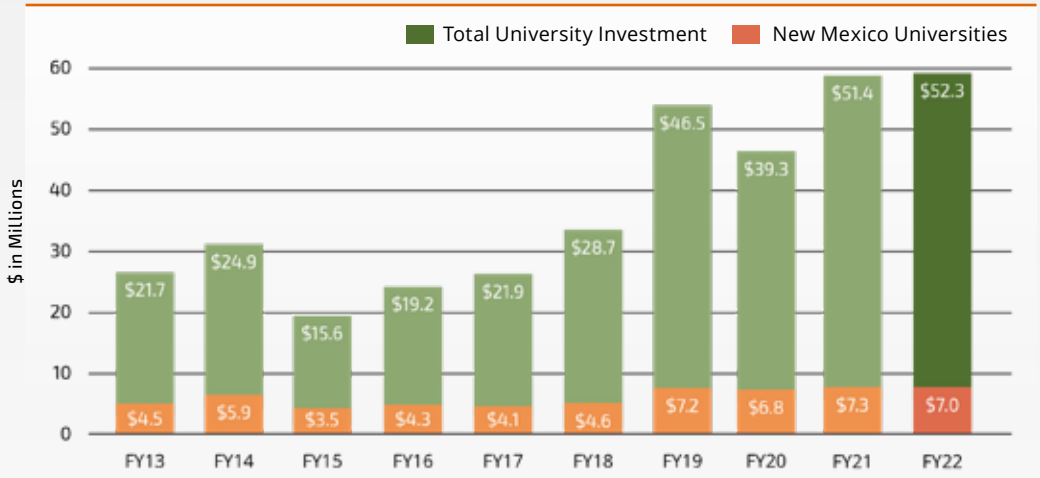
University Partnerships

Since 1997, when the Campus Executive program was established, Sandia National Laboratories has formally cultivated university research to expand its science and technology base. Through the Campus Executive program, Sandia formalized agreements with about 20 schools that defined partnership goals, including research collaboration areas and talent pipeline objectives. In 2016, Sandia began more focused collaborations with a subset of the Campus Executive schools under its Sandia Academic Alliance (SAA) Program. These schools had strong historical partnerships with Sandia, possessed synergistic research competencies and capabilities, and shared Sandia values and an affinity for national security work. In 2021, Sandia began its minority-focused program, Securing Top Academic Research and Talent (START), with Historically Black Colleges and Universities (HBCUs).

Sandia also revisited its strategy for university engagement in 2021, and is in the process of implementing the new Sandia University Partnerships Network (SUPN). The SUPN is a graduated spectrum of relationships with universities across the United States. The objectives of this network are to partner broadly with universities based on merit to ensure diversity in Sandia's pipeline of top talent and innovative ideas, and to establish and cultivate enduring strategic and mutually beneficial relationships with a focused set of schools.

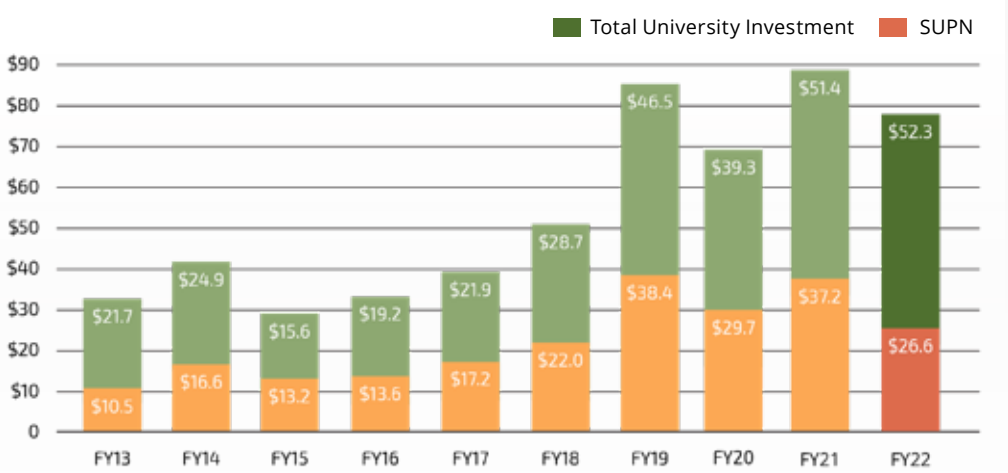
The Academic Programs Office, under the auspices of the Chief Research Officer, serves as the point of contact for university research, and implements those processes that enable and enhance university partnerships.

Investments in Research at New Mexico Universities*



Investments in Research with Sandia University Partnerships Network (SUPN)*

These programs pair Sandia executives with university officials at schools that share research interests and capabilities.



*Historic data has been updated to reflect current university structure and some investment numbers may have changed from previous reports.

Sandia Science & Technology Park (SS&TP)

Companies and Organizations	34
Employees	1755
Buildings	27
Public Investment in the Park*	$99.3M
Private Investment in the Park*	$321M
Total Investment in the Park*	$420.3M
Increase in Tax Revenue*	$4.0B
Increase in Wages*	$7.2B
Average Salary of Full-time Jobs in Park	$97K
Average Salary of Full-time Jobs in Metro Albuquerque	$54K

**Since Park opened in 1998.*

2022

During the calendar year, BlueHalo expanded its facilities from about 50,000 square feet to over 200,000 square feet.

SANDIA SCIENCE & TECHNOLOGY PARK

New Mexico Small Business Assistance (NMSBA)

	Sandia: 2000-2022
New Mexico Small Businesses Assisted	2,474
Rural vs. Urban Businesses	
Rural (58%)	1,447
Urban (42%)	1,027
Combined	2,474
Dollar Amount of Assistance	$48M

	Sandia and Los Alamos: 2000-2021*
Return on Investment (ROI)**	$1.60
(For every $1.00 of state tax credit invested)	
Economic Impact	
Small Business Jobs Created and Retained	11,116
Average Reported Salary (2021)	$65K
Increase in Revenue	$486M
Decrease in Operating Costs	$276M
Investment in NM Goods/Services	$184M
New Funding/Financing Received	$249M

**Surveys are performed six months to one year after project completion.*

***ROI is based on salaries of jobs created and retained.*

2022

During the calendar year, Sandia invested $2.4M helping 120 small businesses in 17 counties throughout New Mexico. There were 55 Sandia Principal Investigators across 37 departments that supported NMSBA.

NMSBA
Los Alamos National Laboratory
Sandia National Laboratories

Entrepreneurial Separation to Transfer Technology (ESTT)*

Sandians Who Left on ESTT	175
To Start up a Company	79
To Expand a Company	96
Companies Affected by ESTT	126
Start-up Companies	64
Expansion Companies	62

**Since ESTT began in 1994.*

2022

During the fiscal year, nine Sandians were approved to leave on ESTT.

ESTT
Entrepreneurial Separation to Transfer Technology

TRGR Technology Readiness Initiative*

	Sandia and Los Alamos: 2020-2022
Companies Assisted	12
New Licenses	12
New CRADAs	2

**Since TRGR began in 2020.*

2022

During the fiscal year, Sandia invested $443K assisting 10 companies.

TRGR Technology Readiness Initiative

Integrated Partnerships Organizations

For information about specific partnership areas, contact the following:

Technology Partnerships & Business Development

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Business Development & Data Analysis, Visualization, and Communications

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Academic Programs

For information about Academic Programs, contact the following:

Academic Programs

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Partnerships National Reach

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

https://www.sandia.gov/partnerships_reach/

Thank you to everyone who contributed to this report.

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NNSA National Nuclear Security Administration
U.S. DEPARTMENT OF ENERGY

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TECHNOLOGY Partnerships

Sandia National Laboratories

To learn more about the Center for Collaboration and Commercialization (C3), visit www.C3abq.com, or stop by our partnership space in downtown Albuquerque at 101 Broadway NE.

IPO Integrated Partnerships Organizations

To learn more about industry or university partnership opportunities with Sandia, visit www.sandia.gov/partnerships or contact us at 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

Academic Programs

To learn more about academic partnerships at Sandia, visit www.sandia.gov/working-with-sandia/academic-partnerships/ or contact us at acadalli@sandia.gov

Small Business First

To learn more about how to do business with Sandia, visit http://sbu.sandia.gov or contact us at supplier@sandia.gov