SANDIA —— 

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DETECTING GASES - Retired Sandia geoscientist Steve Bauer, left, and Brynna Silvk, an intern from the University of New Mexico, work on setting up a mass spectrometer to measure noble gasses released by crushing a piece of granite. Photo by Craig Fritz

## Let's get cracking

Scientists detect gases from fractured rock

#### By Mollie Rappe

PUBLISHED SINCE 1949

eoscientists have detected specific gases being released from fractured rocks in real time after a series of small chemical explosions set underground.

This fundamental research, led by Sandia geoscientist Steve Bauer, could one day improve the prediction of earthquakes or detection of underground explosions.

"In the different shots, we were able to measure different relative amounts of noble gases, which we hope is consistent with the amount of deformation caused by the explosion," said Steve, who recently retired. "The chemical explosions had the same amount of TNT equivalent, but produced different amounts of liquids and gases, so they deformed the rock to different extents. My pie-inthe-sky goal is to measure the amount of noble gas at a location after an explosion or earthquake and then be able to understand the amount of strain the rock has experienced."

#### Fundamentals of noble gases and lab tests

Inert noble gases, including helium, neon and argon, naturally form underground as radioactive elements in rock decay into lighter, more stable elements. These gases become trapped in the structure of nearby rock and some of it can be released when the

- CONTINUED ON PAGE 4

## An unlikely plan helps fast-track conventional hypersonic weapons

Faced with an urgent mission, staff reshape how they work with industry

#### By Troy Rummler

ypersonic weapons have been a top priority for modernizing the U.S. armed forces, with ultrafast, long-range and maneuverable munitions being touted as a revolutionary advance in modern warfare. The U.S. has fast-tracked their development and announced plans to field the first conventional hypersonic missile battery this year. To meet this deadline, some contributing organizations have partnered in unprecedented ways.

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PARTY PLANNING - From left, Janelle Garcia, Heather Sandoval and Scott Nance invited an unprecedented number of defense contractors to build a hypersonic glide body side by side with Sandia staff. Photo by Lonnie Anderson

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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.

# Using math to map social connections

#### By Michael Ellis Langley

magine being able to predict how a group of people will behave before they even know it. From the dynamics of a sports team to the complexities of a nation, the ability to anticipate human interactions has long been a goal of scientists and analysts. Now, a team of cybersecurity experts at Sandia is pioneering a new approach to social analysis.

Cybersecurity expert Mike Brzustowicz believes a well-known mathematical function may provide the key to predict that level of social interaction.

"The Fourier transform is a mathematical principle which very simply tells you the frequency — the count — of things that you're observing. A famous use of the Fourier transform is transforming sound waves and time into frequency," Mike said. "We are working with the non-Abelian Fourier transform. This is a totally different thing. It tells you not about individual entities — it tells you about combinations of them. So instead of understanding what individual things



SOCIAL NETWORK — Cybersecurity expert Mike Brzustowicz thinks a mathematical equation can help understand team dynamics and other social interactions between different people. Photo by Spencer Toy

are happening, it tells you what connections exist between groups of things."

The work builds upon what was started with one of Mike's collaborators, David Uminsky at the University of Chicago. Uminsky began the work at the University of San Francisco when trying to analyze genetic sequences and identify mutations. Eventually Uminsky and his team reached a point where they lacked the computing power to analyze large number sets and needed the computational capability that Sandia can offer.

"When you talk about a combination of things, there's many, almost infinitely many, combinations of very small groups," Mike said. "The basketball team idea is something my collaborator published a long time ago. There are 15 players on the bench and there's five on the floor at a time. And then with those five on the floor, you look at thousands of combinations of the different players."

But that is a small system to look at when compared to a community, a state or a nation — or groups of people who are not even geographically related.

"Ten years ago, it took forever to compute that on a computer, and now it takes me like a second. But when you think of a social network, you may be thinking of hundreds or thousands of people," Mike said. "If you have 20 people together or 30 people, there are so many possible group



Event is included with paid museum admission.



**MAP QUEST** — A diagram demonstrates the intricacy of human interactions with a myriad of potential combinations.

**Illustration by Tilman Piesk** 

combinations. You couldn't maybe write them all down because you wouldn't have enough memory on your computer or you wouldn't be able to annotate them. If we wanted to look at social networks and understand how subgroups interact with social networks, we're barely getting there. So that's our challenge. We want to build this Fourier transform and what we really needed to take advantage of is Sandia's compute cluster Kahuna. The team that runs that is awesome."

Now Mike and his team are trying to figure out how big a transform they can compute and the kinds of groups they can predict.

"We're already doing stuff that's really cool," Mike said. "It's enviable that we can get to this level, but if we can go further, you know, like no one's doing this. This is the non-Abelian Fourier transform."

He added that research on these functions stopped in academia years ago because the numbers just got too big. But Sandia is ideally positioned to figure out where the math goes next.

"I think that's what the national labs are good at," Mike concluded. "We're not academics; we're not industry. We're not bound by those two extremes — bounded by what can you do that will get published and bounded by, does this make the submit button at Google work better or make the timeline at Facebook more appealing? We're in the middle where we're, like, we solve practical problems, but we have these huge resources available to us."

With funding from Labs Directed Research and Development, Mike and his team may soon be able to predict even the complexities of human interactions.

#### **Cracked rock**

CONTINUED FROM PAGE 1

rock is cracked, whether by a natural earthquake or a human-caused underground explosion, Steve said.

"The release of noble gases had been observed in the field in relation to earthquake activity, so we thought we would have a good chance of making these measurements in the field," Steve said.

But before Steve and his colleagues Scott Broome, a Sandia geoscientist, and **Payton Gardner**, a geosciences professor at University of Montana, conducted their experiments in the field, they deformed, or crushed, a two-inch-diameter cylinder of rock along three axes — the top-bottom, left-right and front-back — inside a sealed container.

"In the lab we learned that when we stress or strain different types of rock to a certain point, it begins to fracture, and at the time the rock fractures, it releases noble gases that we can sense with mass spectrometry," Steve said. "We can sense the gas coming out when the rock is fractured internally. We've done this experiment with numerous types of rock: tuff, salt, granite, other igneous and sedimentary rocks. We were probably the first to make the gas measurements in real time as the rock was being deformed."

Mass spectrometry is a powerful method for measuring ions to either determine what an unknown material is made up of, or as in this case, to precisely determine the ratios of different elements in a sample. The team used a quadrupole mass spectrometer for these tests.

Then they moved on to in-field experiments, using the same powerful method to detect noble gases.

#### **Moving to field tests**

The team was involved in a collaboration where three underground explosions were conducted at the Energetic Materials Research and Testing Center outside of Socorro, New Mexico, in the Blue Canyon Dome made of rhyolite rock.

Each of the test explosions used a different explosive compound but the same basic setup. The explosion was set off down a well less than a foot across at a depth of 130-200 feet. Arrayed 15-23 feet away around this central hole were eight other monitoring wells that went down about 200 feet.

Steve's team monitored the naturally formed noble gases and trace gases after the chemical explosions in these wells while other teams from Sandia and Pacific Northwest National Laboratory looked at large-scale changes in the permeability of the rock, the release of radon, as well as traditional and emerging seismological measurements.

"Conducting these experiments in the field is technically challenging," Scott said. "To measure these gases, you need equipment that is very sensitive to pressure fluctuations and inherently, when you explode rock underground, it creates large pressure fluctuations. You need to protect the mass spectrometer from the initial shock of the experiment. We have seen noble gas released from these tests, and we have also not seen it. We've been able to publish on both of these observations. This is pretty fundamental research."

The first explosion didn't release any noble gases that could be recorded, which led the team to infer that the explosion caused shifts in existing fractures underground, rather than creating new fractures, Scott said. They published their results and conclusions from this first test in 2021 in the scientific journal Geofluids.

"In the two additional explosions we got much better data; we were able to document the release of noble gases as a function of time after the explosions," Steve said. "After the explosion, it takes a certain amount of time for the gases to travel through the damaged rock to get to our detection array."

They plan to continue their work with another set of experiments in the field, in a different type of rock, called tuff. For this set, they will not measure the gases in real time, but instead collect samples from different locations and at different times after the explosions for later analysis.

In addition to monitoring earthquakes and underground explosions, improved understanding of how and why rocks fracture could also be valuable for **enhanced geothermal systems** and strain detection in unconventional oil and gas production.

This work was started with funding from Sandia's Laboratory Directed Research and Development program in 2016 and continues with support from NNSA's Office of Defense Nuclear Nonproliferation Research and Development.



CRACKIN' TIME — Steve Bauer, a retired Sandia geoscientist, prepares a sensitive mass spectrometer to detect the gases released by crushing a piece of granite. Recently he detected noble gases released by a test explosion underground. Someday this research might improve the prediction of earthquakes or detection of underground explosions. Photo by Craig Fritz

#### Hypersonic weapons

CONTINUED FROM PAGE 1

Scott Nance, a manager at Sandia, is at the forefront of one such collaboration. He and his team piloted a new way to transfer Sandia's technical designs to defense contractors for the common hypersonic glide body, which detaches from a rocket and soars at speeds above Mach 5.

The pilot program is now earning recognition and could change how Sandia partners with industry in the future.

"Sandia National Labs' successful teaming with the Army, Navy and industry has been crucial to keeping the services on the path to our nation's first operational hypersonic capability," said Lt. Gen. Robert Rasch Jr., director of the Army's Rapid Capabilities and Critical Technologies Office.

This year, the Federal Laboratory Consortium for Technology Transfer awarded Sandia a national Interagency Partnership Award for its successful transition of hypersonic technology to industry partners.

The plan, Scott said, initially alarmed some people when he proposed it.

"We got a lot of wide eyes to: 'Can we do this?" Scott said.

## New program for a tight timeline

Scott manages a team of experts in transferring technical designs from Sandia to industry. He said that for similar projects, moving plans out of the lab and into manufacturing is a slow and meticulous process of documentation, training and testing, especially for projects where the designs are very complicated and margins for error are slim.

"We were given three years to take our design, redesign it to meet the Defense Department's weapon system requirements, make it more producible, get it into production and get it fielded," Scott said. "It's a time scale that was very hard to meet."

The only way to get the job done, Scott thought, was to bring in outsiders, lots of them, which seemed to break every rule of a national security lab.

## One does not simply walk into a national security lab

As a research and engineering lab born

with the atomic bomb, Sandia prioritizes security. Its researchers work on a wide range of sensitive national security projects, including nuclear weapons modernization, critical infrastructure protection, and homeland security. Sandia is primarily located on Kirtland Air Force Base. Information is carefully protected, and access is controlled.

Sandia commonly grants access to subcontractors who pass a vetting process to assist with these projects, but Scott proposed something new. He wanted to bring in dozens of the Army's contractors, who had no agreement with Sandia, and provide them with access to Sandia equipment and resources so they could build the advanced flight systems side by side with Sandia experts.

Scott said he is unaware of any program that has brought in so many uncontracted visitors to work at Sandia. Though the idea surprised many of his colleagues, Scott and his team developed a plan that satisfied management and security specialists at the Labs.

Companies and individuals would need to sign safety and security agreements. Guests would complete the same training as regular employees, from counterintelligence awareness to safety and ethics. DOD security clearances would be verified.

Sandia's Heather Sandoval, an information management professional on Scott's team who helped hatch the plan, hosted on-site onboarding for classification briefings and facility tours after partners completed online training.

In 2019, the first class of 14 industry partners reported to Sandia for training. Within six months, the total number grew to 138.

"The second wave was more manageable with the new onboarding process, even though the class size increased dramatically," Heather said.

### A new path for industry partners

At its height, Sandia had trained a total of around 200 partners and was hosting workers from seven companies, including Dynetics, the Army's lead manufacturing contractor for the common hypersonic glide body. As many as 50 partners were on site at a given time.

Alex Roesler, a Sandia senior manager involved in hypersonic weapon development, said, "Sandia's facilities team was instrumental in helping us quickly get space configured — lab and office space — to support the work and provide places for these partners to work."



HYPERSONIC MISSION — A March 2020 test of a U.S. hypersonic missile used the common hypersonic glide body designed and built at Sandia. The Labs partnered with industry to accelerate manufacturing of glide bodies for future deployment. Photo courtesy of the U.S. Navy

The payoff was visible as visitors and staff formed a powerful camaraderie.

"What was most memorable to me was seeing all these companies coming together in one space sharing their expertise," Heather said. She was amazed at the mix of managers, technologists, administrators, engineers and others from different companies who filled their daily 8 a.m. team meetings.

"They built Sandia flight hardware side by side with us, learning our culture, learning our language, learning our design and our drawings, and then they were able to take the information back to their companies," Scott said.

By the end of 2022, Sandia's industry partners had produced its

first flight system. Collaboration at Sandia is ongoing, but components for hypersonic glide bodies are now being produced at facilities around the country.

"We have the knowledge and the expertise. Now it's our turn to pass the baton to another company for production," Heather said.

The success of the program could change how Sandia approaches technology transfer projects in the future. Heather said she has been contacted by other programs that want to learn how her team used industry partners, and Scott said he and his management are evaluating how to adapt the pilot to other programs.

"I absolutely think this is the model for future programs," Scott said. n

## Sandia Fellow Amber Romero: Fixing supply chain ills

#### By Neal Singer

etecting the risk of counterfeit parts or the insertion of malicious software is important for workers charged with maintaining Sandia's supply chain. Also undesirable are the shorter lifetimes and uncertain performance of counterfeit components sold as the real thing.

But there's more. The COVID-19 pandemic made it harder to transport electronic parts and raw materials in a timely manner.

"We can never fully get on top of supply chain problems," said recently appointed Sandia Fellow Amber Romero, who has focused on supply chain issues for Sandia on a daily basis for much of the last 25 years. "We continually analyze to mitigate risk and keep our heads above water."

But even serving for seven years as team-review chairperson for all contracts above \$500,000 — a tenure that ultimately involved the disposition of billions of dollars — did not prepare her for the developments she has seen in supply chains over the last decade. Given this and the Labswide **rally cry**, she has changes she'd like to see implemented.

"We at Sandia have been subcontracting for a long time," she said. "Slowly we've come to resemble a federal agency. There's less of the agility with which we started. We've got to reverse that trend. "We need to turn in the opposite direction to the way we've proceeded. I want to pivot us back toward reclaiming some of that early agility."

Requirements are difficult for Sandia suppliers, she said. "The processes have gotten more and more cumbersome. Over the decades, our agility took a back seat to compliance. We need to reprioritize to focus on risks that matter, such as quality and lead time."

Taking an active role, Amber instituted more extreme background checks on vendors to restrict the flow of counterfeit goods, which have become more prolific. Her team has also partnered with several Sandia computational groups to help ensure that software vendors are examined for potential risk of malicious software insertions.

There are now advanced college degrees and certificate-offering courses that train examiners in her line of work, she said. Long ago, such granularity did not exist. Amber opted not to pursue a doctorate and professorship in linguistics, a subject in which she holds a master's degree. Instead, she took a more practical second master's degree from the University of New Mexico's Anderson School of Management and came to work at Sandia as a buyer. After receiving early mentoring from manager Skip Reeder, her expertise has been self-taught. Her drive to penetrate the fog of supply chain



SUPPLY CHAIN EXPERT — Supply chain analyst Amber Romero was recently named a Sandia Fellow. Her work ensures that the Labs receives electronic parts and raw materials securely and swiftly. Amber lends her experience to federal agencies and other national laboratories to inform decision-making and improve their processes. Photo by Lonnie Anderson

decision-making has made her an expert in supply chain security in the DOE and DOD complexes, where she is often requested to share her insights.

At the White House in May 2019, Amber briefed the Department of Justice chief information officer and federal chief information security officer on supply chain risk management. She also briefed and led discussions with the Air Force Supply Chain Risk Management Working Group at the Pentagon.

She regularly teaches supply chain topics to Sandians in programmatic positions, acquisition, legal, quality and counterintelligence, as well as to people at other national security enterprise sites and federal agencies, such as NNSA and DOE. Several sites in the enterprise have adopted Sandia's methods for performing supplier background checks.

For her work and leadership, Amber was the teamrepresentative recipient of a DOE Secretary's Honor Award for the National Security Enterprise Supplier Quality Working Group and an NNSA Defense Program Award of Excellence for subcontractor risk assessments.

People in comparable positions at other national labs and Washington, D.C., headquarters who have written her references make no bones about it: At what she does, she is the best there is.

#### Sandia Fellows program adds six

Labs Director James Peery recently announced six new Sandia Fellows. For the first time in Labs history, the fellows program has expanded beyond research and development positions to include all professions that are required to meet Sandia's mission.

"This is a rare and highly selective honor that recognizes pioneers with the highest accomplishments among their peers," James wrote in his announcement. "A promotion to this level allows each fellow to focus on advancing the frontiers of their fields and enhancing Sandia's reputation."

**Cynthia Phillips, Tina Nenoff, Ted Kim, Elizabeth Roll,** Amber Romero and Lonnie Love joined the Sandia Fellows this year. Lab News will profile each fellow.

# Time to shine



READY FOR PROM — Community Involvement teamed up with the Mission Services to host Sandia's first prom dress and formal wear drive. Sandians donated more than 350 formal wear items — gowns, dresses, blazers, pants, dress shirts, shoes, ties and jewelry — to outfit students attending prom in Albuquerque this spring. Students will be able to select prom attire during boutique-style trunk shows organized by the Albuquerque Public Schools Community Clothing Bank. Photo by Craig Fritz

# Vet-owned small business nominated for DOE award

It all started with a pen

#### By Kim Vallez Quintana

andia nominated Pluma LLC as the DOE Protégé of the Year as part of its Mentor-Protégé Program. Pluma, a general construction business started in Albuquerque, was one of five businesses accepted by Sandia into the program with the mission of helping them grow with the Labs' guidance, knowledge, leadership and resources.

While not selected as a finalist, Pluma's owner said the real award is being part of the project in the first place.

"What's important is the positive impact being a protégé has had on our business. We are sincerely grateful for being a Sandia protégé," said Chris Pacheco, a disabled veteran, 1984 graduate of the U. S. Military Academy at West Point, former Airborne Ranger, Gulf War veteran and Bronze Star recipient.

#### A pen, a name

Pacheco became a partner in the business in 2011, but it was started nearly a decade earlier by his father Filiberto.

"My dad was filling out the paperwork for the business license. It asked for the name of the company. He paused; he was holding a pen, looked at the pen and said, 'it will be Pluma."" Pluma being the Spanish word for pen.

In fiscal year 2022, just two years after being accepted into the Mentor-Protégé Program, Pluma was awarded a \$4 million contract purchase agreement by Sandia. Pluma has also been awarded contracts through Los Alamos National Laboratory worth \$600,000. Pluma has increased its workforce to 30 employees and revenue to \$13 million annually, three times higher than previous years.

Pluma has reached this success in part



LEVELING UP — Cruz Duran works with plaster while insulating a maintenance garage in Eldorado, New Mexico, as part of a Pluma project. The Sandia small-business program nominated Pluma as DOE Protégé of the Year. Photo by Craig Fritz

because of the specialized training it has received from experts at Sandia. They have taught the team how to obtain DOE contracts, including safety and quality inspection, badging, pricing negotiations, cybersecurity, marketing proposition development and preparing presentations.

Beau Dawson, a construction manager at Sandia, is one of Pluma's division champion mentors. "My job is helping Pluma learn how to work at Sandia, maneuvering the system, deciphering the language, basically how it works and how we do business out here."

The first project for Pluma at Sandia was building an access ladder.

"We're giving them the opportunity to show they can perform under this scrutiny and pressure," Ben said. "It was a very complicated access ladder. They had to work through permitting, inspection, testing and placement. They learn what a schedule means to Sandia, what is fair and reasonable in pricing and changes. Those are the key takeaways in mentoring. There is a vast difference working outside of the fence of Kirtland and Sandia and working inside our boundaries."

For Pacheco and the small business, it was a rare opportunity. "We understood that Sandia is a world-class organization, worldclass in safety and quality, and figured if we are going to be a type of company to operate in that environment, it would behoove us to be trained by somebody who is world-class in those environments, and we were fortunate to get selected," Pacheco said.

#### **Cultivating local businesses**

The Mentor-Protégé Program is part of Sandia's small-business portfolio, managed by Laura Lovato, Sandia's small-business program manager and led by Royina Lopez, Mentor-Protégé Program lead. Protégés go through specialized workshop sessions geared toward growing their capabilities.

"Pluma has demonstrated dedication in their development journey, applying what they have learned to their processes and projects, and enhancing their ability to compete for federal contracts through engagement and participation in the Mentor-Protégé Program," Royina said.

Pacheco said the business has grown in many ways. "We've increased the value we can bring to customers. It's a quality program that Sandia has put in place with safety plans. Training with Sandia has made us stronger, which has a direct, positive impact on the bottom line."

Pluma is currently working on several major projects, including building a 6,000-square-foot maintenance facility for the Eldorado Water District and working with the Veterans Association shrine project to realign headstones at the National Cemetery in Santa Fe. The project involves surveying each headstone and resetting them to the same height to ensure perfect alignment. Proving Pluma is on the road to bigger things. A great place to be for a small business that all started with an idea and a pen.



SMALL-BUSINESS SUCCESS — Pluma's projects include a 16,000-square-foot indoor golf facility at the New Mexico Junior College. Photo by Chris Pacheco



NOMINATED PROTÉGÉ — Pluma electrician Guadalupe Cardoza coils wire while working on a maintenance garage in Eldorado, New Mexico. Photo by Craig Fritz

## **Sandians** prepare community garden on **Earth Day**



DIGGING DEEP — Manager Justin Ford helps repair a fence at Rio Grande Food Project, a nonprofit that grows nutritious food for the Photo by Katherine Beherec community.

MOVING MULCH — Manager Vanessa Kuca, right, engineer Michal Kuca, center, and their son Lucas shovel mulch into a wheelbarrow for spreading across the garden during an Earth Day event at Rio Grande Food Project. The organization provides a food pantry, an urban garden and serves as a community hub that works to ensure that families have nutritious food.

Photo by Katherine Beherec

### Mileposts





Ron Ralson



Russell Clark

Annette Gallegos

30

25



Mike Heroux

Nathan Heermann

15



25

35



25

20

Tom Smith



**Carol Eubanks** 



John P. Sullivan



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## **Conference room dedicated to deceased Sandia leader**

Scott Collis honored

#### By Neal Singer

n a gesture of respect, a large conference room usually lively with computing presentations and discussions was quietly dedicated to honor the memory of Samuel Scott Collis, who died in a battle with cancer last September.

The life and work of Scott, a former Center for Computing Research director who served almost 20 years at Sandia, was praised in a 15-minute ceremony chaired by Sandia senior manager Jim Stewart.

The ceremony, attended by more than 50 people with others attending virtually,



sandia.gov/LabNews

A



LIFE AND LEGACY — Senior manager Jim Stewart chaired the celebration of Scott Collis's life and work held on March 28 at the conference room dedication. Photo by Lonnie Anderson

was held on March 28 at the close of the workday at Sandia's Computer Science Research Institute, located in the Sandia Science and Technology Park.

Jim announced that the conference room, long known as CSRI 90, would now be officially designated the S. Scott Collis conference room.

Until the building was closed due to the pandemic, Jim said, "Scott spent countless hours in this room, including team meetings, team celebrations, department reviews, seminars, external reviews, center town halls and much more.

"This room is truly where important business of the Center for Computing Research is conducted," Jim said.

Scott's wife Emily, unable to attend, provided remarks that Jim read: "Naming this space in Scott's honor is a wonderful, meaningful tribute to his legacy. Our family is forever grateful."

The ceremony also included remarks by senior manager John Feddema and current Center for Computing Research director Jen Gaudioso. Jen noted that the dedication of the conference room — the heart of the center — was particularly appropriate given Scott's passion and care for the people of the organization.

After the ceremony, Rob Leland, director of Sandia's Climate Change Security Center and a former director of the Center for Computing Research, said, "Scott was as passionate about excellence as any Sandian I've known and was able to combine that with a truly considerate and kind nature — a rare combination."

A recent example of Scott's leadership was his negotiation of the Quantum Systems Accelerator research hub that Sandia leads jointly with Lawrence Berkeley National Laboratory.

In addition to the conference room, a wall plaque memorializing Scott was officially unveiled. A tree planted in his name is slated for installation in front the Computer Science Research Institute later this spring.

# **Record-setting Kids Day**

#### Seeing science in action By Kim Vallez Quintana

early 2,000 guests filled Sandia's Albuquerque site and 200 visited the Livermore site to see the cool things their parents and relatives do as part of Kids Day — the highest attendance ever recorded.

During the April 27 visit, middle and high schoolers got to see an explosives test, using a quarter pound of a common chemical explosive. "We test a variety of items by measuring the aspects of the explosion and how targets react," manager Kevin Gamble said to a crowd before a siren blared that warned of the impending boom at the Explosives Test Site.

Students also saw a fire ignited at the Thermal Test Complex inside the flame test cell, which is surrounded by water-cooled walls. "I think it was really cool. I'm trying to get into physics, and it's always fun to come over and see this," said Elizabeth Titus, 10th grader at Cottonwood Classical

Preparatory School and daughter of Paul Titus, who manages the vibration and acoustics test laboratory.

She was one of hundreds of children, relatives and friends of Sandians who walked through the Labs and learned what goes on each day, what their family members do when they head off to work and the types of careers they could have someday.

Some families made the long trip out to the solar tower, where they saw the sun's heat bake cookies in minutes. Others went beyond the rainbow by participating in optical experiments. "Our job is to see the invisible," said electrical engineer Chris Saltonstall, who works in remote sensing. Students had the opportunity to measure their hair strands using a laser and light wavelengths. They also saw what bugs see when they view flowers under ultraviolet light.

More hands-on experiments included making ice cream using liquid nitrogen, seeing how virtual reality and robotics work, extracting DNA from a strawberry and examining its microbes under a microscope, watching luminol glow, making slime and soap and learning how to catch and identify polluting particles in the air.

This year's Kids Day was the first time since 2019 that staff in Albuquerque were able to take families behind the fence. It was the first Kids Day in 10 years at Sandia California. The day not only fostered more appreciation for what their relatives do at Sandia but also sparked imagination in young minds.



**SPECIAL GUESTS** — Tenth-grader Elizabeth Titus, daughter of manager Paul Titus, makes a bubble while visiting the Thermal Test Complex on Kids Day at Sandia. **Photo by Craig Fritz** 



COOL REACTION — Student Harold Pendleton, bottom left, watches as technologist Mike Hutchinson prepares ice cream by pouring liquid nitrogen into a stand mixer during a demonstration at Sandia New Mexico. Photo by Craig Fritz



A YOUNGER PERSPECTIVE — Student Christian Martinez, right, explores his surroundings through augmented reality glasses during a demonstration led by cybersecurity during Kids Day at Sandia New Mexico. Photo by Craig Fritz



coaster during Kids Day at Sandia California. Photo by Spencer Toy LESSONS FROM FIRE — A 2-by-2-meter pool of aviation fuel burns during a demonstration at the Thermal Test Complex on Kids Day at Sandia New Mexico. Photo by Craig Fritz