SANDIA LABNEWS
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Proven on ground, solar tower next Page 2

Swifter simulations for modern science. All of it

THE NEED FOR SPEED — Sandia scientist Rémi Dingreville has co-developed a way to speed up virtually any kind of computer simulation, a ubiquitous research tool across science and industry. **Photo by Craig Fritz**

Universal accelerator finds faster answers to complex problems

By **Troy Rummler**

A good machine-learning algorithm is a powerful research accelerator. Pair it with a computer simulation and it can sniff out mathematical shortcuts through the program, propelling scientists to faster insights about the effects of drugs on cells or the potential of rocket engines to send humankind to Mars and beyond.

New research is putting this tool into the hands of scientists around the world. In a machine learning paper recently published in the journal *npj Computational Materials*, a team of researchers from Sandia and

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Lighting the way for quantum innovation

Sandia collaboration combines integrated photonics and light-wave frequency for novel quantum information processing

By **Kenny Vigil**

Sandia and Arizona State University, two research power-houses, are collaborating to push the boundaries of quantum technology and transform large-scale optical systems into compact integrated microsystems.

Nils Otterstrom, a Sandia physicist specializing in integrated photonics, is at the forefront of scaling down optical systems to the size of a chip. This innovation offers performance advantages and scalability for an array of applications from advanced computing to secure communications.

"Integrated photonics takes optical systems that are macroscale

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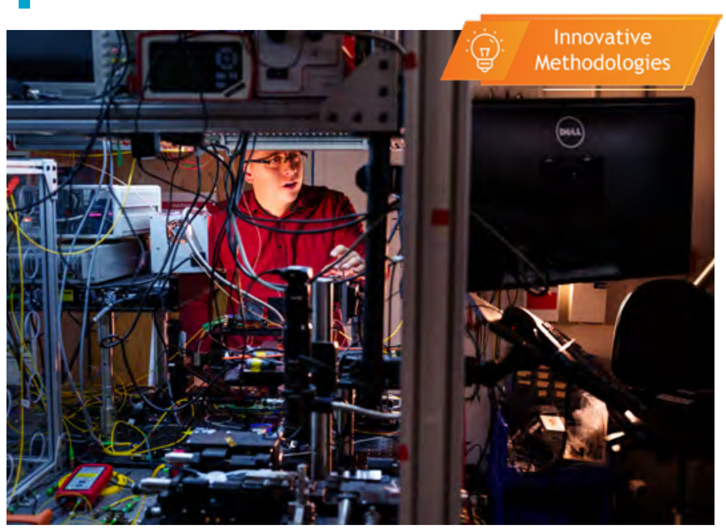

QUANTUM ADVANCEMENTS — Sandia physicist Nils Otterstrom works to align an integrated photonics chip at the quantum photonics lab. It's part of ongoing work with Arizona State University to combine the power of integrated photonics and frequency-bin quantum information processing. Recently, Sandia awarded $17 million in Laboratory Directed Research and Development funds to take this work to the next level. **Photo by Craig Fritz**

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Successful G3P3 particle receiver test a major step toward commercial scalability

RECEIVER ON DECK — The Generation 3 Particle Pilot Plant receiver sits on rails ready to be moved up to the front of the new tower.
Photo by Craig Fritz

By **Kelly Sullivan**

Scientists at Sandia's National Solar Thermal Test Facility have successfully tested a new falling-particle receiver that will operate within the Generation 3 Particle Pilot Plant currently under construction. Operating at up to 2 megawatts of concentrated radiative energy, the receiver is double the size of the facility's previous falling-particle receiver and represents a major step toward the commercial scalability of particle-based concentrating solar power, as well as a key milestone for the G3P3 project.

"Successfully completing this test campaign was a critical step on the road to demonstrating a fully integrated, particle-based concentrating solar power facility," said Brantley Mills, acting principal investigator on the G3P3 project. "It allowed us to derisk a key system in the loop and confirm important performance metrics ahead of installation in the tower. Until now, these metrics had been demonstrated using numerical models only."

Testing the receiver prior to installation

In the spring of 2021, the DOE announced a Phase III, $25 million award to Sandia to build, test and demonstrate a next-generation concentrating solar thermal power plant at the National Solar Thermal Test Facility. The award is part of a $70 million multiyear DOE Generation 3 CSP Systems program that began in 2018. Sandia broke ground on the Gen 3 CSP power plant in February 2023.

The receiver system is a critical component of a particle-based concentrating solar power system that raises the temperature of a particle stream up to 800 degrees Celsius by flowing it past a beam of concentrated sunlight. Ultimately, those particles are then used to heat a high-efficiency supercritical carbon dioxide loop to generate electricity.

Rather than wait until the tower's completion to move particles through the receiver, a test campaign was executed on the ground by flowing batches of particles through the receiver cavity at anticipated flow rates. As the particles fell through the cavity, control and data acquisition systems could be properly evaluated. Additionally, the path that particles fall in the cavity and mass flow rate uniformity, which are essential to the receiver's performance and efficiency, could be evaluated.

By evaluating these key metrics on the ground, modifications could be made to the system before it was installed in the tower, reducing costs and accelerating the schedule.

Promising particle curtain behavior

The tests demonstrated that many of the key design features integrated into the receiver, which were incorporated after learning lessons from previous prototypes, showed promising particle curtain behavior in line with expectations. These features include a cavity shape that minimizes thermal losses and catch-and-release particle obstructions. This metal trough — which catches particles and then overfills on the leading edge — was designed to increase particle residence time and improve curtain uniformity.

Although final confirmation will occur on the completed tower, observations from these tests provide confidence that particles can be delivered at necessary temperatures to generate electricity. These tests also show that the control and data acquisition systems were successfully integrated with the receiver hardware to precisely vary the particle flow rates.

Envisioning the future

Moving forward, the G3P3 team will make final modifications to the receiver hardware and controls. Once it is in its final position, the receiver will be integrated into the rest of the G3P3 system.

When the full system is complete, the concentrated sunlight from the National Solar Thermal Test Facility heliostat field will be pointed to the receiver to begin delivering hot particles to the G3P3 system.

"Ultimately, we hope that this tower will demonstrate that particle-based CSP plants like this one can be a critical technology in helping the country achieve a fully decarbonized energy grid," Brantley said.

Additional resources

Read more about Sandia's Concentrating Solar Power program and the development of the G3P3 project.

Swifter sims

CONTINUED FROM PAGE 1

Brown University have introduced a universal way to accelerate virtually any kind of simulation.

"From a user standpoint, there's no difference between running your simulation tool or running this accelerated simulation tool. It gives you exactly the same predictions. The difference is how much time it takes to get those results," Sandia's Rémi Dingreville said.

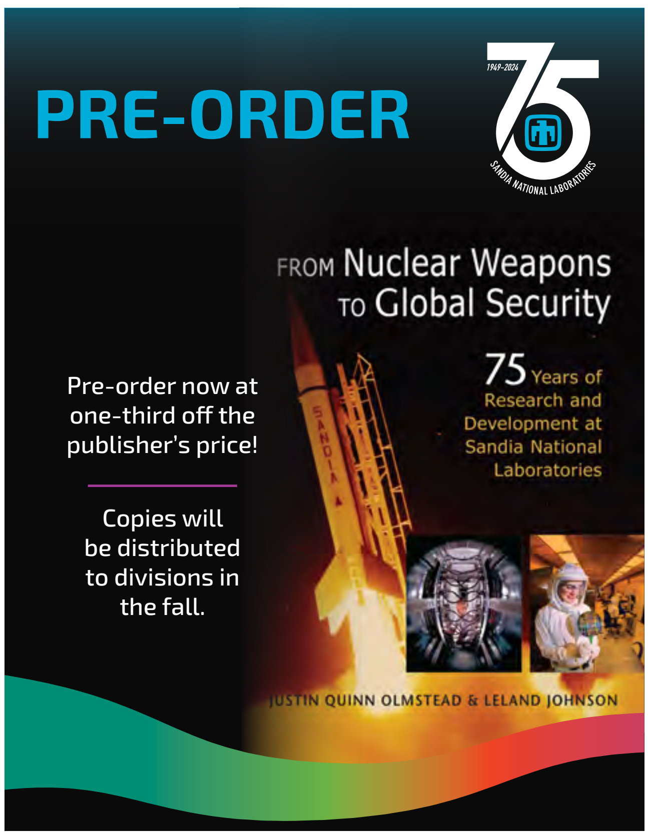
Rémi and his team ran a simulation for materials science 16 times faster than normal with their accelerator. And more importantly, they outlined in their paper how it can just as easily speed up computer programs for climate change research, self-driving vehicle navigation or hardware acceleration.

"The potential to generalize our approach to different systems could lead to more efficient and sustainable technologies," said Brown's Vivek Oommen, first author on the paper.

The research was funded by Sandia's Laboratory Directed Research and Development program and supported by the Center for Integrated Nanotechnologies, a DOE Office of Science user facility, as well as Brown's Center for Computation and Visualization.

Accelerator democratizes fast science

As a kid, Rémi loved to go fast. He biked fast, skied fast and ran fast. He even raced to be the first one done with his schoolwork. Now, as a scientist, he



uses machine learning to speed through his research. In a previous project, he retooled a simulation to run 40,000 times faster.

While a 16-fold speedup may seem modest in comparison, Rémi and the team emphasize their latest work could have a much bigger impact because it benefits virtually every field of science. It is not limited to specific types of problems like other accelerators.

"Physics, chemistry, geochemistry, weather prediction — it really doesn't matter," Rémi said.

The team considers its paper a challenge to researchers to fundamentally rethink how they design and use simulations.

"I'm deeply fascinated by the challenges and potentials of integrating traditional numerical methods with artificial intelligence to solve complex problems in materials science," Oommen said.

Speedier simulations enable new research opportunities

While the simulation accelerator saves time and money for routine research, it also removes obstacles to studying phenomena that normally can't be simulated. Try modeling an event that unfolds slowly, like glacial melting, and your program will probably take too long to be useful.

"The current state of the art is that you have to use these direct numerical solvers. Even though they are accurate, they're slow," Rémi said.

The team hopes this research is the genesis of a modern, common way for scientists to zip through normally sluggish simulations.

"Looking forward, I am eager to see how our methodologies can be applied to other challenging problems across various domains, such as energy, biotechnology and environmental science," Oommen said.

"I'd love to see this applied in geoscience," Rémi added.

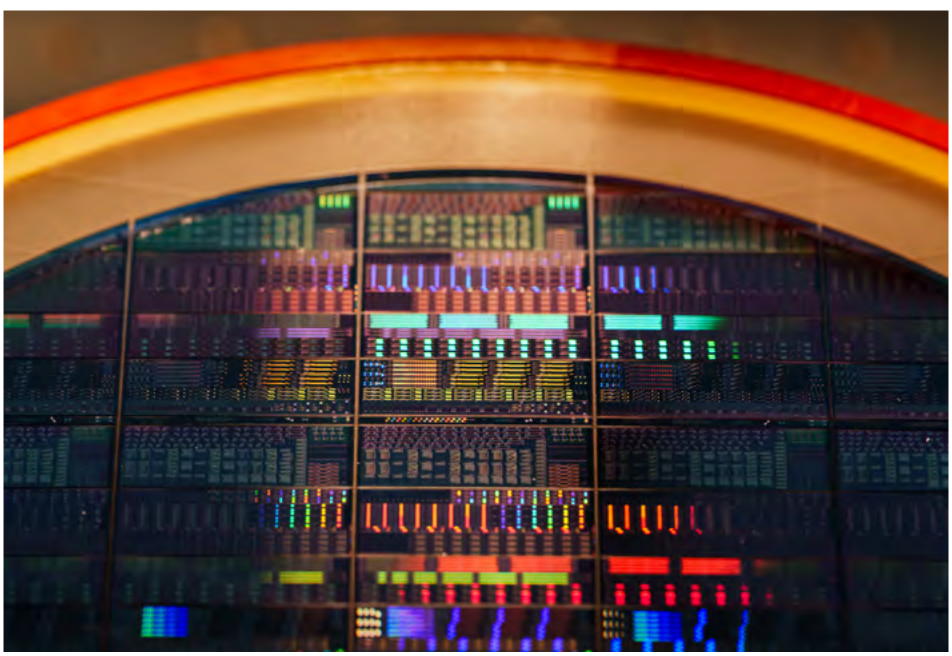
Quantum innovation

CONTINUED FROM PAGE 1

and makes them microscale," said Nils, who earned his doctorate in applied physics from Yale and joined Sandia as a Harry S. Truman fellowship recipient. "What we do in integrated photonics is develop novel devices and explore device physics to provide all the functionalities that we need to do fundamental research and create next-generation quantum microsystems. The world-class fabrication capabilities and high degree of customizability we have here at Sandia in the Microsystems Engineering, Sciences and Applications Complex, or MESA, uniquely position us to impact the most cutting-edge science and technology."

Quantum Collaborative

Nils has been collaborating with Senior Director of Quantum Networking at Arizona State University Joe Lukens. Lukens is the leading expert on using the frequency of light to carry quantum information for quantum computing and networking systems.



ILLUMINATING QUANTUM'S POTENTIAL — Sandia is collaborating with Arizona State University to advance how light can carry quantum information. Instead of using typical large optical tables, Sandia is developing acousto-optic device technologies, such as the eight-inch wafer above, that can selectively reflect different colors of light. **Photo by Craig Fritz**

This effort was recently formalized through a new Cooperative Research and Development Agreement funded by the Quantum Collaborative. The Quantum Collaborative brings together academic and research institutions — including national labs — to advance quantum information and technology research, as well as education and workforce development.

"The inspiration for the Quantum Collaborative is the recognition that the future is quantum. If we're going to be successful, it cannot be done by single investigators or even single institutions; it's just not going to be possible," Lukens said. "The collaborative is an intentional network of like-minded individuals who are interested in building up quantum information technology, and it's a way for us to connect and work together."

The state of Arizona funds the Quantum Collaborative and Arizona State University manages the initiative.

From bulky to chip

Before the agreement with Sandia, Lukens focused on fiber-optic systems for his work in frequency-bin quantum information processing. He explained that qubits exist in all sorts of platforms, including photonics.

"In the frequency approach, your qubit is a photon that can possess two different wavelengths, or colors of light simultaneously," Lukens said. "A zero corresponds to one color, and one corresponds to the other color. That encoding is advantageous for quantum communications. It's transmitted well in optical fiber."

The work was done previously with commercial light-wave components on optical tables.

"We're using big bulky systems. They have high losses of photons, they are very expensive and they take a lot of space," Lukens said. "I think I've done all I can do with tabletop devices in frequency-bin encoding."

This is where Sandia's resources for integrated photonics come into play.

"Sandia has one of the most flexible foundries in the world, not only in microelectronics but also in photonics," Lukens said, referring to the MESA complex. "Sandia can fabricate small photonic integrated circuits that can realize the same capabilities as a big square meter-size optical table."

Sandia's National Security Photonics Center offers a wide variety of component and platform technologies, with a portfolio of more than 50 issued patents in integrated photonics.

Quantum photonics components

Spatial beam splitters, which take photons and split them in two directions, are fundamental components in quantum photonics.

"In this frequency encoding paradigm, we need to create special types of beam splitters that instead take one color of light and split it into two colors," Nils said. "What we've developed here at Sandia, in collaboration with professor Peter Rakich's team at Yale University, are these very efficient novel phase modulator devices."

The devices are based on suspended silicon waveguides that convey light and gigahertz soundwaves, which are generated by co-integrated aluminum nitride electro-mechanical transducers.

"The result is highly flexible optomechanical structures that acousto-optically split a photon into multiple frequencies. This allows you to do quantum information processing on a much higher dimensional space," Nils said. "You can think about it as the light's color can actually carry the quantum information."

What's next?

Lukens said his goal is to move work from proof-of-principle experiments to deployment in quantum networks.

"In order to do that, we need systems with lower loss than what we can achieve today with commercial devices, and we need systems that are a bit cheaper," Lukens said. "If we can realize those capabilities on chip, now we're talking about a much more practical and plausible way to do quantum networking."

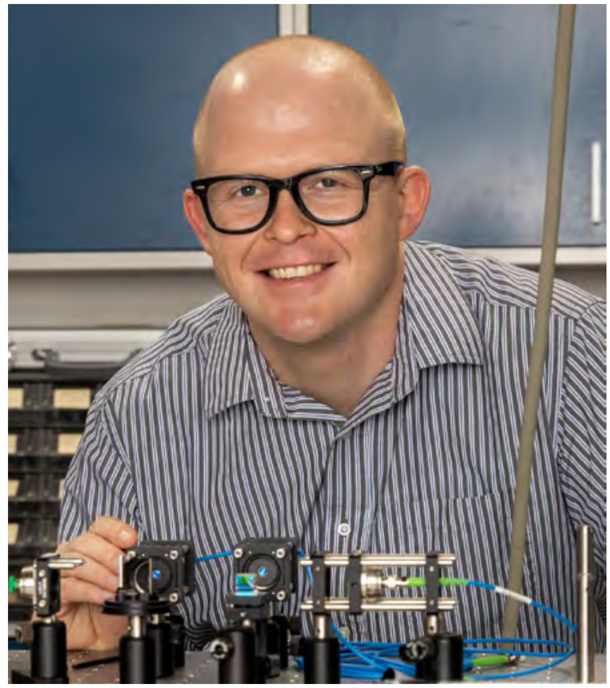
Nils has been guiding Lukens to acquire components, such as microscopes and optical mounts, to use the Sandia-built photonic integrated circuits in a testbed at the university's lab.

A Grand Challenge

The collaboration is paying off. Sandia's Laboratory Directed Research and Development program has awarded $17 million to advance the team's work in frequency-based quantum photonics. The funding comes in the form of a Grand Challenge program called Error-Corrected Photonic Integrated Qubits, or EPIQ.

"Without the partnership between Sandia and Arizona State University, we would probably not have the EPIQ Grand Challenge in its current shape and form," said Paul Davids, the principal investigator on the project. "Nils' outreach to Joe Lukens began our first foray into the ideas around frequency-encoded photonic qubits. His thoughtful leadership in this area and Joe Lukens' prior work and expertise are central to the EPIQ Grand Challenge."

Nils said the funding will enable large-scale implementation and integration of the device physics explored in the early collaboration with Arizona State University to create a useful photonic qubit that can be error-corrected.



THE FUTURE IS QUANTUM — Research professor Joe Lukens, senior director of Arizona State University's Quantum Networking, says a partnership with Sandia has the potential to significantly advance quantum networking. Arizona State University leads a nationwide Quantum Collaborative to accelerate the quantum field. **Photo courtesy of Arizona State University**

SWAP Hub

In addition to participating in the Quantum Collaborative, Sandia offers the MESA complex's microelectronics prototyping capabilities as a core partner of the Southwest Advanced Prototyping Hub. SWAP Hub, which is also led by Arizona State University, is one of eight Microelectronics Commons Hubs across the country. The Microelectronics Commons is funded by the CHIPS and Science Act enacted by Congress to jump-start American competitiveness in the semiconductor industry and reduce dependence on foreign suppliers.

75th Anniversary: Innovators

Teaming with possibilities

By **Michael Ellis Langley**

Of all the brilliant people who have worked at Sandia in its 75 years, Jackie Chen has distinguished herself, not just through innovative work in the field of combustion, but also by defining entirely new ways to advance hers and other areas of scientific endeavor.

Jackie's undergraduate career in Ohio State University's mechanical engineering program was just the start of a learning journey that would include fluid mechanics, combustion and high-performance computing. Her will to innovate went so far beyond her initial training that she breathed a new specialty into existence and became a pioneer of its practice: computational simulation of turbulent reacting flows with complex chemistry.

"When I completed my doctoral study program at Stanford, focused on computational fluid dynamics, and came back here to Sandia, I had the choice at that time of moving over to the Combustion Research Facility, which was rapidly growing and in its heyday," Jackie said. "That was one early fork in the road that felt like a big risk because I didn't know a whole lot about combustion."

PICTURE OF INNOVATION — Jackie Chen, who joined Sandia in 1982, developed entirely new ways of 3D modeling that helped advance combustion science by leaps and bounds.

Photo by Randy Wong

Jackie said that her managers encouraged her to learn on the job — about several different disciplines.

New trend, big learning curve

"When I moved to the CRF, I was immediately taken under the umbrella of the Basic Energy Sciences, Gas Phase Chemical Sciences Program — and my main job was to apply first principles direct numerical simulations to study fundamental turbulence-chemistry interactions in combustion," Jackie said. "There were many world-renowned experts in laser diagnostics at the CRF, among other things, and I was worried I wouldn't fit in."

She said her sponsor at the time encouraged her to incorporate detailed chemical kinetics into her modeling. She also witnessed how rapidly computing was evolving from room-sized Cray Vector supercomputers to massively parallel distributed computing. Jackie was, to put it simply, studying flames embedded in homogeneous turbulence, the so-called "flame-in-a-box," and how air turbulence would affect it by wrinkling and strain. The computers to model those interactions were much less powerful, so she could only afford to transport a single global reaction.

"I realized that there's no way that I could do that on my own. I needed to consult with experts on the different machine hardware, understanding what programming models to use for my reacting flow simulations," she said. "So, I attended computer science conferences that were completely out of my area, even though I felt like a fish out of water."

The connections she made by going places she was unfamiliar with would pay off for the rest of her career. Some colleagues at the Center for Turbulence Research at Stanford shared a piece of early computer code to help her modeling. But Jackie quickly began to realize that she might just be ahead of a wave about to crest across the entire world.

"In the early '90s, high-performance computing was changing," she said. "Killer micros (microprocessor machines that were able to do some of what supercomputers could do) were coming online. Large-scale Beowulf computing clusters were coming online, and so I realized that my VECTORAL code they had given me optimized for Cray Vector supercomputers was not going to work well on these distributed clusters."

Evolving in real time

Jackie said she also realized that she lacked the expertise to convert her code to a language that would work on emerging systems built on rapidly evolving microprocessor technologies. That was when she kicked into high gear something that would become a signature for her career: connecting different interdisciplinary sciences to create something new.

"I solicited the help of computer science experts at Pittsburgh Supercomputing Center to help me with the task of creating a parallel version of the code I needed," she said. "They basically threw out everything that was in the original code, and we modified not only the computer science infrastructure of the software using the message passing interface protocol for scalable parallelism on distributed machines, but also the underlying numerical discretization algorithms to make it more computationally efficient."

At the time, computer scientists working with her on data analysis and visualization had no concept of flame dynamics or the physics associated with turbulence-chemistry interactions. They were able to ingest the input data but couldn't interpret the results. So, Jackie, with her computer science colleagues, created better feature tracking tools to analyze and render flame and turbulence

Making History, Shaping the Future

features embedded in a sea of computational data. The tools ultimately enabled her to understand the causality between the complex turbulent flow and flame interactions. With that nexus of understanding, Jackie was able to not only use the most powerful computing systems, but also model even more complex interactions occurring at the finest scales of the turbulence-flame coupling.

"Before direct numerical simulation and other high-fidelity simulation methods matured, researchers and developers relied on lower dimensional representations to model the behavior of a flame in highly turbulent, real-world fluctuations," she said. "There were a lot of assumptions, and oftentimes they were inadequate. As DNS gradually matured it complemented experiments by providing benchmark data for validation of model assumptions."

Finding power in partnerships

Soon, another hurdle arose.

"We needed to put more realism into the simulations," Jackie said. "But supercomputers were becoming twice as powerful every couple of years, making the codes we were running inefficient, if not obsolete."

Jackie had to find a new collaboration that could keep pace with the rapid advance of supercomputers — she had to turn constant transition into continued evolution. She turned to DOE's Office of Advanced Scientific Computing Research. This office was at the forefront in developing high-performance computing initiatives that actively supported collaborations between applied mathematicians, computer scientists and computational scientists and engineers. The office recognized early on that such collaborations were needed to enable the computational science and engineering community to exploit rapidly evolving capabilities of supercomputers. In the aughts of the 21st century, Jackie was able to capitalize on the Scientific Discovery through Advanced Computing program by collaborating with computer scientists on scientific data management and visualization of her combustion simulations.

Following on the heels of Scientific Discovery through Advanced Computing, Jackie led one of the three application centers, the Exascale Simulations of Turbulent Combustion Center as part of the Exascale Computing Initiative, a joint partnership between Advanced Scientific Computing Research and NNSA, that laid the foundation for developing an exascale computing plan to enable science and engineering applications to make effective use of future heterogeneous supercomputers. As part of the Exascale Computing Initiative, she helped develop a process where scientific problem requirements influence computer architecture design and technology paths, and constraints on these architectures and technology paths inform formulation and design of algorithms and software. There, she worked closely with applied mathematicians developing adaptive mesh refinement algorithms for combustion solvers and computer scientists developing dynamic task-based programming systems well suited for heterogeneous computer architectures with many GPUs. She continued to tap the foundations laid by Scientific Discovery through Advanced Computing and the Exascale Computing Initiative in the Exascale Computing Project, another joint venture between the DOE Office of Science and NNSA that provided exascale-capable modeling and simulation solutions to address critical challenges in scientific discovery, energy assurance, economic competitiveness and national security.

With Advanced Scientific Computing Research sponsorship, Jackie led a team from several DOE labs to develop domain name systems tools that simulate many more decades of length and time scales, greater chemical complexity, including multiphysics, and with complex geometries.

Today, it is feasible to simulate the burning rate and emissions of alternative carbon-free fuels, such as hydrogen or ammonia, in gas turbines for dispatchable power, and flame stabilization near lean blow-off of different drop-in sustainable aviation fuels for propulsion.

From big data to big results

The simulations were capturing a lot of data, but Jackie had to teach computer scientists how to tell the programming which data were important.

"I'm able to run my calculation, but now I've got several hundred terabytes of raw data that I must sift through to find, to analyze, and pull out some meaningful information," she said. "So, I went again back to my computer science colleagues at the University of California at Davis, who are experts in scientific visualization, and they specialize in methods to visualize, drill down, segment and track features of interest in large data. It just takes a person like me to define the combustion or fluids features we are looking for. They're able to apply math constructs to help aggregate statistics about features that are buried in mountains of data, which is really cool."

Jackie and her computing partners are producing full 3D simulations of interactions of more than 40 different chemical species at the micrometer scale — a far cry from the one-dimensional simulations she was able to produce a generation ago.

Connect the dots

Like a translator at the United Nations, Jackie learned to speak different languages to get to a point where her collaborators all began speaking the same language and surging forward in the research. But the success of this approach spread to sponsors and areas of research no one saw coming.

At one of the conferences where she was swimming with a new school of fish, she met Mike Kweon from the U.S. Army Research Laboratory. Jackie recalls that he was interested in whether these high-fidelity simulation tools could help understand ignition processes in intermittent and continuous engines for unmanned aerial systems.

"I formed a collaboration with the Army and applied many of the tools that we had developed under sponsorship from DOE to the Department of Defense problems," she said. "We have also applied our DNS capabilities to understand differences in chemical and physical properties of sustainable aviation fuels in aero-gas turbine engines that affect how a flame stabilizes near lean-blowoff and soot particle sizes that affect contrail formation that the DOE Vehicle Technologies Office is interested in."

The chemistry of a collaborator

In her career, Jackie has earned a lot of recognition. To name a few, she was elected a member of the National Academy of Engineering in 2018, received the Achievement Award by the Society of Women Engineers that same year, and was named a DOE Office of Science Distinguished Scientist Fellow in 2020.

At the heart of things, Jackie said modestly, she is still a fluid mechanics and combustion engineer.

"I have superficially dabbled in computer science more by osmosis through my real computer science colleagues," she said. "It's the same thing with algorithms, with the applied mathematicians. I learned numerical algorithms, algorithms for forward, and now also for machine learning and AI to accelerate DNS with lots of chemistry."

Jackie takes a lot of enjoyment from that constant, new learning through collaborating with others in different fields.

"I am kind of outgoing. I'm not shy," she said. "So, I think that helps to build relationships, especially when you're in uncomfortable situations. I have a willingness and persistence to learn something, even if it means embarrassing myself with a colleague when I ask them to explain a concept to me for the 20th time. If you're willing to stick your neck out there and work with them, eventually you get it."

That mixing of different perspectives opens new possibilities and new futures for everyone.

"Oftentimes with collaborators, it's like a lightbulb turns on in both of our heads," she said. "We are working at this interdisciplinary divide, and if you're willing to put in the effort, there's a lot of low-hanging fruit. Discovering new physical understanding or applying new tools in a way that nobody else has thought of doing — that part's fun!"

A career built by bringing people together for greater innovations is exactly the career that makes Jackie integral to Sandia's 75 years of success.

"I think we need each other," she said. "I feel like I don't belong to birds of any feather. I like flying across different flocks."

Sandia mathematician Richard Lehoucq chosen as SIAM fellow

Practitioner of openness shows it can work

By **Neal Singer**

Sandia mathematician Richard B. Lehoucq once received bad reviews for falling asleep in class. Now, he's one of 26 fellows inducted in 2024 by the Society for Industrial and Applied Mathematics. The honor recognizes his significant contributions to the field.

"SIAM Fellows form a crucial group of individuals helping to advance the fields of applied mathematics, computational science and data science," the society stated.

Rich's journey from disengaged student to curious and open-minded scholar is evident in his willingness to explore both new math and unfamiliar cultures and ideas. For example, during a conference in China, his colleagues were amused by his willingness to try a range of exotic Chinese dishes — an enthusiasm for learning that he brings to every aspect of his life.

"I expect to learn from this interview too," Rich said as the conversation shifted to his mathematical contributions. His work spans the field, from nonlocal modeling, to numerical linear algebra and software, continuum mechanics, the applications of probability to optimization and high-dimensional data analysis.

"All these fields have edges or borders, which creative mathematicians like me work to extend to make better tools," he said. "Since that process affects engineers working with actual material, there's a lot to consider.

"It's not so easy to explain," he added. "Localized modeling assumes all forces act through a surface, which makes it difficult for engineers to model fractures." A nonlocal model uses integral equations instead of differential equations, but engineers not used to this new approach can be dubious.

"People have deadlines," he said. "You can't force change. The consequences of a new approach are daunting. You have to rewrite models that have taken over 20 or more years to write. You are, in a sense, saying that's no longer relevant. Change happens when fairly moderate changes lead to significant improvement."

A career shaped by mentorship

Rich has spent 27 years at Sandia refining his ideas. He credits his arrival at Sandia to the late Richard Hansen and his wife Karen Haskell, who discovered him working at a software development company in Houston. Despite making a good salary, he was bored.

VINDICATED — Richard B. Lehoucq, honored as a 2024 SIAM Fellow, reflects on his journey from a struggling student to a renowned leader in applied mathematics. **Photo by Craig Fritz**

Impressed by the quality of Rich's work as a subcontractor, the couple strongly suggested he return to graduate school at Rice University for his Ph.D. Hansen pleaded Rich's case with the admissions committee, supporting his candidacy. His support helped Rich get a tuition waiver and a research assistantship.

"I grew up in modest circumstances, so I didn't mind being poor," Rich said. His parents, immigrants from Colombia, spoke Spanish to him the first five years of his life and, pursuing employment, moved with him to various U.S. locations.

Asked whether frequently switching social structures as a child may have prepared his mind to move comfortably among different systems of mathematics, he responded, "I never thought of that. It's possible.

"Early on, having to navigate culturally distinct situations in my formative years — Virginia, Pennsylvania and more — allowed me to be not scared about trying different things."

His unexpected career turn to Rice introduced him to his wife of 30 years, offered the opportunity to earn a doctorate in computational science and engineering in 1995, and led to a Wilkinson postdoctoral fellowship at Argonne National Lab, equivalent to Sandia's Truman fellowship. Two years later, he arrived at Sandia.

At Sandia, Rich has published more than 75 papers, co-authored a book, given plenary presentations at international conferences, served as an associate editor for several journals, organized workshops and served on organizing committees for conferences.

Rich appreciates the certainty that mathematics provides. "I love being able to express complex mathematical ideas in a simple, clean and neat way, much like writing something well," he said.

When it comes to research, Rich offers two key pieces of advice: "Strip away details to uncover the core idea" and "Listen to different groups that have experiences you don't have; it equips you with valuable tools.

"I wasn't a good K-12 student and don't do well on standardized tests. But I have resilience. And I'm flattered that colleagues half my age are willing to collaborate with me."

Careerapalooza inspires opportunity for change

By **Erika Y. Bonilla**

From Boy Scouts to Army Reserve Officer Training Corps, and Texas A&M to working on Sandia systems, Georgia-born athlete Kyle Rex believes that "Sandia's work is my opportunity to be a part of something greater than yourself."

Kyle is an undergrad summer intern based at Texas A&M in College Station, Texas. He aspires to a career that combines military service and engineering. This dual path provides a platform to "serve my country while also applying my technical skills to develop cutting-edge technology for the military," he said.

GOING PLACES — Undergraduate research and development intern Kyle Rex, center, attended this year's Careerapalooza to make new connections and learn about opportunities to grow in his career and make a difference for the nation. **Photo by Craig Fritz**

Kyle was influenced by his family's military background from an early age, positioning him to pursue his passion for supporting the nation and its strategic defense systems.

Upon receiving an email invitation to attend Careerapalooza, Kyle seized the opportunity to learn about Sandia's mission work and the full range of career paths available at the Labs.

Kyle traveled from Texas to New Mexico to attend the three-day event and further his own career exploration. The event provided a platform to connect with professionals from various divisions within Sandia, "helping me understand the Labs' organizational structure and identify where my skills could best contribute."

Kyle did not expect his view of Sandia to change from a potential future employer to "the ideal place for me to pursue my career goals and make a difference in the world."

"The Career Expo, networking opportunities, panel and career talks at Careerapalooza, along with the New Mexico site visit, solidified my desire to work at Sandia," he said.

Kyle learned that adaptability is key for personal and professional growth and ensures that Sandians can find roles that align with their evolving interests and goals.

"The knowledge that I gained from Careerapalooza reinforced that I can do what I love, challenge myself to explore other areas throughout the Labs, and have the support and resources that open up doors for change," he said. "Support from managers at Sandia, who view their colleagues as more than just co-workers but as family, seals the deal for me. The support, state-of-the-art technology, and opportunities for growth and career development at Sandia are nothing short of amazing."

Kyle's path of commitment and service continues, aligning his aspiration to become a Sandian through pursuit of his passion.

Sandia employees can search for career development opportunities on the Career Development Office website.

Summer, sun and STEM

Sandia and Explora host renewable energy summer camp

Story and photos by ***Spring Booth***

What do solar cells, mirrors, wind turbines and wave energy converters have in common? This summer, a group of New Mexico students explored how sun, light, wind and water contribute to a sustainable, renewable energy-powered future at Sandia's first STEM summer camp. In partnership with Explora, sponsored by funding from the DOE Water Power Technologies Office and the Office of Technology Transitions' C-4 Partnering Model, and with support from Sandia's Community Involvement office, members of Sandia's renewable energy program provided theory and hands-on demonstrations in a five-day summer camp.

Photovoltaics

Sandia electrical engineer Dan Riley kicked off the camp by leading students in a discussion on photovoltaics, units that convert sunlight into electricity and the building blocks for solar panels. Next, the students powered small electronic devices, including alarms and solar cars, with photo-voltaic snap circuits. When they real-ized the photovoltaic cells didn't produce enough electricity to power the cars, the students scaled down and refined their designs.

POWER PLAY —Sandia electrical engineer Dan Riley shows students how photovoltaic cells can power small electronics.

TOASTY TECH — Students make s'mores after systems engineer Miguel Leyba and Dan Riley roasted the marshmallows using a solar dish concentrator, a technology featured at Sandia's National Solar Thermal Test Facility.

Concentrated solar power

On the second day, systems engineer Miguel Leyba handed the students mirrors and asked them to reflect light from a high-intensity flashlight onto one spot on the whiteboard. Students saw how reflecting the light with multiple mirrors and merging it into one spot created more intense light than any single mirror could—the core idea behind concentrated solar energy.

Miguel also provided students with a virtual tour of Sandia's solar tower and a description of the roles that worked together to make its design and construction possible. The morning ended with s'mores roasted using a solar dish concentrator, a technology featured at the National Solar Thermal Test Facility.

IN SYNC — Electrical engineers Jorge Leon and Rachid Darbali help students.

Wind energy

On the third day of camp, mechanical engineer Dan Houck introduced students to wind turbine design and related professions. Students pondered why the three-blade turbine design was the most widely used and brainstormed how engineers came up with that design. Using newspaper, cardboard, CDs and hot glue, students built, designed and tested their own mini wind turbines. Using a fan to generate wind, they tested the voltage output of a small DC motor and learned how different blade shapes and numbers impact energy production.

MAKING WAVES — Students build model wave energy convertors on the fourth day of STEM camp.

Water power

On the fourth day, marine renewable energy mechanical engineer Kelley Ruehl, electrical engineer Jorge Leon, and interns Megan Hinks and Rafael Baez Ramirez introduced types of water power devices and discussed the pros and cons of marine energy. With a basic grasp of how wave movement can be converted to energy, it was time for students to get their hands wet. They were tasked with reverse engineering a wave energy converter, called a point absorber, with magnets and copper wire then testing it in bins that served as mini wave tanks. The wave tanks were outfitted with a wave maker, built from metal rails and a yoga block. Students used a multimeter to measure the energy their devices produced and to see how wave intensity impacted energy output.

Grid integration

The last day of the camp, Jorge and electrical engineer Rachid Darbali explained how photovoltaic, concentrated solar, wind and wave energy can work together to create a resilient and green energy grid. Students had the opportunity to design a grid that would provide constant and consistent power in the face of demand spikes and natural disasters. They finished the camp by examining model wind turbines and racing wind and solar cars.

Going forward

Kelley and Explora educator Tabitha McFarland set a promising precedent for future camps focused on green energy, climate and diverse STEM careers. The STEM camp was part of an ongoing partnership between Sandia's Water Power DEI in STEM project and Explora, which also includes teacher development workshops and other STEM events.

Explora and Sandia hope to expand the program into a full-day camp next summer, continuing their shared mission to inspire and educate future scientists and engineers.

EASY BREEZY — Students design model wind turbine blades using cardboard and newspaper.
Photo by Tabitha McFarland

Retiree Deaths

Feb 3-July 31, 2024

Craig Olson (age 81)	February 3
James Spells (83)	February 5
Roy Fitzgerald (92)	February 8
Howard Tessler (90)	February 10
Helen Lucero (91)	February 16
Wayne Trott (75)	February 21
Donald Wesenberg (83)	February 25
Janice Robertson (91)	February 26
David Huskisson (82)	February 26
Robert Wilson (86)	February 29
Clifford Mendel (87)	February 29
Fred Cericola (92)	March 2
Carla Sanchez (69)	March 2
Linda Smith (76)	March 8
Larry Burke (88)	March 9
Curtiss Moses (90)	March 11
Raymond Culy (91)	March 11
F. Richard Ulrech (95)	March 13
R. Michael Bell (73)	March 15
Sharon Ann Walker (76)	March 20
Richard Howell (91)	March 21
Jack Young (99)	March 24
Victor Ham (91)	March 24
Ricardo Garcia (84)	March 26
Leroy Chavez (76)	March 30
Gordon Hansen (89)	April 2
Donald Gregson (96)	April 4
Walton Errickson (81)	April 7
John Kinney (92)	April 8
Gilbert Aragon (80)	April 13
Andrew Aragon (69)	April 22
Mae Lambert (64)	April 25
Louis Carrillo (93)	May 4
Jude Worden (88)	May 10
William Gardner (90)	May 12
John Shane (84)	May 17
Steve Strickland (68)	May 21
Vernon Duke (91)	May 22
Ruben Urenda (90)	May 22
Mary Armijo (77)	May 25
Joseph Grant (85)	May 28
Frank Bacon (84)	May 30
Ronald Young (81)	June 5
Alex Griego (94)	June 10
Hugh Bivens (93)	June 11
Dolores Allen (92)	June 15
Lee Ann Hubbs (83)	June 17
B. Leo Cafferty (96)	June 20
Albert Miera (75)	June 22
Raymond Bland (88)	June 23
Todd Jones (72)	June 25
R. Bruce Nevin (82)	June 26
Donald Schueler (83)	June 26
Juanita Valdez (84)	June 30
Charles Lee (91)	July 1
William Chambers (84)	July 6
Connie Tilgner (86)	July 12
Dawn Calek (96)	July 21
Ronald Soutar (82)	July 25
Guillermo Griego (85)	July 26
Elizabeth Scott Patterson (73)	July 31

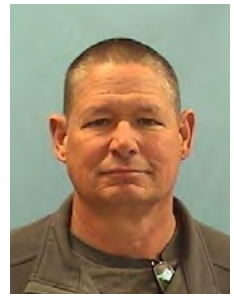
Mileposts

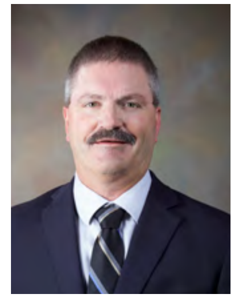

Chris Knight 40


Cathy Vortorlomei 40


Linda Jaramillo-Alfaro 35


Tracy Jones 35


Jimmy Potter 35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Angela Cabanillas 30


Justine Johannes 30


Curtis Ober 30


Steven Giles 25


Robert Hatcher 25

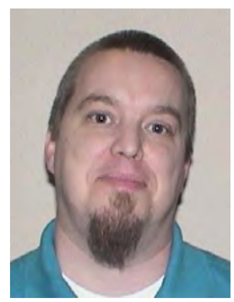

Jacquii Scoggin 25

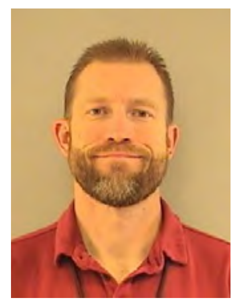

Lisa Walla 25


Robert Koudelka 20


Nikki Lobato 20


Billy Martin 20


Cody Steele 20


Von Trullinger 20


Emily Weber 20


Drew Ackerman 15


Carla Durant 15


Josh Hubbard 15


Jon Murray 15

Gearing up for a new year

BACK TO SCHOOL — From left, Sandia senior management assistant Melissa Mercier and Camp Parks employee Liliam Cordoba distribute backpacks full of school supplies to military families during the Operation Backpack event in California on Aug. 11. Sandians donated 225 backpacks to families at Camp Parks in Dublin and Moffett Airfield in Mountain View, California. **Photo by Irene Bohannon**

CLASSROOM READY — Logistics team member Ely Anaya carries one of many boxes of donated school supplies into Moriarty-Edgewood District Schools on Aug. 14. Through Stuff the Bus and Operation Backpack initiatives, Sandians in New Mexico donated $8,500 plus school supplies that were delivered to schools in Albuquerque, Los Lunas and Moriarty-Edgewood. **Photo by Craig Fritz**