SANDIA LABNEWS
PUBLISHED SINCE 1949

Vol. 74, No. 6, April 8, 2022

Quantum New Mexico Symposium Page 4

Record-breaking, ultrafast devices step to protecting the grid from EMP

STRENGTH AND SPEED — Sandia electrical engineer Luke Yates, left, passes Jack Flicker, electrical engineer and grid-resiliency expert, a gallium nitride wafer with an array of diodes that can shunt a record-breaking 6,400 volts of electricity within a few billionths of a second. **Photo by Rebecca Gustaf**

New Sandia device can shunt record-breaking excess electricity in a few billionths of a second.

By **Mollie Rappe**

Sandia scientists have announced a tiny electronic device that can shunt excess electricity within a few billionths of a second while operating at a record-breaking 6,400 volts — a significant step toward protecting the nation's electric grid from an electromagnetic pulse.

The team published the fabrication and testing results of their device on March 10 in the scientific journal IEEE Transactions on Electron Devices. The team's ultimate goal is to provide protection from voltage surges, which could lead to monthslong power interruptions, with a device that operates at up to 20,000 volts.

— CONTINUED ON PAGE 8

International collaboration compares geologic repository assessment tools

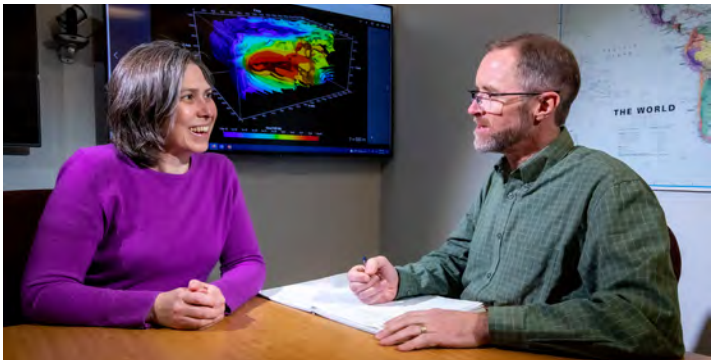
Sandia software supports assessment of future spent nuclear fuel disposal.

By **Mollie Rappe**

Researchers from Sandia and partner national laboratories will compare their Geologic Disposal Safety Assessment software framework to the safety assessment software of international peers at a late-April workshop.

The Sandia-led Geologic Disposal Safety Assessment framework is a computer modeling system designed to answer critical safety assessment questions about future disposal options for spent nuclear fuel deep underground and the system of tunnels, containers and possible concrete-like barriers used to keep the

— CONTINUED ON PAGE 10



SPENT SAFELY — Sandia engineers Emily Stein, left, and Paul Mariner discuss recent results from their Geologic Disposal Safety Assessment software framework for the international collaboration. The software modeled the spread of radioactive materials in a hypothetical spent nuclear fuel repository over 1 million years. **Photo by Rebecca Gustaf**

SANDIA LABNEWS
PUBLISHED SINCE 1949
Managed by NTESS LLC for the National Nuclear Security Administration

Sandia National Laboratories

Albuquerque, New Mexico 87185-1468
Livermore, California 94550-0969
Tonopah, Nevada | Nevada National Security Site
Amarillo, Texas | Carlsbad, New Mexico | Washington, D.C.

Katherine Beherec, Editor kgbeher@sandia.gov
Alicia Bustillos, Production abustil@sandia.gov
Paul Rhien, California Site Contact prhien@sandia.gov

CONTRIBUTORS

Michelle Fleming (milepost photos, 505-844-4902), **Neal Singer** (505-846-7078), **Stephanie Holinka** (505-284-9227), **Kristen Meub** (505-845-7215), **Michael Baker** (505-284-1085), **Troy Rummler** (505-284-1056), **Manette Fisher** (505-844-1742), **Valerie Alba** (505-284-7879), **Luke Frank** (505-844-2020), **Michael Langley** (925-294-1482), **Meagan Brace** (505-844-0499), **Mollie Rappe** (505-288-6123), **Darrick Hurst** (505-844-8009) **Jim Danneskiold** (jddanne@sandia.gov), **Heather Clark, manager** (505-844-3511)

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Published on alternate Fridays by Internal, Digital and Executive Communications, MS 1468

LAB NEWS ONLINE: sandia.gov/LabNews

TABLE of CONTENTS

LABNEWS Notes

The Communications team is devastated by the sudden passing of Sandia employee Rebecca Gustaf, whose photos grace the front-page stories in this issue. Rebecca was a talented photographer and videographer and a great team member. She is missed.

EDITOR'S NOTE: Please send your comments and suggestions for stories or for improving the paper. If you have a column (500-800 words) or an idea to submit, contact Lab News editor Katherine Beherec at kgbeher@sandia.gov.

Cheers to five more years

FURTHERING TECH — Sandia materials physicist Paul Clem holds a sample of nanoparticle-coated glass. Supported by the New Mexico Small Business Assistance program and a Cooperative Research and Development Agreement, a team of researchers including Paul worked with IR Dynamics on polymer films made from thermochromic nanoparticles. To help it mature further, Sandia provided technical assistance to IR Dynamics through the Technology Readiness Gross Receipts Tax Credit Initiative.
Photo by Randy Montoya

Successful Sandia, Los Alamos tech maturation program extended until 2027

By **Manette Newbold Fisher**

An initiative that helps businesses transform New Mexico national laboratories' technologies into viable products and services will continue driving innovations to market into 2027. Passed by the state legislature and signed into law by Gov. Michelle Lujan Grisham in March, the bill graduates the pilot **Technology Readiness Gross Receipts Tax Credit Initiative** into a five-year program.

"We couldn't be happier that the legislature supported extending the life of this program," said Mary Monson, Sandia senior manager of Technology Partnerships and Business Development. "The New Mexico Senate and House of Representatives unanimously voted in favor of the bill that could help create jobs and enhance the state economy through technology commercialization."

The program is offered in partnership between the state of New Mexico, Sandia and Los Alamos national laboratories. Since the establishment of the pilot in 2020, Sandia provided technical assistance to companies in cybersecurity, energy, robotics and medical industries. This includes businesses maturing technology that could reduce heating and cooling bills, assist with imaging procedures to diagnose life-threatening diseases and protect critical infrastructure from hackers.

Currently, there are 11 New Mexico companies accessing technical assistance from Sandia and Los Alamos national laboratories through this avenue. The initiative has accelerated technology transfer to New Mexico businesses, resulting in 10 licenses and two Cooperative Research and Development Agreements, with more in the pipeline, according to the Sandia business development team.

"The assistance we've been able to provide has been exciting and rewarding," said David Kistin, Sandia manager of technology and economic development. "Some of the assistance included testing components in simulated spaces. In another project, we are helping a company advance disinfectant technology licensed from Sandia. We're looking forward to seeing what the businesses do next."

Labs claim up to $1M per year for technical assistance

Each year, national labs call for proposals and companies to submit statements of intent. If selected to work with Sandia or Los Alamos national laboratories, the companies can receive up to $150,000 worth of technical assistance during a 12-month period.

The new law that extends this program enables the state's national laboratories to claim up to $1 million per fiscal year in tax credits against their gross receipts tax liabilities for their work with businesses. Initially through the pilot program, each lab could claim up to $500,000 the first year, $750,000 the second year and $1 million the third year.

"New Mexico is the only state with two Department of Energy research labs," said Cabinet Secretary Alicia Keyes of the New Mexico Economic Development Department. "This program can provide New Mexico businesses with an unmatched opportunity to tap into scientific expertise and use this collaboration to push ideas and products into the marketplace."

Eligible businesses must be registered to do business in New Mexico and have a facility in the state. They also must have licensed a technology from the laboratories or participate in a Cooperative Research and Development Agreement with a New Mexico national lab.

Work provided by scientists and engineers may include prototyping, proofs-of-concept and other activities that are not available in the private sector.

"Los Alamos and Sandia are committed to assisting companies during the critical stage between technology development and commercialization," said Deputy Program Manager Mariann Johnston of the Los Alamos Feynman Center for Innovation.

Sandia program lead Genaro Montoya said when technology is transferred from laboratories, companies sometimes struggle to commercialize it without further technical validation, but "through this program, we are able to help."

For more information, visit the Technology Readiness Gross Receipts initiative website.

Could quantum technology be New Mexico's next economic boon?

Quantum New Mexico Coalition aims to establish state as national hub

By **Troy Rummler**

Science, education and economic development leaders across New Mexico have formed a coalition to bring future quantum computing jobs to the state.

Sandia, the University of New Mexico and Los Alamos National Laboratory announced the new coalition at UNM during the Quantum New Mexico Symposium.

"Quantum technology is going to change the world someday, and it's going to bring with it high-paying, high-value jobs. New Mexico already has intellectual capital and world-class research facilities. We can bring in industry, too. We can change the outlook of our state by establishing New Mexico as a national hub for this high-tech sector," said Sandia's Rick Muller, senior manager over advanced microsystems.

Quantum computers can run some tasks faster than would ever be possible with supercomputers. While the technology is still experimental, funding for its development has steadily increased worldwide as governments and businesses eye its economic and national security implications, Rick said.

"Whoever makes the first breakthrough is going to have a big advantage. As a state, we want to be part of that," Rick said.

Ivan Deutsch, regents' professor and director of UNM's Center for Quantum Information and Control, said, "The Quantum New Mexico Coalition has the goal of a broad partnership across New Mexico, including our major research university, tribal colleges and community colleges, as well as national laboratories and industry."

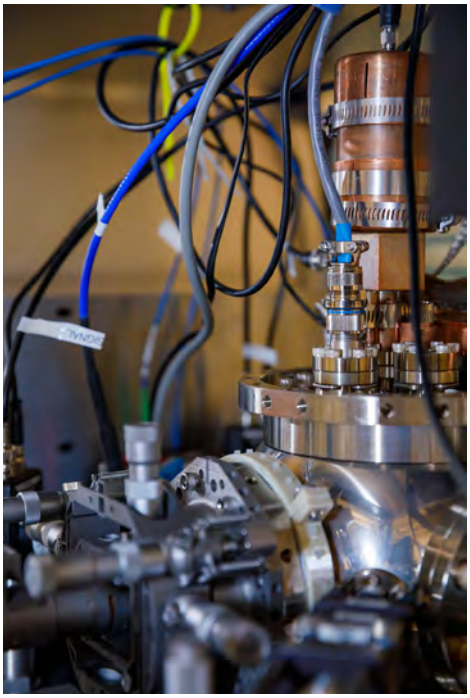
The coalition is supported by more than 30 colleges, businesses, labs and nonprofit organizations that operate in the Land of Enchantment.

"Los Alamos National Laboratory has been a world leader in quantum science for decades," said John Sarrao, deputy laboratory director for science, technology and engineering. "The state of New Mexico is poised to benefit from quantum capabilities and technologies at Los Alamos and at our fellow institutions. We share a commitment to collaborative quantum research and development that

QUANTUM NEW MEXICO
New Mexico is a Quantum State

STATEWIDE COLLABORATION — Sandia is co-leading the Quantum New Mexico Coalition, whose logo is pictured here, to bring future jobs and economic development to the state. **Image by Sandia**

QUANTUM TOURS — Sandia's Andy Mounce, left, leads a tour group through the Center for Integrated Nanotechnologies during the Quantum New Mexico Symposium following the announcement of the Quantum New Mexico Coalition. Symposium attendees also toured the Center for High Technology Materials and the new Physics & Astronomy and Interdisciplinary Science building, both at the University of New Mexico, which is co-leading the coalition with Sandia and Los Alamos National Laboratory. **Photo by Bret Latter**



QUANTUM ECONOMICS — Quantum technologies, like this quantum computer at Sandia, might be a source of future jobs in New Mexico's tech sector. **Photo by Bret Latter**

engages and uplifts the broader communities and industries of our home state."

Sandia and UNM additionally formed the Quantum New Mexico Institute last week, a joint research and education initiative that will create opportunities to build New Mexico's local quantum economy, develop a quantum-ready workforce and collaborate with leading institutions.

"Most people don't know that New Mexico has made many major scientific discoveries in this field of research," said Setso Metodi, Sandia's manager over quantum computer science. "As we keep pushing the science, we want to also grow the number of people who can participate in it."

Other coalition activities will focus on industry engagement, business development, policy and infrastructure enhancement.

Mary Monson, Sandia's senior manager of technology partnerships and business development, said the state has advantages when it comes to drawing businesses in this emerging sector.

"New Mexico has a huge government presence, including two national laboratories with strong quantum research programs. That makes the state attractive to businesses and startups that want to work on government projects. So, we're asking ourselves: What else will these businesses need? How can New Mexico remove supply chain barriers for manufacturers, for example? What programs do our higher education institutions need to build up a quantum-savvy workforce?" Mary said.

The Quantum New Mexico Symposium was a public event held March 31-April 1 that included talks, networking sessions, tours and panel discussions about the breadth and importance of quantum information science across the state.

Center of collaboration

By **Michael Ellis Langley**

It may not be common knowledge within Sandia that the Labs are home to the Plasma Research Facility. However, those who study plasma around the nation and the world are not only acutely aware, but they are also coming in great numbers to perform experiments and work with the experts.

"There are critical technologies in the world — anything with a microchip in it — that are based on plasma science. Manufacturing chips requires plasmas," said Shane Sickafoose, administrative head of the program.

The Sandia facility was fully funded by the DOE's Fusion Energy Sciences program in fall 2019.

"The depth and breadth of Sandia's technical expertise and facilities enable collaborations not possible anywhere other than at a national laboratory," Shane said. "The ability to have a team of experts in both experimental and modeling-simulation efforts focused on a problem is truly unique."

So, the team started to invite collaborators.

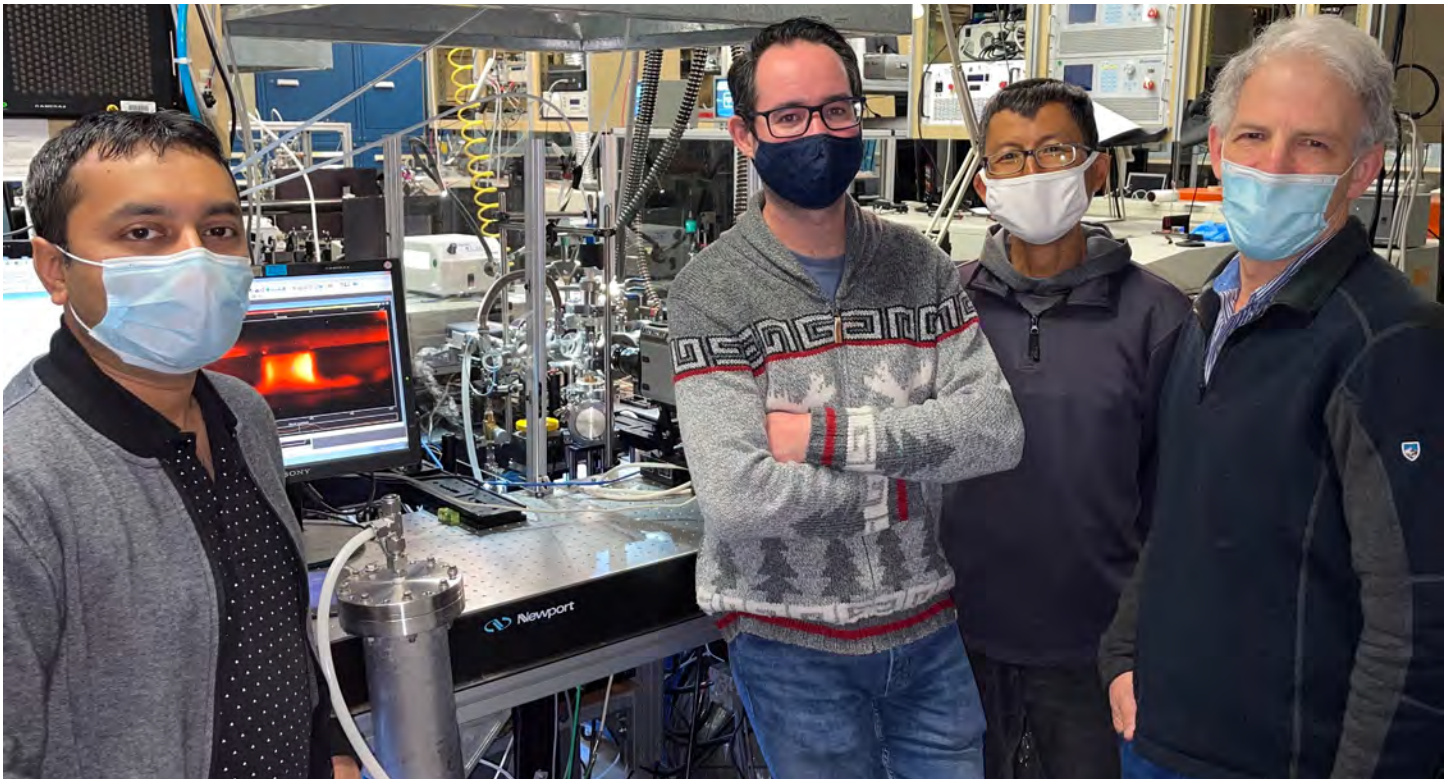
"The overall idea was that there would be proposals from universities, other national labs, both in the U.S. and abroad, to do collaborative research," said manager Nils Hansen, who was part of the facility from the start and helped write the funding proposal. "My first user was professor Yiguang Ju from Princeton University. He was studying plasma chemical looping. We chose him because he had a compelling argument that he was stuck with the instrumentation at Princeton and wanted to take advantage of what we had here at this facility."

Tackling new problems in new ways

Since then, even throughout the pandemic, the Plasma Research Facility has been able to host multiple scientists studying a variety of plasma effects. Plasma scientist Jonathan Frank, who also helped write the funding proposal, said some of the studies have been directly influenced by urgent needs.

"The second user I hosted was professor Tanvir Farouk from the University of South Carolina," Jonathan said. "He and his student

HOT STUFF — From left, Sandia scientists Chris Kliewer and Scott Steinmetz team with Princeton University doctoral student Madeline Vorenkamp in Chris' lab in the Plasma Research Facility. **Photo by Randy Wong**



COLLABORATORS — From left, University of South Carolina student Malik Tahiyat, and Sandia scientists Dirk van den Bekerom, Erxiong Huang and Jonathan Frank all perform experiments in the Plasma Research Facility. **Photo by Angie Zhang**

Malik Tahiyat were looking at the effects of having water vapor in a plasma, which could be used for treatments of heat-sensitive surfaces, including sterilization of contaminated surfaces. The pandemic made research related to killing viruses on surfaces particularly relevant."

Sandia chemistry researcher Chris Kliewer also hosted the growing network of collaborators. He said that in the last couple of years, only U.S.-based scientists could easily come to do work at the Plasma Research Facility. That is changing.

"On the next round, a number of people were coming from overseas," Chris said. "It's kind of interesting that the proposals we are seeing to do research here are ones that span a couple of our labs within the facility because they have multiple interests and goals."

Bringing computer power to bear

Sandia modeler Matt Hopkins added that the experimental capabilities are linked with a capability most labs lack: advanced simulation capabilities and algorithms, the robust computational power to take advantage of them and experienced modelers who know how to maximize computing capabilities.

"We have multiple high-performance computing platforms — an astounding amount of computing resources available," he said. "We have simulation codes that have benefited from decades of DOE investments. They have access to world-leading experts to harness that computing power."

And it is that breadth of capabilities that Matt believes will benefit the entire sector of plasma research.

"I've been in the low-temperature plasma community since the last millennium. It can be extremely difficult to collaborate with folks outside the Labs, but the Plasma Research Facility has set up a venue for that," he said. "There are very, very few places that have all of these things: the computational machine, the fancy code and the experts. The plasma problems that they are modeling, being able to solve problems at the scale that we can, it's just not something a lot of people have access to."

People at the heart of the facility

Jonathan underscored Matt's point that the Plasma Research Facility is about more than technological capabilities. "It's not just the equipment — it's the expertise that has been developed over a long time," he said. "Now we are developing new capabilities as we get new users."

Nils agreed. "We've definitely had examples of proposals we never thought of. This is something we would never have started without the user proposal. We wanted to help the plasma community as a whole," he said.

Matt sees a broad future of innovation and invention coming from the Plasma Research Facility.

"There are a lot of current industrial uses — semiconductor manufacturing, lighting, medical applications," he said. "But this is just the beginning. Think of fantastical things: thrusters like you would see in Star Wars or new applications like nanoparticle synthesis, medical sterilization techniques or virus decontamination from plasmas. There is a frontier of new applications for plasma that are becoming important."

The new facility brings Sandia to the forefront of that frontier.

One year after nuclear deterrence reorganization: internal, external collaborations going strong

By **Myles Copeland**

When designing something as complex as a nuclear weapons system, challenges are expected. It was the way that Sandia colleagues responded to one such challenge that made a lasting impression on Deputy Labs Director for Nuclear Deterrence Laura McGill.

"We were working with one of our teams going through really tough technical problems with a component," said Laura, describing a situation that unfolded only a few months after she joined Sandia following a career at Raytheon Missiles and Defense, where she served as deputy vice president of engineering. "We had just received some new test data that indicated it was going to be even more complex than we thought. Instead of resigning themselves to a delayed schedule, the team already had a recommendation for potential solutions."

Laura came to Sandia in January 2021 as part of an update of Sandia's approach to nuclear deterrence that added two executive leaders and restructured the organizations supporting this crucial mission. A year later, Sandia leaders reflected on the effects of this change.

"Nuclear deterrence is a very large mission area here at the Labs," said Rita Gonzales, a 30-year Sandian who became associate labs director for Nuclear Deterrence Modernization and Future Systems as part of this updated approach. "We do everything from partnering with our colleagues in Sandia's Advanced Science and Technology organizations on early research, to production, to assessing the stockpile that's in the field today. I think the current organizational structure helped to put focused attention on multiple areas of that complex mission."

"I believe [the new structure] enhanced our capacity to do more and have more rigorous, executive-level attention across more topics," said Steve Girrens, associate labs director for Nuclear Deterrence Stockpile Management, Components and Production, who came to Sandia in 2017 following a 40-year career at Los Alamos National Laboratory.

Managers from the span of Sandia's nuclear deterrence program credit improvements to the reorganization.

"By spreading out the large nuclear deterrence portfolio, it has increased leadership focus in their respective areas, like NNSA engagement by Laura using the breadth of knowledge she brings from her external experiences, driving the modernization programs differently from Rita's leadership experiences, and it has enabled Steve to focus more deeply on component and production needs," said Ernie Wilson, director of Advanced Systems and Transformation. "Laura, Rita and Steve have worked well together during an incredibly challenging year."

The change appears to have enhanced nuclear deterrence's engagement with both internal and external partners.

"The reorganization has made it more natural to include other organizations outside the nuclear deterrence core, but that are central to execution," said Asset Security and Weapons of Mass Destruction Response Director Gary Laughlin, whose organization collaborates with the nuclear deterrence program, including on development of the Mobile Guardian Transporter. "I am grateful for the very welcoming and inclusive environment the nuclear deterrence leadership team has created. With extended teams that include NNSA, the Kansas City National

POWERFUL PARTNERSHIP — From left, Associate Labs Director Rita Gonzales, Deputy Labs Director Laura McGill and Associate Labs Director Steve Girrens meet to discuss nuclear deterrence goals and challenges. The nuclear deterrence program was reorganized one year ago with Laura, Steve and Rita at the helm. **Photo by Bret Latter**

Security Campus and the supplier base, that helps us find the most fruitful efficiencies."

"The leadership transition has significantly amplified our engagement with our NNSA customers, allowing for much closer coordination and deeper understanding of key progress and challenges, not only with critical deliverables but also with the underlying capabilities that are so important for Sandia to meet the needs of the nation," said Brad Boswell, director of the Nuclear Deterrence Weapon Engineering and Production Program Management and Executive Office.

Brad's office manages the collaboration between the nuclear deterrence program and Sandia's science and technology program, which invests in foundational science and engineering capabilities, including those that address current and future security challenges. This collaboration is working well from the perspective of Susan Seestrom, associate labs director for Advanced Science and Technology.

"About 60% of our work is executed on behalf of the nuclear deterrence program, so we think about those needs every day," said Susan. "I lead the weapons science and technology program for nuclear deterrence, which is all about developing advanced technology that can impact the stockpile. Lastly, through the Advanced Science and Technology program portfolio — with funding from the DOE Office of Science — and the Chief Research Office, we support foundational research benefiting all the Labs' programs, of which nuclear deterrence is the largest. Personally, I greatly value the collaboration between the Advanced Science and Technology and nuclear deterrence programs and have three outstanding colleagues [Laura, Rita and Steve] to work with on the future of our nation's nuclear deterrent."

With first production units for the W88 Alt 370 and the B61-12 Life Extension Program delivered in 2021, the past year was a culmination of nearly a decade of work on these critical systems. Rita and Laura credited Sandia's nuclear deterrence staff and management.

"When I became associate labs director, I was super impressed with the people — the staff and the leadership, and how they distinguish themselves as highly dedicated, competent individuals — really delivering on every commitment and putting all they had into our nuclear deterrence mission," said Rita.

"Every week, maybe almost every day, I look around a room of people, and I just can't believe I get to be here with these people, getting to work on these problems that are so important to our country," said Laura.

As Sandia partners with the Kansas City National Security Campus to support full rate production of the W88 and B61-12 systems, it is allocating resources to design and develop the W80-4, the W87-1 and the W93 systems.

"I think the future remains extremely challenging," said Steve. "The work scope and intensity are increasing. But when I look back over the past year, it fills me with great pride, both as a Sandian and as an American in our fellow Sandians. They're overcoming and delivering for the nation, above and beyond, during a pandemic."

Protecting the grid

CONTINUED FROM PAGE 1

For comparison, a household electric dryer uses 240 volts of electricity.

An electromagnetic pulse, or EMP, can be caused by natural phenomena, such as solar flares, or human activity, such as a nuclear detonation in the atmosphere. An EMP causes huge voltages in a few billionths of a second, potentially affecting and damaging electronic devices over large swaths of the country.

EMPs are unlikely, said Bob Kaplar, manager of a semiconductor device research group at Sandia, but if one were to occur and damage the huge transformers that form the backbone of our electric grid, it could take months to replace them and reestablish power to the affected portion of the nation.

"The reason why these devices are relevant to protecting the grid from an EMP is not just that they can get to high voltage — other devices can get to high voltage — but that they can respond in a couple billionths of a second," Bob said. "While the device is protecting the grid from an EMP, it's at a very high voltage and thousands of amps are going through it, which is a huge amount of power. A material can only handle so much power for a certain amount of time, but we think the material in our diode has some advantages over other materials."

A regulator valve for the grid

The new Sandia device is a diode that can shunt a record-breaking 6,400 volts of electricity within a few billionths of a second. The team, including Sandia electrical engineer Luke Yates, the first author on the paper, is working toward fabricating a diode able to operate at around 20,000 volts, since most grid distribution electronics operate at around 13,000 volts.

Diodes are electronic components found in nearly every electronic device and serve as one-way regulator valves, said Mary Crawford, a Sandia senior scientist leading diode design and fabrication for the project. Diodes allow electricity to flow in one direction through the device but not the other. They can be used to convert AC power into DC power, and in this project, divert damaging high voltage away from sensitive grid transformers.

Bob agreed the diode operates somewhat like a regulator valve in plumbing. "In a regulator valve, even if you open that valve all the way, you can't flow an infinite amount of water through the valve," he said. "Similarly, there's a limit to how much current you can flow through our diode. If the valve on the pipe is closed, if the pressure reaches a certain point, it'll burst. Analogously, the diode cannot block an infinite voltage. However, our EMP device uses the point at which the diode can no longer block the high voltage, holds the voltage to that 'pressure,' shunting the excess current through itself, to the ground and away from the grid equipment in a controlled, nondestructive fashion."

The voltage surges caused by EMPs are a hundred times faster than those caused by lightning, so experts don't know if the devices designed to protect the grid against lightning strikes would be effective against an EMP, said Jack Flicker, a Sandia electric grid resiliency expert on the team.

"The electric grid has a number of different protections," Jack said. "They range in timeframe from very fast to very slow, and they're overlaid on the electric grid to ensure that an event cannot cause a catastrophic outage of the electric grid. The fastest protection that we typically have on the grid reacts against pulses at one millionth of a second, to protect against lightning. For EMPs, we're talking ten billionths of a second, a hundred times faster."

The new Sandia device can react that quickly, Jack said.

Growing perfect layers

Part of what makes the diode special is that it is made from gallium nitride, the same basic material used in LEDs, Bob said. Gallium nitride is a semiconductor, like silicon. But because of its chemical properties it can hold off much higher voltage before it breaks down than silicon, Mary said. The material itself also responds very quickly and therefore is a good candidate to achieve the fast response needed to protect the grid from an EMP.

Mary and materials scientists Brendan Gunning and Andrew Allerman made the devices by "growing" gallium nitride semiconductor layers using a process called chemical vapor deposition, she said. First, they heat a commercially available gallium nitride wafer to around 1,800 degrees Fahrenheit and then add vapors that include gallium and nitrogen atoms. These chemicals form layers of crystalline gallium nitride on the surface of the wafer.

By tweaking the ingredients and the "baking" process, the team could produce layers with different electrical properties. By building up these layers in a specific order, combined with processing steps, such as etching and adding electrical contacts, the team produced devices with the needed behavior.

"A major challenge of achieving these very high-voltage diodes is the need to have very thick gallium nitride layers," Mary said. "The drift regions of these devices have thicknesses of about 50 microns, or one-sixth of a sheet of notebook paper. This may not sound like a lot, but the growth process we use can have growth rates of only one or two microns per hour. A second major challenge is maintaining very low densities of crystalline defects, specifically impurities or missing atoms in the semiconductor material, throughout the growth time in order to generate devices that work at these very high voltages."

For the team to reach their goal of a device that operates at 20,000 volts, they will need to grow the thick layer even thicker with even fewer defects, Mary said. There are several other technical challenges to constructing a device that can operate at such high voltages and currents, she added, including designs to manage the very high internal electric fields within the devices.

Testing ultrafast diodes

Once Mary's team fabricated the devices, Jack and his team tested how the devices responded to fast voltage spikes, like what would occur during an EMP. His challenge has been modifying a tool to measure the very fast response time of the devices.

"Developing the tools that can accurately measure the very fast responses, is very difficult," Jack said. "If we're talking one or two billionths of a second, they need to be able to measure even faster than that, which is a challenge."

GRID PROTECTION — A close-up of an array of record-breaking gallium nitride diodes created by a team of Sandia scientists. These diodes are a step on the path to protecting the electrical grid from an electromagnetic pulse.
Photo by Rebecca Gustaf

Jack and his team used very specialized equipment to apply a high-voltage pulse, then measure the electric pulse that is reflected back from the diode to tell when the device turns on, very accurately and in less than a billionth of a second.

Useful for smart transformers, solar panel converters and more

Diode devices like the Sandia gallium nitride diode can be used for other purposes, beyond protecting the grid from EMPs, Bob said. These include smart transformers for the grid, electronic devices to convert electricity from rooftop solar panels into power that can be used by household appliances, and even electric car charging infrastructure.

Commonly, solar panel converters and electric car charging infrastructure can handle 1,200 or 1,700 volts, he added. But operating at higher voltage allows for higher efficiencies and lower electricity losses. Another portion of the project is to develop diodes for these types of devices that operate at high, but not record-breaking voltage, but are easier to manufacture, Bob said. The Naval Research Laboratory is leading this part of the project.

Some smart transformers and electronic devices can now operate at up to 3,300 volts, Jack said, but efficiencies would be even greater if they could operate at 10,000 or 15,000 volts with one semiconductor device.

"We have this primary goal of protection of the electrical grid, but these devices have other uses beyond that," Jack said. "It's interesting to have our application area but know that these devices can be used in power electronics, power converters, everything that's at very high voltages."

This research is funded by the Advanced Research Projects Agency-Energy and the larger project is conducted in partnership with the Naval Research Laboratory, Stanford University, National Institute of Standards and Technology, EDYNX Inc. and Sonrisa Research Inc.

Spent nuclear fuel framework

CONTINUED FROM PAGE 1

radioactive material contained far from the surface and water sources, said Emily Stein, a Sandia manager overseeing the development of the framework. Work on this framework is supported by the DOE's Spent Fuel and Waste Science and Technology campaign.

"The goal of the framework is to provide DOE with a flexible and intuitive simulation and analysis capability for investigating different deep geologic repository systems," Emily said. "It has to be flexible to look at different host rocks and the different processes that can occur in those different kinds of rocks. It has to work with different 3D engineering designs. The DOE also wants it to be fairly straightforward to explain how various thermal, chemical, hydrological and mechanical processes were coupled in the model. There's all this different stuff that goes on underground and the DOE wants to be able to think about the connections between those processes in a way that is somewhat intuitive."

Sandia started working on the framework in 2012. Comparing the results from Sandia's software against the results from the safety assessment software of international peers will build confidence in the software and models, Emily said. The comparison could also highlight areas for improvement.

Importance of a flexible software framework

The U.S. has approximately **90,000 metric tons** of spent nuclear fuel — uranium rods no longer used for producing electricity at nuclear power plants — stored at nuclear power plants across the country, and this number will keep growing. While nuclear provides **more than half of the carbon-free electricity** in the U.S., a permanent solution to spent nuclear fuel is needed.

There is broad international scientific consensus that a geologic repository is the safest and most secure method of permanently disposing of this spent nuclear fuel, Emily said. Sandia's framework is designed to assess the safety of future geologic repositories and assist in licensing efforts. It can model everything from what happens to the spent nuclear fuel rods and the canisters that contain them, to the rock mere inches from the canisters or rock miles away.

"All of us in the international nuclear community are in the same boat — we need a safe place for our waste," said Paul Mariner, a lead Sandia engineer on the project. "The framework is a system of codes that we can use to build a total-system model of a potential repository for a safety assessment. It really comes down to probabilistic risk assessment, which is a way to carefully and methodically address all of the questions regulators and citizens have about a repository by accounting for the probabilities of various events that could cause the release of radioactive material."

The Geologic Disposal Safety Assessment framework is built upon two core Sandia software packages: PFLOTRAN and Dakota. **PFLOTRAN** is open-source software maintained and developed at Sandia and several other national labs that models how chemicals react and how liquids and gases flow, underground, Emily said. "This is an important toolset because the primary thing we're concerned with for a deep geologic repository is the movement of radioactive atoms out of the repository."

Dakota is Sandia software that specializes in uncertainty sampling and sensitivity analysis, in other words, determining which input values have the largest impact on the results. Since no one can predict the future, Dakota assures researchers that the results are trustworthy, even if, for example, their estimate for the likelihood of a big earthquake occurring at the location over the next million years is uncertain. Laura Swiler, a Sandia computer scientist, has been instrumental in ensuring that the team has the sensitivity analysis tools needed for the safety assessment framework, Emily said.

"Uncertainty quantification calculations help us better characterize the repository system and also help us assess the significance of certain input values and processes that affect the final results," Paul said.

Emily added that the framework is massively parallel and runs on supercomputers, which is important for modeling what happens at a repository over a million years.

Recently a Sandia team, led by Michael Nole, made some significant improvements to PFLOTRAN to speed up calculations of certain challenging processes and improve the representation of how dry soil acts like a sponge, Emily said.

International competition improves confidence

In late April, 10 teams of repository scientists from across the globe, including teams from Canada, Germany and Taiwan, will compare the safety-assessment models they developed for two reference cases. These reference cases are hypothetical repositories in two different kinds of rock that would be relevant for every team. One reference case is for a repository in a salt formation. The other reference case is for a repository in crystalline rock. Each case comes with a set of key questions, which took about two years of discussion to fully define along with the details of the hypothetical repository.

Comparing the results of Sandia's software against the results from other teams' software will build confidence in the software and models, Emily said. Specifically, the teams will compare the results of their models to see if there is a consensus reached by multiple teams. Then the models that produced different results will be studied to try to determine why their results were different. This will allow repository scientists from across the globe to learn from one another and improve their models. This comparison is part of an international collaboration called **Development of Coupled Models and their Validation against Experiments**, or DECOVALEX.

"The DECOVALEX initiative creates an important framework for experts in repository sciences from around the world to test and improve simulation models that are important to assessing the safety of geologic disposal," said Jens Birkholzer, the chairman of the initiative and a senior scientist at Lawrence Berkeley National Laboratory. "Seventeen partner organizations, 50 modeling teams and more than 100 simulation experts are currently involved in this global effort. Through collaborative model comparison, DECOVALEX demonstrates that long-term prediction of complex subsurface processes associated with geologic disposal can be achieved with a high level of confidence."

Specifically, for the two DECOVALEX reference cases, the

Sandia team expanded the framework to model how salt mined out of a salt-based repository and then replaced around waste containers can heal itself back into solid, impermeable blocks over millennia, Emily said. They also refined their model on how water can flow around cracked crystalline rock and possibly move radioactive atoms within a geologic repository. These two improvements will likely be helpful in answering safety assessment questions about future U.S. spent nuclear fuel repositories.

In the future, Emily and her team hope to add more machine learning algorithms to the framework to speed up modeling some complex processes without impacting accuracy or transparency, she said.

"This type of comparison, where we're all starting with the same two problem descriptions and are developing numerical models around them is one important way to create confidence in safety assessment models and the tools we're using to do the simulations," Emily said. "We can't actually take this big, full million-year simulation and compare it to a real-world experiment of the same scale. It's a very important exercise."

Other DOE national laboratories involved in developing the framework and the DECOVALEX initiative include Argonne, Idaho, Lawrence Berkeley, Lawrence Livermore, Los Alamos, Oak Ridge and Pacific Northwest national laboratories.

Shaping the next generation of scientists

By **Debra Menke**

Sandia hosted the virtual regional DOE National Science Bowl for middle and high school students in New Mexico and California in February, inspiring youth to pursue careers in STEM. The competition is a nationwide academic event that tests students' knowledge in all areas of science and mathematics. Teams compete in a fast-paced Q&A format, answering questions about subjects like earth and space science, physics, biology, mathematics and energy.

Winning regional teams from across the nation, including La Cueva High School, Mission San Jose High School, Los Alamos Middle School and Pleasanton Middle School, will compete in the semifinals in May with a chance to advance to the national championship in July in Washington, D.C.

Special volunteers make their mark with the youth

The DOE National Science Bowl relies heavily on volunteers to serve as moderators and scorekeepers. More than 40 Sandia employees volunteered as moderators and scorekeepers.

Sandia electrical engineer Dan Riley has been officiating the DOE Science Bowl for 14 years. As a former high school competitor, he is passionate about carrying the torch to instill a love for STEM in today's youth. "I get the same sense of anticipation that a child does before Christmas when the science bowl is around the corner," Dan said.

PASSING ON A LOVE OF STEM — Sandia electrical engineer Dan Riley, second from left, coaches the Eisenhower Middle School science bowl team, pictured with Dan and the team's sponsor, at the 2022 DOE National Science Bowl. "It's wonderful to see kids that may be hesitant at first now diving headfirst into STEM when they come into contact with some friendly competition through these events," Dan said.

Photo courtesy of Eisenhower Middle School

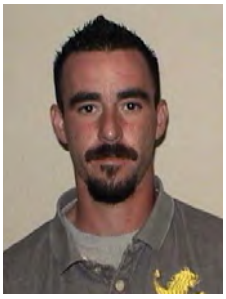
Dan, a father of five children, began coaching in 2019 with students at Eisenhower Middle School. He assists his daughter's team weekly to practice reviewing and answering science-related questions, listen to short fact-filled lectures and connect with her classmates.

"An important component to officiating and coaching is engendering a love for STEM fields and encouraging students to become the next generation providing STEM solutions for the world," Dan said. "It's wonderful to see kids that may be hesitant at first now diving headfirst into STEM when they come into contact with some friendly competition through these events."

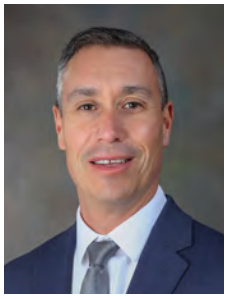
To check out volunteer opportunities with Community Involvement, visit the Education Outreach page on the Community Involvement Sharepoint website.

Mileposts

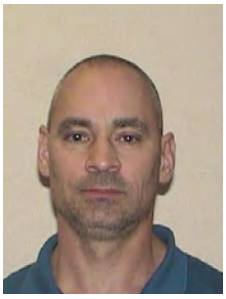
David Sanchez 25



Eric Capener 20



M. Anthony Chavez 20



Joe Chirieleison 20

Phap Dinh 20

Robert Kaplar 20

Mike Kent 30

Mike McLean 20

Lin Nguyen 20

Virgil Rankin 20

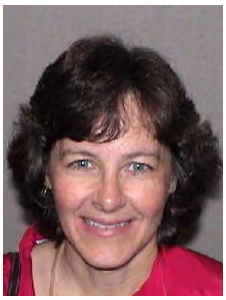
Steve Rinaldi 20

Jim Stephens 20

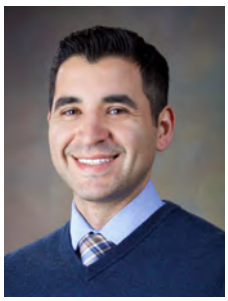
James Burt 15

Gary Huang 15

Jason Plake 15



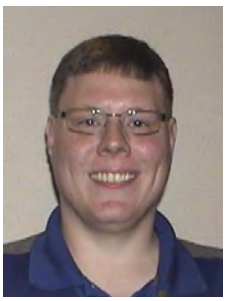
Laura Price 15



Michael Rosales 15

Darlene Serna 15

Mike Starr 15



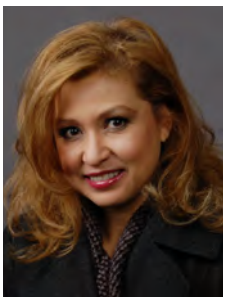
David Tarbell 15

Tina Vazquez 15

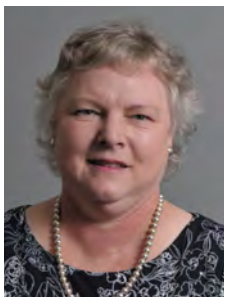
Laurie Wallis 15

Recent Retirees

Douglas Dederman 38



Karen Griego-Peralta 32



Denise Bleakly 28

Julian Melgarejo 10

Retiree Deaths

July 20, 2021 - Feb. 21, 2022

Thomas Linnerooth (age 80)	July 20, 2021
Louis Pitts (81)	July 20
Orlando Sanchez (96)	August 4
Bud Wimber (87)	August 5
Joyce Mckenzie (80)	August 5
Donald Tipping (77)	August 7
Eugene Cnare (88)	August 8
Farrell Perdreauville (85)	August 13
David Keese (67)	August 17
Arlyn Blackwell (89)	August 19
Marie Syme (99)	August 20
Delfino Aragon (83)	August 21
Juanita Davis (96)	August 21
Marvin Causey (102)	August 24
Alec Willis (86)	August 25
Richard Bild (75)	August 26
Ruth Jones (95)	August 27
Gary Miller (83)	August 30
Susan Wayland (83)	September 2
David Harstad (78)	September 5
Patrick Garcia (63)	September 5
Larry Humpherys (86)	September 6
Gary Beeler (80)	September 10
Elizabeth Ruiz (45)	September 12
Ben Sedlack (89)	September 16
Bruce Tuttle (69)	September 16
Sandra Evans (78)	September 17
Richard Fleming (78)	September 19
Michael Baca (89)	September 20
Barbara Thompson (80)	September 21
Francis Higgins (91)	September 22
Jerry Adams (61)	September 24
Barbara Frederickson (88)	September 25
Victor Dickerson (82)	September 30
James A. Miller (75)	October 3
D. Maxwell Ellett (99)	October 6
Olivia Salisbury (70)	October 7
J. Thomas Grissom (82)	October 8
Mary Lockwood (85)	October 10
Michael Deveney (73)	October 10
S. Thunborg (92)	October 11
James Fee (85)	October 11
Emma Winter (92)	October 13
John Moyer (85)	October 18
Garry Ogle (86)	October 20
Charles Trauth (84)	October 20
Robert Woods (88)	October 24
Thomas Thompson (94)	October 26
William Hale (82)	October 27
Bruce Wickesberg (88)	October 27
Audilio Barela (92)	October 28
Joseph Smith (77)	October 30
Edward Roberts (80)	October 30
Leonard Hiles (82)	October 31
Gibson Guernsey (88)	November 1
Henry Harada (95)	November 1
Alan Swain (98)	November 2
Merril Robinson (93)	November 2
Grover Hughes (96)	November 3
Jean Gaeddert (91)	November 3
Clifford Jacobs (87)	November 3
Frances Aguilar (59)	November 5
Eulojio Sanchez (84)	November 6
Luberto Ortiz (85)	November 7
Eldon Julius (91)	November 7
C. Christensen (99)	November 10
Richard Luther (77)	November 11
Juan Garcia (86)	November 12
Ernest Gonzales (83)	November 16
Sara Reid (67)	November 16
Joshua Valerio (62)	November 16
Hazel Willyard (92)	November 18
William Perea (96)	November 19
Carla Honeyestewa (71)	November 19
Dolores Aragon (94)	November 20
James Todd (91)	November 24
Fred Rodriguez (82)	November 24
Steve Valdez (80)	November 26
Lucy Armijo (90)	November 27
Gilbert Muniz (83)	November 28
Jon Munford (82)	December 1
Robert Wilde (90)	December 3
Robert Facer (89)	December 4
Salvador Lopez (82)	December 9
Lillie Peters (83)	December 10
Clinton Shirley (72)	December 10
Laura Koontz (68)	December 11
Thomas Silva (87)	December 12
Kenneth Grant (86)	December 16
James Freese (85)	December 18
Phillip Vouterin (90)	December 19
Carl Fitzgerald (78)	December 21
David Like (72)	December 21
J. Dolores Parra (76)	December 22
David Caskey (79)	December 23
Lee Davison (84)	December 25
Jose Martinez (75)	December 27
R. Eugene Church (87)	January 1, 2022
Patricia Ann Dahlgren (84)	January 2
Nancy Jackson (65)	January 3
Jack Pons (87)	January 4
William Sanchez (87)	January 7
Raymond Caster (94)	January 8
Meredith Thompson (89)	January 8
J. Lee Schoeneman (66)	January 12
David Palmer (75)	January 14
Laurie Bergeron (64)	January 15
Fred Allen (83)	January 17
Kenneth Smith (74)	January 17
Carla Perea (74)	January 18
Christine Erickson (78)	January 21
Floyd Kent (85)	January 22
Orlando Rodriguez (93)	January 24
Perry Cowen (64)	January 24
Jan Nobel (67)	January 29
Robert Schultz (90)	January 30
Jay Grear (95)	January 30
Marvin Perdue (85)	February 12
Harold Barnett (94)	February 14
Lucille Baca (71)	February 15
Ernie Gurule (92)	February 16
E. Joseph Kerr (86)	February 16
Frederick Norwood (82)	February 20
Donald Mattox (89)	February 21

Including everyone at the table

Tech transfer specialist creates programs for women inventors, wins award

By **Manette Newbold Fisher**

In less than three years at Sandia, competitive intelligence specialist Kelli Howie has made waves throughout the federal laboratory complex by creating programs to boost diversity in technology transfer activities.

Kelli's targeted work to develop and advance women inventors was recognized by the Federal Laboratory Consortium with a national Rookie of the Year Award. The award honors just two employees or teams who are new to technology transfer and have demonstrated an ability to create meaningful impact above and beyond standard responsibilities.

"Inclusion and diversity are important in every way I can think of," Kelli said. "I was honored to be nominated for the award and humbled when I received it. I'm optimistic about Sandia's future because we are constantly examining areas for improvement and this award demonstrates the national labs' and the consortium's continued commitment to diversity, equity and inclusion practices."

The Federal Laboratory Consortium is a network that honors significant technology transfer accomplishments among more than 300 federal laboratories and research centers. The annual awards are some of the most prestigious awards for federal laboratories that demonstrate outstanding technology transfer achievements. Winners received awards April 6.

Initiatives attract 700-plus participants

Since joining Sandia in 2019, Kelli has focused on engaging with and educating women on inventorship and technology transfer at the Labs and throughout the DOE enterprise. She serves as the Sandia staff lead for the Diversity and Inclusion in inVentorship and EntrepReneurship Strategies and Engagement-Women, or DIVERSE-W, program, which is funded by the DOE Office of Technology Transitions as part of its **Practices to Accelerate the Commercialization of Technologies**. The program was announced in October 2019 and launched the following year in partnership with 11 other national laboratories.

Kelli's team researched university technology transfer programs that hadn't been adopted by federal laboratories. Early results at those universities showed positive impact following the creation of targeted inventorship programs for women and minorities. Even so, according to the Patent and Trademark Office, only 13% of patent inventors in 2019 were women. According to 2017 data from the National Bureau of Economic Research, women CEOs receive only 2.7% of all venture funding, and women of color receive only 0.2%.

"We can't just count on the pipeline to backfill this issue and bring in more people," Kelli said. "We need targeted programs that bring women into the patent ecosystem."

NATIONAL RECOGNITION — Sandia competitive intelligence specialist Kelli Howie won a national Federal Laboratory Consortium Rookie of the Year Award for her efforts to boost diversity in technology transfer. **Photo by Jennifer Plante**

Combining ideas from university programs with national labs culture in a virtual environment due to the pandemic, Kelli led the development of instructional programs, communication strategies and a **2021 speaker series** for women inventors to increase awareness of and participation in technology transfer and commercialization activities.

The series focused on an overview of technology transfer and partnerships, specifics of the patent process, effective engagement and customer discovery, basics of entrepreneurial mindset and the value of networking. DIVERSE-W events drew more than 700 participants that year.

"Kelli has taken the time to understand the many different facets of technology transfer, from development of intellectual property to the execution of agreements," said Joel Sikora, Sandia manager of Technology Partnership Agreements, Intellectual Property, and Business and Competitive Intelligence. "In her short time at Sandia, she has worked to increase the engagement of scientists in the disclosure process and has become a leading advocate at the DOE labs for increasing the involvement of women in innovation."

In addition to her work on the DIVERSE-W program, Kelli was appointed lead of the Inclusion, Diversity, Equity,

Accountability and Solutions, IDEAS, working group of the Quantum Systems Accelerator, one of five National Quantum Information Science Research Centers newly funded by the DOE in 2020. The Quantum Systems Accelerator is a multidisciplinary team comprising dozens of researchers from 15 labs and universities. Together, they are collaborating to transform rudimentary quantum computers and related technologies into machines that perform valuable work for the nation.

The IDEAS group that Kelli leads is focused on growing Quantum Information Science as a discipline that fosters innovation, engagement and psychological safety for all participants, including those from underrepresented backgrounds. She is working to create equitable access to resources and opportunities within the field.

Kelli also established a new internal partnership between Sandia's Integrated Partnerships Organizations and the Sandia Women's Action Network, which promotes participation in community outreach activities that encourage women and girls to pursue fulfilling careers.

Tapping into larger innovation pool

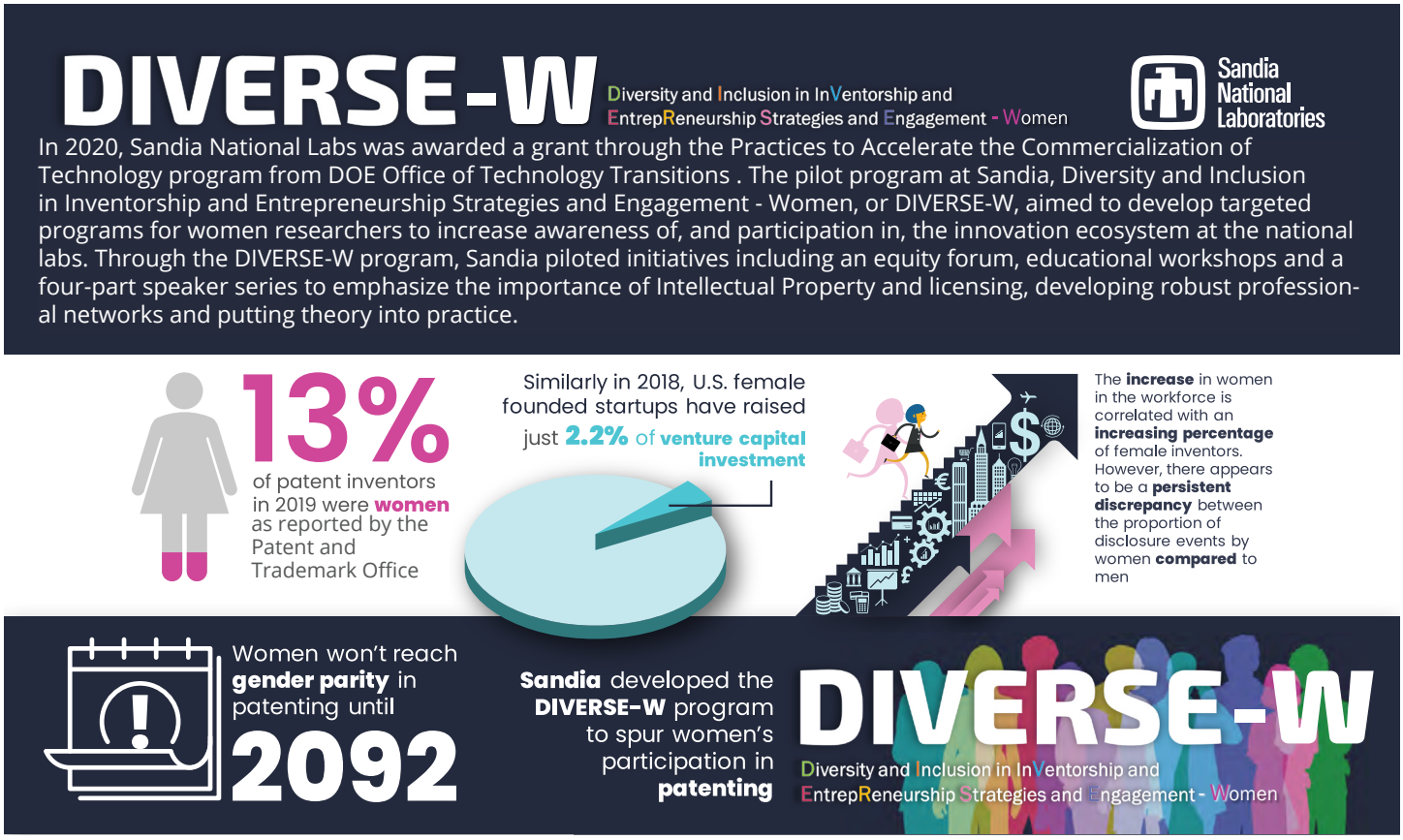
From a young age, Kelli began to see the importance of inclusion and diversity. As a teenager, she worked with students in public school English as a second language programs. Inspired by her experiences there, she helped develop a similar program, in partnership with churches in Texas, that provided English language instruction for families in the community.

Kelli's early career began in criminal defense as a paralegal. She then worked for seven years at the University of New Mexico on program development, operations and health equity research. In 2018, she received her master's degree in business administration from the university. When she transferred to Sandia to focus on technology transfer, Kelli brought her passions for writing, research, inclusion and diversity.

"In terms of technology transfer, I didn't have any experience prior to coming on the job and once I got here, I felt like a sponge. It was all so fascinating to me," Kelli said. "How cool is it that we get to take amazing technologies from the national laboratories and find new purposes for them in industry? This creates dual use so that the public is getting the best of both worlds from everything we create."

As a mother of two daughters who are both fascinated by science, Kelli said creating targeted programs for women became personal.

"I hope that something like this kind of paves the way for them in the future," she said. "Women were excluded from STEM for centuries, and as a result they are playing catch up, even today. The opportunities Sandia is establishing through these programs could help level the playing field so that when it comes to technology transfer, we're bringing all talent into the equation and really tapping into an innovation pool that expands and grows when we include everybody at the table."



Graphic by Manuel Rubio; Data provided by the Patent and Trademark Office, TechCrunch and the Institute for Women's Policy Research

New Mexico education, now and in the future

Community Engagement Speaker Series hosts NM public education secretary

By **Stephanie Holinka**

The Community Engagement Speaker Series hosted New Mexico Public Education Department Secretary Kurt Steinhaus, who provided an overview of the department and his role, shared insight into the state of education in New Mexico, discussed outcomes of the 2022 legislative session and presented his goals for education throughout the state.

Steinhaus was born in Los Alamos and has dedicated his career to education and advocating for New Mexico students. He previously served as the superintendent of Los Alamos Public Schools and as the director of student programs, education, workforce development, scholarships and community giving at Los Alamos National Laboratory. Steinhaus also served as New Mexico deputy secretary of education, prekindergarten czar and education policy advisory for Gov. Bill Richardson.

His current role allows him to put his education and leadership to work, leading New Mexico on a path toward improving the state's educational system and better enabling New Mexico schools to turn out the types of graduates the national laboratories need, as well as attract and retain parents of school-aged children. But he remains a teacher at his core.

"I still consider myself a teacher every day. Some days I teach with the Legislative Finance Committee. Today, I'm a teacher for Sandia," Steinhaus said.

Education in New Mexico faces many challenges. Although on-time graduation rates have risen steadily since 2015, New Mexico still only graduates 77% of high school students in four years, Steinhaus said. Despite these continued challenges, he says the state has made historic investments in evidence-based educational programs to improve student outcomes at every grade level.

As the secretary of education, his current goals are to make this year the "Year of Literacy," make New Mexico the fastest growing state in student achievement in math and language arts and make state educator salaries competitive with other states in our region.

SCHOOL SUCCESS — Sandia invited Kurt Steinhaus, New Mexico Public Education Department secretary, to present an update on public schools throughout the state and goals for the next academic year. "I still consider myself a teacher every day. Some days I teach with the Legislative Finance Committee. Today, I'm a teacher for Sandia," Steinhaus said.

Photo courtesy of the New Mexico Public Education Department

Steinhaus said public education funding will increase by $3.87 billion for academic year 2022 to 2023. The largest increases are slated for school personnel compensation, incentives for extending learning, and teacher preparation and professional development.

To address the educator workforce crisis, the state will set new minimum salaries at three levels, including a starting salary level for beginning teachers at $50,000. All school personnel will receive an average 7% increase and additional incentives will be available for extended-learning programs, he said. Higher raises may also be available for hard-to-fill positions in some places, such as special education.

He lauded the Sandia workforce for its volunteer work with Big Brothers Big Sisters, the various science night events, the ABQ Reads Program and other activities that encourage students of all ages and backgrounds to excel. He also discussed the alternate licensure programs and substitute teaching options that some staff could consider post-retirement or on Fridays off, that would help address the teacher shortages.

The Sandia Parents Group led the Q&A at the end of the talk, discussing academic achievement, teacher pedagogy, mental health, and special education and disability resources.

Resources for parents and educators

The following resources are related to the questions and issues discussed in the talk and Q&A.

- Public Education Department strategic plan
- Mental Health First Aid portal
- State Plan for the American Rescue Plan Elementary and Secondary School Emergency Relief Fund
- NM ARP ESSER highlights page

Making waves to combat climate change

Sandia water systems engineer featured on DOE STEM Rising website

By **Sarah Jewel Johnson**

Kelley Ruehl, an Energy Water Systems Integration mechanical engineer at Sandia, arrived in her current career by remaining open minded to new opportunities and following her passion for environmental research. Prior to joining Sandia as an intern in 2011, Kelley participated in a crime scene investigation summer camp, studied in a NASA undergraduate research program and interned at Mercedes-Benz after sales during a study abroad program at the University of Stuttgart.

Kelley's diverse background and experiences highlight her affinity for research and guided her desire to make a positive impact in her local and global community through innovative engineering research. After traveling abroad and experiencing renewable energy firsthand, Kelley pursued graduate studies to combine her love of the outdoors and research into a career in marine renewable energy.

Kelley is currently the lead on Sandia's Wave Energy Converter Simulator, or WEC-Sim, project, an open-source software used to simulate wave energy converters. Kelley and her peers work to leverage the motion of ocean waves to produce clean energy. Energy generated by wave energy converters can be used for utility-scale power generation, powering desalination plants and a wide-variety of mechanical and electrical power applications.

Kelley attended Rose-Hulman Institute of Technology in Terre Haute, Indiana, for her undergraduate degree in mechanical engineering and Oregon State for her graduate degree in mechanical engineering and ocean engineering.

Read more about Kelley's career path into renewable energy, her work on WEC-Sim and her advice for anyone pursuing a STEM career and those new to that workforce.

What inspired you to work in STEM?

I always had a passion for math and science. I always really enjoyed those subjects, and I think I had a lot of mentors, particularly teachers and my parents, who encouraged me to go into STEM fields, specifically engineering.

In terms of finding my path, it was trial and error. When I was in high school, crime scene investigation shows were all the rage. I thought, "maybe I want to be a crime scene investigator." I signed up for a summer camp and really enjoyed it, but then I realized that I may not be able to stomach cadavers and blood spatter analysis on a day-to-day basis.

The next summer, I did another science program at Rose-Hulman Institute of Technology, called Operation Catapult. It's a two-week program where you do fun projects like design a Rube Goldberg device. That summer program made me interested in attending Rose-Hulman for my undergrad.

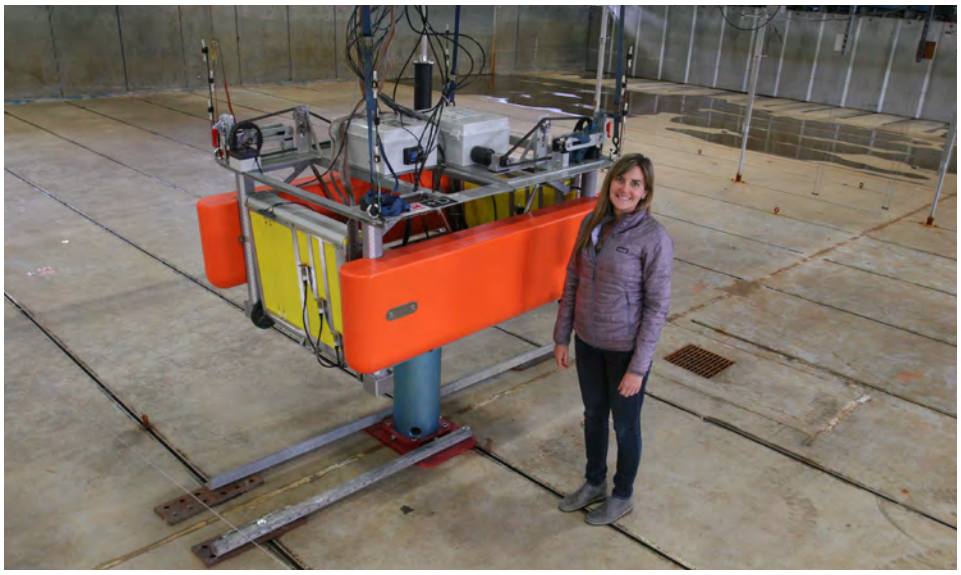
I was also fortunate to go to a high school in Ohio that offered an Ohio State introduction to engineering class. I took that class when I was a junior, and it really solidified my desire to study engineering.

What excites you about your work at the DOE?

I really like working on projects that are directly impactful to people — especially when the projects align with my passions. Even as a kid, I loved the outdoors, and I was passionate about conservation. I was a member of the Lorax Club, and I was really into recycling at a young age. So, a career in renewable energy was a natural draw to me.

I have the great fortune of being able to work on projects in the renewable energy field where I have a direct, positive impact on the community. I have supported the WEC-Sim project since I started at Sandia, and I have been the project lead from the beginning. WEC-Sim recently won an R&D 100 award for cutting-edge innovation and its adoption by academia and industry. It's awesome to know people all over the world are using the software to better understand how devices convert the motion of waves into usable energy. I love to see that direct impact.

Over the last year and a half, I've also had the opportunity to work on Testing and Expertise for Marine Energy, or TEAMER, partnership projects with industry to help model their wave energy converter designs using WEC-Sim. There is so much tech transfer in the teaming process, and I truly enjoy teaching others how to do things we do at Sandia. Personally, I love seeing the direct impact our team has in a field I am so passionate about.



OCEAN ENERGY — Kelley Ruehl, Sandia Energy Water Systems engineer, stands next to an ocean wave energy converter. Kelley is a lead investigator on the Wave Energy Converter Simulator, or WEC-Sim, project, an open-source software for simulating wave energy converter energy output.

Photo courtesy of Kelley Ruehl

How can our country engage more women, girls and other underrepresented groups in STEM?

That's a great question, and it's something I think about a lot. There is no one answer to this question — it's like a full-court press.

Personally, I'm in a position where I can participate in recruitment and be part of the hiring committee for positions. I actively seek opportunities to build diverse teams and to mentor people, especially underrepresented groups.

Teaming is such an important part of creating an inclusive work environment. It's important to go above and beyond to make sure that people feel valued as an individual and that their voices are heard. We need to recognize that people have different ways of communicating, and it's important we give them an opportunity to integrate into a high-performing team, to support them and enable their success.

I think having role models is another huge asset. Everyone needs someone to look up to, and everyone deserves to be represented. When I first started in my career at Sandia, I really didn't understand how valuable mentorship could be — especially having women mentors. At the time, I didn't think mentorship was important, but my perspective really shifted. Now I'm drawn to successful women who can be mentors. I like picking their brain and asking: How did you get here? What did you do? What worked, and how did you make these decisions? For me, seeking mentorship wasn't originally a conscious effort, but it's now one I consciously pursue.

I also think it's necessary to have uncomfortable conversations with majority groups. I have found myself in situations where I didn't appreciate the way things were handled, and I saw that as an opportunity to initiate a conversation about the importance of inclusive activities. It's important that everyone participates with good faith to avoid being performative. In the big picture, having a conversation with someone is a teaching opportunity to move forward into a better place together and make sure everyone is welcome and represented.

Do you have tips you'd recommend for someone looking to enter your field of work?

I would say reach out to people who are working in that field. Ask questions about what path they took and why — ask about their process step-by-step. Ask them what hard decisions they had to make and how they made them. For me, a big moment was deciding whether to pursue a doctorate degree. I talked to people about how they made similar decisions, and it helped me so much. It doesn't mean you have to make the same decision, but it's certainly educational to get their perspective and learn from their experience.

I think it is also helpful to ask for support and find people to advocate for you. It's such an interesting thing to apply for jobs or internships in a digital world, so never overlook an opportunity to have a personal connection — it can go a long way.

I would also suggest trying new things. Before I settled on my line of work, I sought out a lot of diverse opportunities and tested them before I got a sense of what really fit me. If you have an interest in something, go find a summer program or an internship, and give it a try. You could be like me and really enjoy crime scene investigation as a summer program but realize it's not a career path. Even pursuing a volunteer opportunity is a great chance to get your feet wet and get a sense of whether you enjoy it or not.

Learn more about programs and resources for women and girls in STEM at energy.gov/women.

When you have free time, what are your hobbies?

I love going on hikes and runs with my dog. I really enjoy camping, running, backpacking and just being outdoors — New Mexico is great for me in that respect. I also love getting together with friends and family when there's not a global pandemic.

SWAN supports Roadrunner during Women's History Month

HELPING FEED FAMILIES — Members of the Sandia Women's Action Network volunteered at Roadrunner Food Bank in March as part of Women's History Month. Volunteers supported the community by creating 469 emergency food kits that will be distributed to feed families in need across New Mexico. From left, Jessica Kopatz, Lauren Patterson-Strong, Kara Komula and Ashley Poole assembled boxes during the project. **Photo by Jeffrey Kronz**