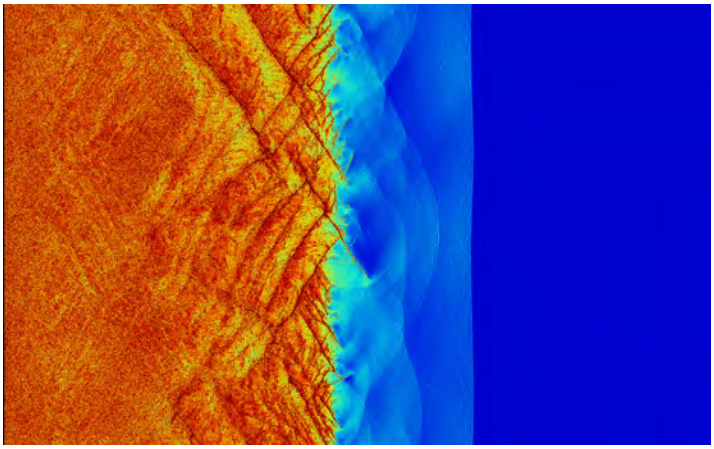
SANDIA LABNEWS
PUBLISHED SINCE 1949

Vol. 74, No. 2, Jan. 28, 2022

Best Company for Women award Page 9

Powerful Sandia machine-learning model shows diamond melting at high pressure



DIAMOND BREAKDOWN — This multibillion atom simulation of shock-wave propagation into initially uncompressed diamond (blue) uses Sandia's high-accuracy SNAP, or Spectral Neighbor Analysis Potential, model to predict that the final state (orange) is formed by recrystallization of amorphous cracks (red) that take shape in the light blue, green and yellow compressed material. **Computer image by Aidan Thompson**

Hardware and software improvements shorten 'run time' from year to a day

By **Neal Singer**

A Sandia supercomputer simulation model called SNAP, or Spectral Neighbor Analysis Potential, that rapidly predicts the behavior of billions of interacting atoms has captured the melting of diamond when compressed by extreme pressures and temperatures.

At several million atmospheres, the rigid carbon lattice of the hardest known substance on Earth is shown in SNAP simulations to crack, melt into amorphous carbon and then recrystallize. The work could aid understanding of the internal structure of carbon-based exoplanets and have important implications for nuclear fusion efforts that employ capsules made of polycrystalline diamond.

— CONTINUED ON PAGE 3

How Sandia is revealing the inner workings of quantum computers

Gate set tomography used to discover and validate two innovations published in Nature

By **Troy Rummler**

A precision diagnostic developed at Sandia is emerging as a gold standard for detecting and describing problems inside quantum computing hardware.

Two papers recently published in the scientific journal Nature describe how separate research teams — one including Sandia researchers — used a Sandia technique called gate set tomography to develop and validate highly reliable quantum processors. Sandia has been developing gate set tomography since 2012, with funding from the DOE Office

QUANTUM SNAPSHOT — Sandia researchers Andrew Baczewski, left, and Erik Nielsen use gate set tomography to analyze problems in a quantum processor. **Photo by Rebecca Gustaf**

— CONTINUED ON PAGE 4

Photo by Kevin Long

TRAM RESCUE

— PAGE 5

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

Lab News may contain photos shot prior to current COVID-19 policies. Individuals in photos followed all social distancing and masking guidelines that were in place when photos were taken.

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.

Team develops roadmap to automated driving future

By **Michael Ellis Langley**

Imagine driving down a country road at night. It's dark, raining and road construction cones block the lane ahead. Driving through such a scene, or even driving on big-city streets crowded with pedestrians, takes a mixture of awareness, caution, split-second decision-making and good judgment — often all at once.

Sandia is working with industry and academia to understand how all that experience and reflex can be entered into a computer to achieve what once existed

— CONTINUED ON PAGE 7

TWISTS AND TURNS — A team of international engineers has drafted a potential research and development roadmap to tackle all the challenges presented by increasing computing energy efficiency for automated vehicles. **Getty Images**

Diamond melting

CONTINUED FROM PAGE 1

Designing novel materials and implications for giant planets

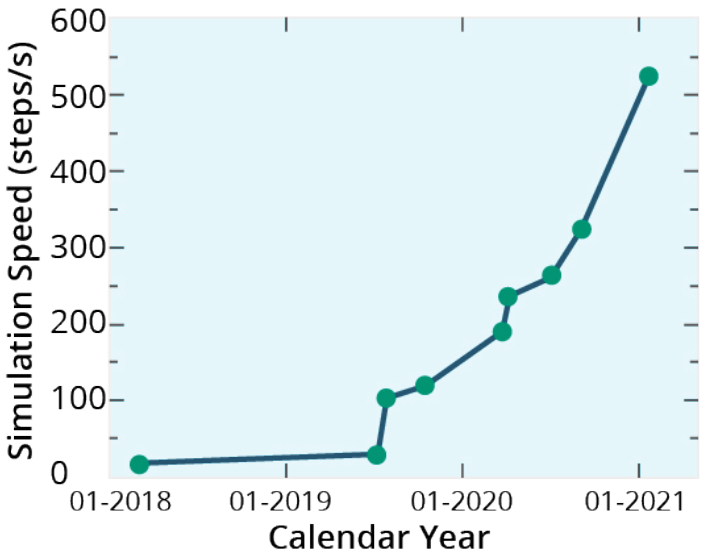
"We can now study the response of many materials under the same extreme pressures," said Sandia scientist Aidan Thompson, who originated SNAP. "Applications include planetary science questions — for example, what kind of impact stress would have led to formation of our moon? It also opens the door to design and manufacture of novel materials at extreme conditions."

The effect of extreme pressures and temperatures on materials also is important for devising interior models of giant planets. Powerful DOE facilities like Sandia's **Z Pulsed Power Facility** and Lawrence Livermore National Laboratory's National Ignition Facility can recreate near-identical conditions of these worlds in experiments that offer close-up examinations of radically compressed materials. But even these uniquely powerful machines cannot pinpoint key microscopic mechanisms of change under these extreme conditions, due to limitations in diagnostics at the level of atoms.

"Only computer simulations can do that," said Aidan.

Gordon Bell finalist is about 'a micron-sized hunk of compressed diamond'

A **technical paper** describing the simulation was selected as a finalist for the **Gordon Bell Prize**, sponsored annually by the Association of Computing Machinery. The diamond-specific modeling, which took only a day on the Summit supercomputer — the fastest in the U.S. — at Oak Ridge National Laboratory, was led by professor Ivan Oleynik at the University of South Florida. In addition to Sandia and university partners, the collaborative team also included software developers at DOE's National Energy Research Scientific Computing Center and Nvidia Corp.



RAPID RISE — The graph demonstrates the dramatic improvement in computational speed achieved by Sandia's SNAP model from 2018 to 2021.
Image courtesy of Sandia

The team's simulations relied on SNAP, one of the leading machine-learning descriptions of interatomic interactions, to model and solve a very important problem, said Aidan. "We created gigantic simulations of a micron-sized hunk of compressed diamond. To do this, we track the motion of billions of atoms by repeatedly calculating the atomic forces over very many, exceedingly tiny, intervals of time."

Machine learning bridged with quantum mechanical calculations

SNAP used machine learning and other data science techniques to train a surrogate model that faithfully reproduced the correct atomic forces. These were calculated using high-accuracy quantum mechanical calculations, which are only possible for systems containing a few hundred atoms. The surrogate model was then scaled up to predict forces and accelerations for systems containing billions of atoms. All local atomic structures that emerged in the large-scale simulations were well-represented in the small-scale training data, a necessary condition for accuracy.

Another critical part of the result was performance optimization of the software to run efficiently on GPU-based supercomputers like Summit, said Aidan. "Since 2018, just by improving the software, we have been able to make the SNAP code over 30 times faster, shortening the time for these kinds of simulations by 97 percent. At the same time, each generation of hardware is more powerful than the last. As a result, calculations that might have until recently taken an entire year can now be run in a day on Summit."

Run time shortened by 97 percent

"Since supercomputer time is expensive and highly competitive," said Aidan, "each shortening of SNAP's run time saves money and increases the usefulness of the model."

Sandia researchers Stan Moore and Mitchell Wood made important contributions to the SNAP model and the dramatic performance improvements.

The first version of SNAP was created in 2012 with support from Sandia's **Laboratory Directed Research and Development** program. Software improvement has been supported continuously since 2017 by the DOE **Exascale Computing Project**, a collaborative effort of the DOE Office of Science and NNSA.

The optimized software for running SNAP on supercomputers is available in the open source distribution of Sandia's **LAMMPS molecular dynamics code**. The Sandia **FitSNAP software** for building new SNAP models is also publicly available.

Quantum computers

CONTINUED FROM PAGE 1

of Science through the Advanced Scientific Computing Research program.

Sandia scientists collaborated with Australian researchers at the University of New South Wales in Sydney, led by professor Andrea Morello, to publish one of the papers. Together, they used gate set tomography to show that a sophisticated, three-qubit system comprising two atomic nuclei and one electron in a silicon chip could be manipulated reliably with more than 99 percent accuracy.

In another Nature article, a group led by professor Lieven Vandersypen at Delft University of Technology in the Netherlands used gate set tomography, implemented using Sandia software, to demonstrate the important milestone of more than 99 percent accuracy but with a different approach, controlling electrons trapped within quantum dots instead of isolated atomic nuclei.

"We want researchers everywhere to know they have access to a powerful, cutting-edge tool that will help them make their breakthroughs," said Sandia scientist Robin Blume-Kohout.

Future quantum processors with many more qubits, or quantum bits, could enable users working in national security, science and industry to perform some tasks faster than they ever could with a conventional computer. But flaws in current system controls cause computational errors. A quantum computer can correct some errors, but the more errors it must correct, the larger and more expensive that computer becomes to build.

So scientists need diagnostic tools to calculate how precisely they can control single atoms and electrons that store qubits and learn how to prevent errors instead of correcting them. This increases the reliability of their system while keeping costs down.

Gate set tomography is Sandia's flagship technique for measuring the performance of qubits and quantum logic operations, also known as "gates." It combines results from many kinds of measurements to generate a detailed report describing every error occurring in the qubits. Experimental scientists like Morello can use the diagnostic results to deduce what they need to fix.

"The Quantum Performance Laboratory at Sandia National Labs, led by Robin Blume-Kohout, has developed the most accurate method to identify the nature of the errors occurring in a quantum computer," Morello said.

Gate set tomography even detects unexpected errors

The Sandia team maintains a free, open source gate set tomography software called pyGSTi (pronounced "pigsty," which stands for Python Gate Set Tomography Implementation). Publicly available at www.pygsti.info, it was used by both research groups published in Nature.

While the Delft team used the pyGSTi software without assistance from the Sandia team, the New South Wales-Sandia collaboration used a new, customized form of gate set tomography developed by the Sandia researchers. The new techniques enabled the team to rule out more potential error modes and focus on a few dominant error mechanisms.

But when the Sandia team studied the gate set tomography analysis of the New South Wales experimental data, they discovered a surprising kind of error that Morello's group did not expect. The nuclear-spin qubits were interacting when they should have been isolated. Concerned that this error might indicate a flaw in the qubits, the team turned to Sandia's Andrew Baczewski, an expert in silicon qubit physics and a researcher at the Quantum Systems Accelerator, a National Quantum Information Science Research Center, to help find its source.

"It came to occupy a lot of my free time," Andrew said. "I would be out for a walk on a Saturday morning, and, out of the blue, something would occur to me, and I would run home and do math for an hour."

Eventually, Andrew and the rest of the team tracked the error to a signal generator that was leaking microwaves into the system. This can be easily fixed in future experiments now that the cause is known.

Robin said, "It was really fulfilling to see confirmation that pyGSTi even detected the errors that nobody expected."

"The collaboration with Sandia National Laboratories has been crucial to achieve the milestone of high-fidelity quantum operations in silicon," Morello said. "The theoretical and computational methods developed at Sandia have enabled the rigorous demonstration of quantum computing with better than 99% fidelity and have provided precious insights into the microscopic causes of the residual errors. We plan to expand this strategic collaboration in years to come."

Contact the Quantum Performance Laboratory

Researchers with questions about gate set tomography, the pyGSTi software package or future collaborations are invited to contact Sandia's Quantum Performance Laboratory at **qpl@sandia.gov** for more information.

Eight Sandia volunteers assist in tram car rescue on New Year's Day

By **Katherine Beherec**

Hours after ringing in the new year, emergency personnel and volunteer rescuers across the state, including seven Sandia employees and one retiree, received a call about an incident on the Sandia Peak Aerial Tramway. Twenty-one people, mostly employees of TEN 3, the restaurant at the top of the tramway, had been trapped in tram cars during a storm since 9 the previous night.

The Sandia employees and retiree are members of the **Albuquerque Mountain Rescue Council or Cibola Search and Rescue teams** that assisted in the rescue on New Year's Day. They joined other search and rescue teams, law enforcement, first responders, tram owners and employees during the sometimes treacherous and harrowing rescue.

Mechanical designer Shane Ruzinsky and chemical engineer Craig Tenney, both members of the Albuquerque Mountain Rescue Council, recounted their experiences from the snowstorms on the rugged mountain with Lab News.

Lab News: How were you notified about the incident?

Shane: I was in Ohio visiting family when I received the call. When search and rescue is requested to respond to an emergency, an incident commander from the state will contact each team in the area. This call goes out simultaneously to the teams' leadership. The first person to answer the call is then designated as the mission manager. This was my role for this incident.

I was able to do this remotely through texts, calls and work on my laptop. Our initial task was to enter the field and provide emergency supplies, like food, water, blankets and clothing, to the people who were trapped. Our job was to keep them comfortable, safe and in good health while the tram employees were working on repairs and other contingency plans. We did not know

— CONTINUED ON PAGE 10

RUGGED RESCUE — Team Four leader and Sandia engineer Jay Johnson inspects the route to Tram Tower Two. The team supplied food, water and clothing to those stranded. Rescuers were prepared to guide people off the mountain. **Photo by Steve Larese**

Mileposts

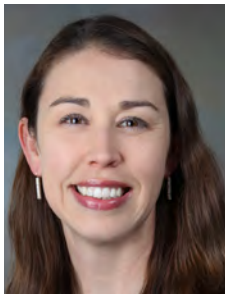
Nikki Angus 30

Georgia Brodbeck 20

Alex Brown 20

Lonnie Diehl 20

Leslie Juarez 20



Susan Adams 15

Damon Gerhardt 15

Nathanael Holle 15

Joshua Jacob 15

Recent Retirees

John Garcia 40

Randy J. Montoya 35

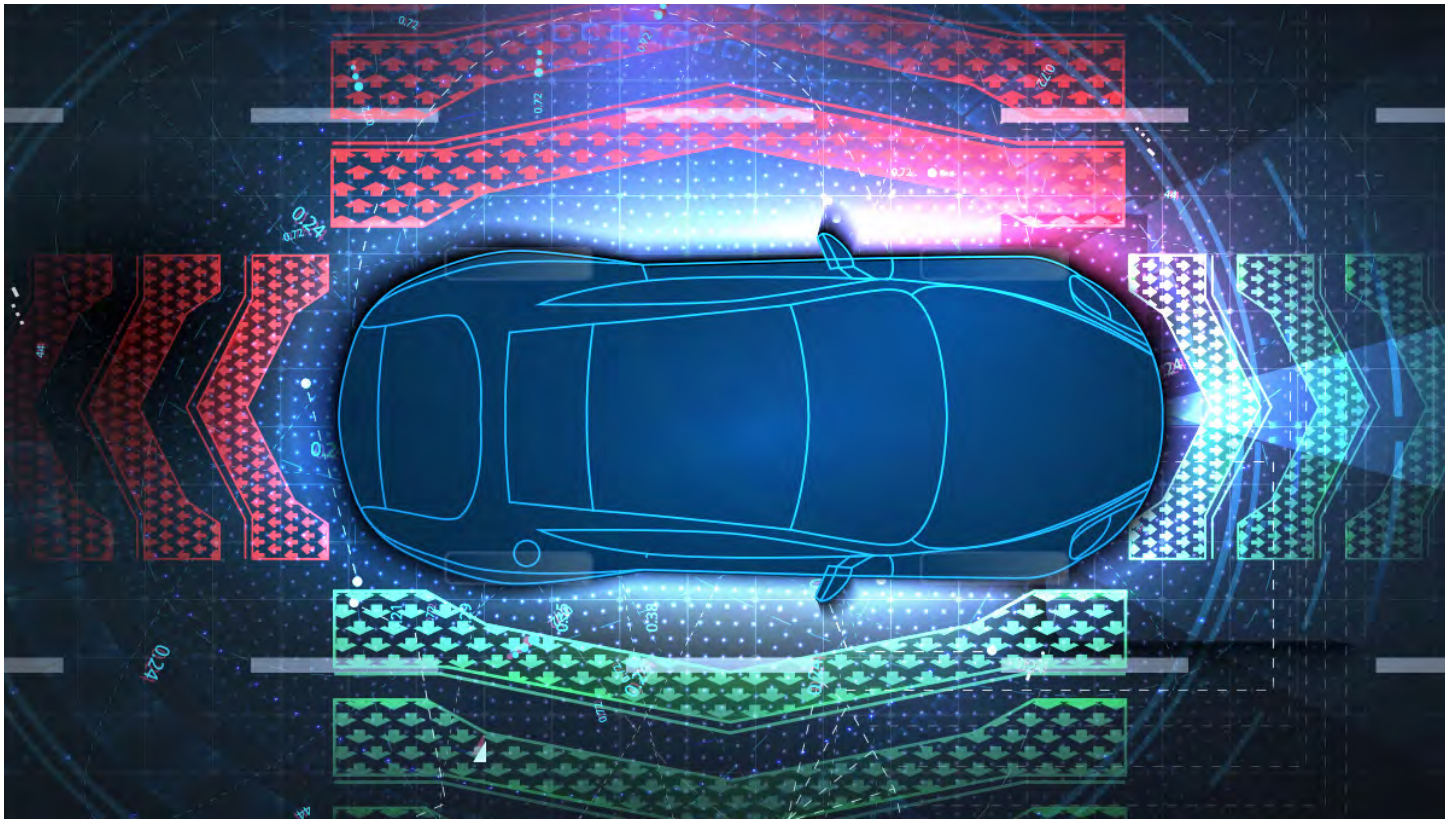
Curt Nelson 31

Luggage drive provides hope, healing

ESCAPING DOMESTIC ABUSE — People escaping domestic abuse often leave with no personal belongings. After receiving clothes and toiletries from the Family Advocacy Center, clients need a way to transport them to a safe place. Sandia staff donated more than 50 suitcases, duffle bags and backpacks to help them during the luggage drive in January. "The actual luggage allows the client the ability to move forward with dignity and hope," said Bev McMillan, pictured, family advocacy manager of United Way of Central New Mexico. **Photo by Katrina Wagner**

SHOWING UP FOR THE COMMUNITY — Systems engineer Angel Urbina drops off luggage to help the clients who seek services from the Family Advocacy Center, which helps victims of domestic violence break the cycle of abuse in their lives by providing resources, guidance and support to help them get to safety, become independent and heal.

Photo by Katrina Wagner



POWERFUL SENSORS — Sensors that feed information into an automated vehicle's computer systems about the real-world driving environment, represented in this graphic, would need to be sensitive enough to capture changing conditions and energy-efficient enough to work within the limited power supply in an electric vehicle.

Image by Michael Vittitow

Automated car

— CONTINUED FROM PAGE 2

only in science fiction — on-vehicle computation that enables highly automated driving in demanding environments. Given the limited amount of energy available in electric vehicles, one of the biggest hurdles is efficiency for the computers that will control automated vehicles.

"We see an opening to make progress in this direction for commercial automated vehicles," said John Aidun, former manager of the team. "But beyond vehicles, it's plain to see that there are multiple Sandia mission needs for autonomous or other smart systems that demand improved energy efficiency of size, weight and power-constrained, embedded computing."

The need in automated vehicles is to ensure computers within vehicles are capable enough without relying upon the power of cloud-based computing, which would delay responses to driving conditions with the time needed for information to travel from the vehicle to the cloud and back.

"The car has to provide everything, because at first there will be little external computational infrastructure available to assist in automated driving," explained team member Lennie Klebanoff. "However, there is almost nothing known about how much computation is needed and how that will be provided. Most assume the computer technology will somehow 'be there.' It may not be. At this point, we are not trying to solve problems. Rather, we are trying to figure out what the important research and development challenges are to enabling high-performance computing for highly automated driving."

A working group of academic, government and commercial partners have joined the Sandia team in this effort, including engineers from the University of Michigan, Carnegie Mellon University, Arm, Hewlett Packard Enterprise, Intel Corp. and the U.S. Council for Automotive Research.

"The automotive environment makes the computational problem harder and even more fun to work on," Lennie said. "Computer technology in cars has to survive shock and vibration, wide variations in temperature, satisfy size and weight restrictions on commercial-vehicle technology, not consume all the power available to the vehicle, all with safety being the most critical item. That's where Sandia's expertise and experience in engineering solutions in complex technical systems are crucial."

The group organized a virtual workshop in May 2021 that brought together about 50 people from the automotive and microelectronics industries and research institutions. The workshop participants provided feedback about the research and development problems identified by the team, divided into four areas seen as critical to energy-efficient computing in automated vehicles, starting with the computer chips themselves. This feedback helped inform a research and development roadmap, meant to guide future research.

"The projected on-board computing needs for highly automated vehicles are unlikely to be met with currently available commercial computing technology," John said.

The workshop participants agreed that advances must be made not only in the raw chip capability, like density of transistors, but also in computer architectures, as well as in the algorithms that simulate human decision-making and, finally, the sensors feeding information into the computing system about the real-world driving environment, including rain, darkness and traffic cones.

There was general appreciation that each participant is necessary to develop computer chips, system architecture and algorithms. Integrated sensors should be co-optimized to advance the energy efficiency of automated vehicle computing.

Sensors that can gather as much data as human perception does require a lot of calculating power, so one question for energy-efficient computing looms large: How smart does a sensor have to be?

"Do we need color capabilities or will black and white be enough?" Lennie asked. "How much spatial resolution is needed? To improve energy efficiency, we need to reduce the demand on computation just as much as we need to increase the computational supply that new chip technology can provide."

Sensors and the other three technical areas — chips, system architecture and algorithms — all need to be considered when trying to improve computational energy efficiency.

These issues are not just theoretical nor isolated to computing for automated cars.

"Any research and development roadmap must be cognizant of the timescales for not only commercially creating the technology, but also, the timescale for implementing it," Lennie said. "We described not only the research and development timeline, but also the associated timelines of chip commercialization and the timeline for implementation of the technology by the automobile manufacturers."

The work of the team can be seen on the **Sandia Transportation Energy website**.

USSTRATCOM commander visits Labs, addresses staff

STRATCOM VISIT — Sandia hosted the commander of U.S. Strategic Command, Adm. Charles Richard, on Jan. 10. During his visit, Richard toured the Labs, met with Labs Director James Peery and associate labs directors and addressed the workforce. During his speech, he thanked Sandia for its work on the B61-12 and W88 ALT 370, which recently marked their first production unit milestones. "When I say there are things that make me proud to be an American, the national labs are at the top of the list," Richard said.

Photo by Bret Latter

Fairygodboss community recognizes Sandia among best places for women to work

By **Meagan Brace**

For the second consecutive year, Sandia has been rated among the **Best Companies for Women** and **Best Companies Where CEOs Support Gender Diversity** as determined by anonymous reviews left on Fairygodboss, the largest career community for women.

The annual rankings are determined by averaging female employees' responses to questions about overall job satisfaction, perceived gender equality and recommendations to other women about working at the organization. Reviews left during 2021 cited Sandia's flexibility, culture of work-life balance and opportunities for women.

"We are honored to be recognized by Fairygodboss as a Best Company for Women and Best Company Where CEOs Support Gender Diversity for the second year in a row," said Executive Director and Chief Human Resources Officer Brian Carter. "Sandia is committed to creating an inclusive environment that values and respects diversity and that takes commitment from employees and leadership at all levels. From the way we recruit and hire to the way we partner and collaborate with our employee resource groups, it takes all of us continuously championing inclusion and diversity in our day-to-day work to achieve this meaningful recognition."

BEST COMPANY FOR WOMEN — Sandia ranked 15th on both the Best Companies for Women and the Best Companies Where CEOs Support Gender Diversity lists, receiving scores of 91.6 and 93.6 out of 100, respectively.
Graphic courtesy of Fairygodboss

A place to connect, find support

Among the resources available to women at the Labs are networking groups formed by employees with common interests that are aimed at supporting, celebrating and retaining a diverse workforce. As the largest employee resource group, the **Sandia Women's Action Network** in New Mexico, along with the Sandia Women's Connection in California, positively influences and supports the work environment, ensures continued professional development, takes bold steps to address burnout and assists the corporate Inclusion, Diversity, EEO and AA Office in bringing the community together to shape a culture free of bias.

"In spite of the challenges, added stress and exhaustion of the COVID-19 crisis, this is an encouraging sign and an honor to be recognized two years in a row by Fairygodboss as a Best Company for Women and a Best Company Where CEOs Support Gender Diversity," said Regina Lucero, executive strategy professional and co-chair of the Sandia Women's Action Network. "This is worth celebrating after an incredibly difficult year. Sandia continues to have a competitive advantage by connecting values, purpose and work-life balance to drive action toward a culture where all women feel valued."

Additional benefits that draw working women to Sandia include flexible work schedules; career-building through tuition assistance, mentoring and leadership coaching; options for time away from work; a 401(k) plan with a company match; on-site health clinics, fitness centers, cafeterias and nursing mothers' rooms; wellness programs; reimbursement spending accounts for healthcare and dependent care; employee associations that provide discounted tickets, recreational activities and equipment rentals; and a wide range of rewarding volunteer opportunities.

Sandia created a presence on Fairygodboss in 2020 to recruit more women to the Labs and enhance awareness around a Sandia career for professional women in science, technology, engineering and math and non-STEM fields nationwide. Visit **Sandia's company profile** to read employee bios and quarterly articles, search active job listings and share your experience working at the Labs.

By the numbers

According to demographic data from the end of FY21, Sandia's workforce was composed of 32.4 percent women:

- Senior leadership: 28.6%
- Research/technical management: 24.1%
- Operations management: 44%
- Technical research staff: 19.2%
- Operations support staff: 53.2%
- Postdoctoral employees: 20.6%
- Graduate students: 33.2%
- Undergraduate students: 43%

Tram Rescue

CONTINUED FROM PAGE 5

initially that we would need to evacuate the tram cars, but our members were prepared for that.

After checking weather reports, I paged out our team of nearly 50 active members with necessary information and a brief description of the situation. As the mission manager, I ensured that they had the correct equipment and were ready for the weather and broadcasted any updates I received.

Craig was one of the first responders that morning and led the first team into the field. He's a technical leader on our team who is qualified in all our specialty skills.

Craig: Four of us assembled as Team One. Shortly after 5 a.m., we loaded up with materials and traveled to Tram Tower Two, an almost three-hour, off-trail hike. Our first objective was simply to make it to the tower, which is not trivial, even in the summer and especially challenging given the conditions.

We were joined by one of the owners and employees of the tram, who were the experts for getting up the tower and into the tram car. The team started handing out supplies, and the people seemed much happier with our arrival. With over 20 people in the tram car, you think it would be warm, but it was quite chilly from hanging in the wind during a winter storm. To add to that, due to all those people breathing, it was slowly raining condensation from the ceiling.

Plans to evacuate were developed after we got into the tram car. Once we passed out materials, cloud cover was still very low, so the helicopter didn't seem like an option. We needed to figure out how to evacuate 21 people from the tram through rugged terrain in winter conditions, keeping in mind that they were dressed for work at the restaurant. The tram owner started making lists of boot sizes so more teams could bring up necessary clothing and footwear for these people to hike out.

The plan would have been to lower people to the ground, escort them to the cliff band, lower further down by rope, then escort them down the mountain using multiple rescuers. It would take a lot of support to pull off that plan safely.

Fortunately, as we were making all these plans, the weather gods smiled upon us, the clouds lifted and the sun came out for a while. We were able to lower people out of the tram car one by one. They were received by rescuers below and escorted to a landing zone that had been set up along the rocky ridge where Tram Tower Two sits. They were loaded into a Bernalillo County Sheriff's Office helicopter and flown to the parking lot of the tram terminal. The helicopter started doing laps, taking two to four people at a time, as we lowered them out of the tram car as quickly and as safely as possible. Fortunately, just as the cloud cover was coming back in with another storm, we were able to get all the employees onto the helicopter and out. Then the weather turned bad again.

Rescuers, including two additional people from the tram company that had arrived after us, and one lone employee in the other tram car were still on the mountain. My team sheltered as best we could in the storm, while tram personnel worked to slowly move the other tram car down to Tram Tower Two. They could only move it an inch or two at a time, so the entire procedure was going to take an hour or two.

At least two of the people the tram company had brought in were certified mountain guides, and all had mountaineering experience, so they had the resources and training to safely get the one remaining employee out of the second tram car. To minimize risk, my team and a Bernalillo County Fire Department rescue specialist, who had originally flown in on the helicopter, began hiking out. This required rappelling off the ridge where Tram Tower Two sits, then two hours of hiking down to the lower tram terminal. Ironically, the weather cleared as we were halfway down, so the six people who were still at Tram Tower Two got a helicopter ride, and we finished our hike down to the tram terminal.

Lab News: What did the teams learn from this experience?

Rescue teams and municipal agencies throughout central New Mexico were involved in the mission.

- Albuquerque Mountain Rescue Council, including Sandia employees Christopher Laursen, Craig Tenney, Gregory Bunting, Jay Johnson, Kevin Long and Shane Ruzinsky.
- Cibola Search and Rescue, including Sandia employee Mike Werner and retiree Evan Ashcraft.
- Atalaya Search and Rescue.
- Santa Fe Search and Rescue.
- Bernalillo County Fire Department.
- Bernalillo County Sheriff's Office.
- University of New Mexico Reach and Treat.
- New Mexico State Police.

Two teams in New Mexico — Albuquerque Mountain Rescue Council and Atalaya Search and Rescue — are part of the Mountain Rescue Association, a national organization composed of teams that are trained and certified in skills specific to mountain rescue, like technical rope work, winter travel and avalanche rescue. These skills were especially helpful during the tram rescue mission.

Search and rescue teams are all-volunteer organizations that rely on donations for expenses like vehicles, insurance and equipment. Sandia staff can support **Albuquerque Mountain Rescue Council** and **Cibola Search and Rescue** by donating online.

Craig: I attended an after-action review for the mission, along with representatives from Bernalillo County Fire Department, Bernalillo County Sheriff's Office, New Mexico State Police, tram owners, tram employees and the incident commander. During this review, we talked about ways to be more prepared in the future. The only big learning point was that when these incidents occur and rely on multiagency responses, it's important that all players have situational awareness and coordinate their communication well. Overall, it went amazingly smoothly.

Lab News: How often is Albuquerque

Mountain Rescue called for rescue operations?

Craig: Historically, 40 to 50 times per year. The distribution is sporadic but tends to be around holidays. We were happy to pay a favor to the tram company. They have been immensely supportive of us during other missions we get in the Sandia Mountains. They give us free rides up and down the tram to save us hours of hiking and travel. Their situation was unfortunate, but we were glad to help out and maybe start to even the scales a bit.

Shane: It's very rare in a mountain rescue scenario to rescue 21 people. This is pretty unheard of and will certainly go down in the history of our team and New Mexico Search and Rescue for being such an unusual situation. Given the circumstances and the number of people stranded, we're very happy that it turned out as well as it did.

CAREFUL STRATEGY — Albuquerque Mountain Rescue teammates and Sandia engineers Jay Johnson, left, and Kevin Long discuss route options for reaching employees stranded in the tram car.

Photo by Steve Larese

Sandia, Lawrence Livermore labs leaders discuss Tri-Valley innovation economy

Business incubation initiative partners with national security labs

By **Paul Rhien**

Nonprofit organization and Sandia partner **i-GATE Innovation Hub** launched its regional business incubation initiative, **Startup Tri-Valley**, in 2021 with a mission to grow and strengthen the science-based startup economy in California's Tri-Valley region. The program aims to connect local innovators to the entrepreneurial and technology resources and expertise across the region including at Sandia and Lawrence Livermore national laboratories.

In one of the first episodes of i-GATE's **Startup Tri-Valley Podcast**, Brandon Cardwell, the organization's executive director, met with Andy McIlroy, associate labs director of Sandia's Integrated Security Solutions, and Kim Budil, lab director for Lawrence Livermore National Laboratory, to discuss the mission of the national labs and how the labs' work intersects with fueling the local innovation economy.

In a nearly hourlong conversation, the leaders discussed the breadth of science, technology and engineering at the Livermore-based labs, especially in DOE's core mission areas of national security, biosciences and climate security.

"Both of our labs have a similar mission space, although we work on different aspects of it," Budil explained. "There's hardly a discipline you can name that we don't have people working on at our labs. We work on a huge range of national security missions across countering the threat — from weapons of mass destruction, assessing adversary capabilities and doing work with the intelligence community to develop tools and technologies for arms control — but also climate security, energy security and big efforts in biosecurity and bio resilience."

Budil and Andy described the symbiotic relationship between the two labs as collaborative and competitive.

"We call it 'coopetition,'" Budil said.

"Or that we are 'competitive mates,'" Andy added.

Partnering with the national labs

The podcast interview gave the leaders an opportunity to discuss the key role of partnerships in promoting scientific and technical advances developed at the labs.

"Looking at some of the high-impact areas in climate and energy, we can't do anything that has real impact without partners," Andy said. "Because it's the private sector who brings these new technologies to market."

"These partnerships are important," he said. "When we all come together, we can accomplish so much more."

Budil explained a growing shift in the research ecosystem. Partnerships between the national labs, academia and industry are becoming even more prevalent and essential to advancing scientific research, she said.

"We want to learn from the private sector and bring the most advanced thinking, tools and technologies into our environment," Budil said. "And we want to take all this incredible innovation that's been driven by government investments and ensure that it gets into the hands of companies and private-sector entities who can really derive the public benefit from that research and development."

Engaging with the Livermore Valley Open Campus

The Livermore Valley Open Campus, a joint initiative between Sandia, NNSA and Lawrence Livermore National Laboratory, is central to that collaboration, the leaders said, lowering barriers that may have previously hindered industry and academic partners from working with the labs on joint research.

"Creating an ecosystem where we can have that kind of free flow of people and information and ideas and exchange is really the underlying philosophy of the Open Campus," Budil said.

"The campus is about creating an area where we can easily and fluidly interact with a wide range of stakeholders in the private sector, in academia, even from other laboratories," Andy said. "It gives us a place to have those interactions and maximize the value of the taxpayer investments in our laboratories by moving technologies out of the laboratories and into the private hands that will make the most of them."

"It's a win-win, really. For the laboratories, for the

Notable Podcast Quotes

On National Security

Andy McIlroy: "Our nuclear deterrence mission is literally a hand-in-glove partnership. We codeliver all of the products in that space. Sandia has a large program working for the DOD and other national security partners. We work on a wide variety of things that include next-generation, hypersonic vehicles, as well as advanced radar systems that allow us to detect improvised explosive devices in theater to save many lives in Afghanistan and Iraq."

Kim Budil: "If you look at the world situation today, our peer competitors in geopolitics have pretty significant capabilities and pretty aggressive programs to modernize their defense capability. That's both in the nuclear and conventional space. This challenge of understanding how to reduce the threat from nuclear weapons and how to create a more stable global environment is a very significant effort for our laboratories. And that's looking in the nuclear space, but also across all the domains of competition and defense, space, cyber, conventional munitions, other things."

On Biosecurity

Andy McIlroy: "We steward the biology capability for Sandia, working very closely with our partners at Lawrence Livermore. We're focused on how to rapidly respond to an evolving biothreat — natural or manmade. This last year has been a huge motivator for exercising those capabilities.

"Both labs have much to offer. Lawrence comes from the computing and physics science perspective. Sandia comes from an engineering perspective, and it's a great balance between the two. We focus on diagnostic development — developing truly fieldable diagnostic capabilities. We also take a systems engineering approach to developing next-generation therapeutics and making it happen on a rapid timescale."

Kim Budil: "We are all very clear now that emerging pandemic disease is really a threat to our way of life. We've spent a year and a half in kind of a holding pattern trying to deal with the current pandemic. We've been working for about a decade to develop new ways of developing therapeutics and vaccines using high-performance computing and novel experimental approaches. We're really transforming the way we think about disease response — both surveillance and the development of therapeutics and vaccines — taking those timelines way down so that we're never in this position again."

On Climate

Andy McIlroy: "A changing climate is an existential threat to us all. We've heard that from both President Biden and our Labs Director James Peery. Both labs are looking to bring the immense capabilities that the taxpayers have invested in with us to bear on this incredibly difficult problem for the nation."

SCIENCE-BASED STARTUP ECONOMY — On a recent episode of the Startup Tri-Valley Podcast, Associate Labs Director of Integrated Security Solutions Andy McIlroy and Lawrence Livermore National Laboratory Director Kim Budil discussed the mission of the national labs and how the labs' work intersects with fueling the local innovation economy. **Image Courtesy of Startup Tri-Valley**

community and for the nation," Andy said. "The open campus is just a great resource — one wonders why we didn't do it sooner."

Praising recent investments in the shared campus, Budil described an inflection point for the initiative.

"There's now enough physical infrastructure in the Open Campus for it to start operating in the way that it was envisioned when it was originally planned," Budil said. "And we have real support from DOE to really think about outward engagement — beyond tech transfer, really building these partnerships and helping."

Building entrepreneurial skills

While discussing entrepreneurship and collaborations with outside partners, Andy highlighted the **national labs entrepreneur academies**, a joint effort with the University of California, Davis. The academies are preparing researchers to move their innovative ideas beyond the labs.

"As we think about how to transition technologies out of the laboratory, sometimes the best way to move new technology into the marketplace is by having the inventors drive the process themselves," Andy said.

"We need to help our folks within the laboratory to navigate the external market and to better communicate to a broader audience the impact and excitement around their technologies."

Both Sandia and Lawrence Livermore labs have many serial entrepreneurs with creative and entrepreneurial genes and instincts, Budil said.

"They are idea factories, just people who are very creative. And over the arc of their careers within the laboratory, they've been able to turn their skills to develop numerous new technologies," Budil said. "These academies are a recognition that there's a real skill set to take those ideas from the idea phase through to realizing a new technology, how to build partnerships, how to think about developing their work, engaging with the outside world."

Taking advantage of the Bay Area tech ecosystem

Asked about the California labs' proximity to the San Francisco Bay Area, Budil and Andy touted the region's strong tech ecosystem.

"The Bay Area's unique among the national lab environments," Andy said. "We're very lucky to be in this innovation hotspot; it's a huge win for us. I think you see it in both Sandia/California and Lawrence Livermore that we're often at the forefront of pushing technology operations for the national lab complex."

"Access to people, access to partnerships, access to capital, infrastructure — is really quite unique in this area," Budil said.

To listen to the full podcast and other in-depth conversations about investments and developments in the Tri-Valley startup economy, visit the **Startup Tri-Valley podcast** webpage.

i-GATE is a nonprofit organization dedicated to building a thriving and diverse startup community in Livermore, Pleasanton, Dublin and Danville, California, and supporting entrepreneurs with resources they need to succeed. To learn more about the organization's work and community partnership, visit **startuptrivalley.org**.