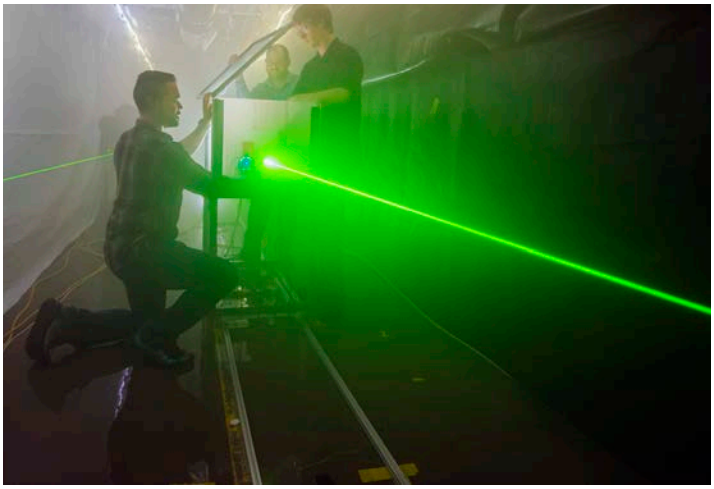
SANDIA LABNEWS
PUBLISHED SINCE 1949

Vol. 73, No. 22, Nov. 19, 2021

President Nez, Native American Heritage Month **Page 6**

Testing sensors in fog to make future transportation safer



IN THE FOG — Andres Sanchez, left, Jeremy Wright, center, and Brian Bentz prepare for an optical test in Sandia's fog facility. Brian is leading a three-year project to use computational imaging to detect, locate and image objects in fog.

Sandia fog facility enables technology testing, foundational research

Story by **Kristen Meub**
Photos by **Randy Montoya**

Self-flying drones and autonomous taxis that can safely operate in fog may sound futuristic, but new research at Sandia's fog facility is bringing the future closer.

Fog can make travel by water, air and land hazardous when it becomes hard for both people and sensors to detect objects. Researchers at Sandia's fog facility are addressing that challenge through new optical research in computational imaging and by partnering with NASA researchers working on Advanced Air Mobility, Teledyne FLIR and others to test sensors in customized fog that can be measured and repeatedly produced on demand.

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Sandia cooks material-storage containers to assess fire safety

Even at 2,000 degrees, the sealed, stainless steel containers did not break open.

By **Mollie Rappe**

A team of Sandians recently completed a series of tests on specially designed stainless steel containers used by the DOE for storage and transportation of hazardous materials.

The engineers, technologists and project managers were surprised to find that the containers did not split open when heated to 2,000 degrees Fahrenheit, or 1,100 degrees Celsius. That is almost as hot as a cement kiln.

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TEAMWORK — Test engineer Austin Baird, left, and thermal test technologist Shane Adee carefully insert a specially designed stainless-steel container to store hazardous material into the custom-built heater. Each container had 18 temperature sensors and two pressure sensors. **Photo courtesy of Sandia**

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LAB NEWS ONLINE: sandia.gov/LabNews

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LABNEWS Notes

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

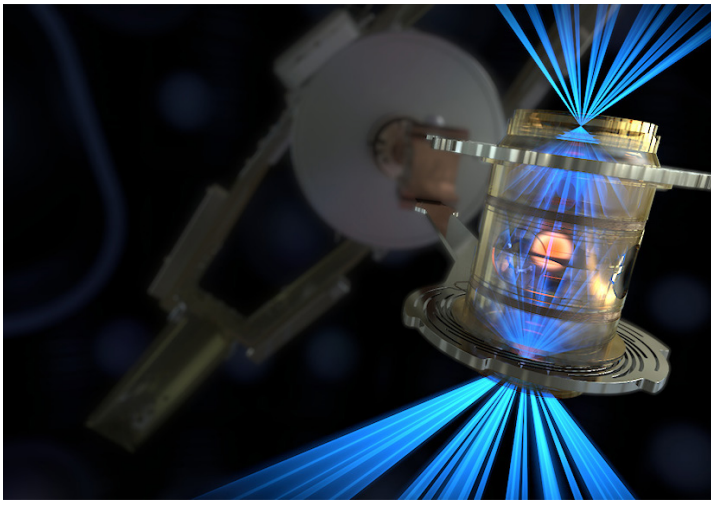
EDITOR'S NOTE: We've stopped printing the *Lab News*, but we want you to remain in our community of readers, so please send your comments and suggestions for stories or for improving the paper. If you have a column (500-800 words) or an idea to submit, contact Lab News editor Katherine Beherec at kgbeher@sandia.gov. The last edition of 2021 will be published on Dec. 10. Editions will not be published on Dec. 3 or Dec. 17.

Labs-directed research drives innovation to advance fusion ignition

By **Amy L. Treece, Lisa Valdez, Kimberly Gotches** *and* **Katsura Rast**

In August, Sandia researchers participated in a groundbreaking experiment at the National Ignition Facility at Lawrence Livermore National Laboratory that made a significant step in the decadeslong quest of inertial confinement fusion: attaining a yield of more than 1.3 megajoules. The ability to focus the energy from 192 high-power laser beams at the National Ignition Facility onto a tiny fuel capsule that is typically only a few millimeters in size, then create a reaction that generates more than 10 quadrillion watts of power, puts researchers at the threshold of fusion ignition.

The groundbreaking experiment was the result of many innovations, developed in recent decades by pioneering scientists and engineers at NNSA's national laboratories, working in collaboration with DOE colleagues and other research institutions. Many of those pioneering new ideas were transformed into solutions



FLOATING CAPSULE — A typical hohlraum cylinder is about a centimeter wide with laser entrance holes at either end. The fuel capsule is suspended inside the hohlraum.

Images and photos courtesy of Lawrence Livermore National Laboratory

through funding provided by Laboratory Directed Research and Development programs at Sandia and other NNSA labs.

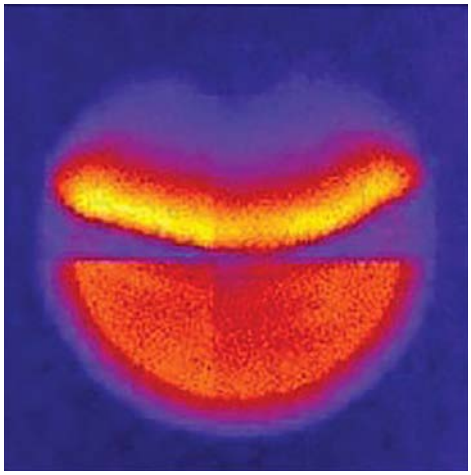
Sandia develops diagnostic sensors and imagers that support National Ignition Facility

Laboratory Directed Research and Development investments and other NNSA support allowed scientists and engineers at Sandia to contribute to the ability to capture images of the recent high-yield National Ignition Facility experiment — including investigations regarding integrated circuits, imaging technology, micro-electronics and radiation.

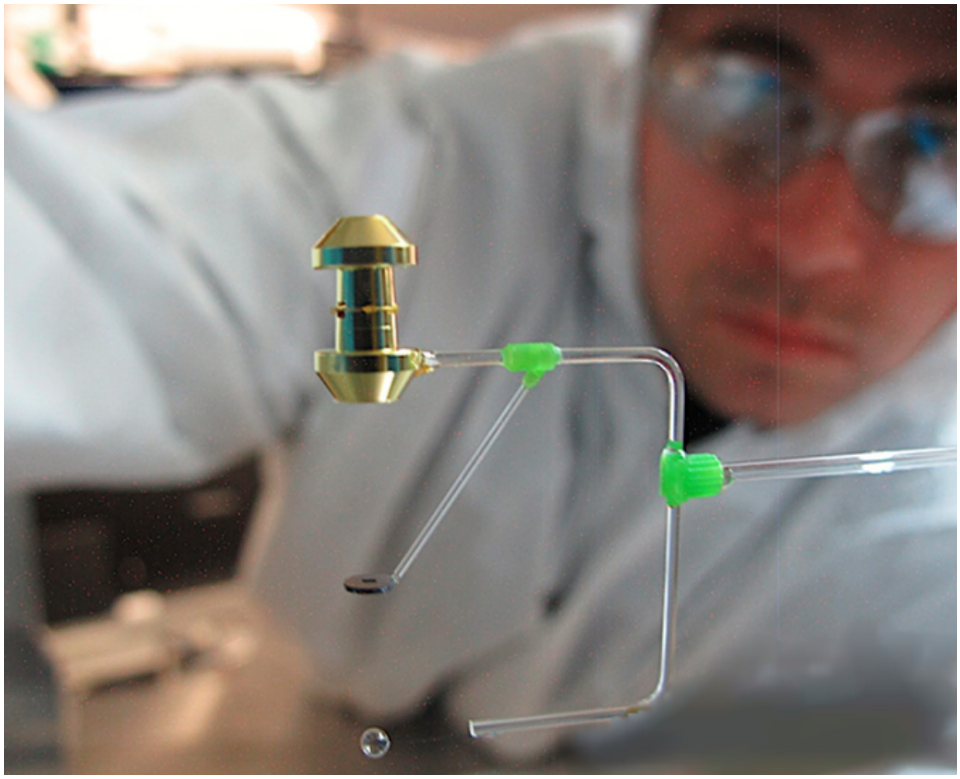
For example, Sandia-based researchers developed an innovative ultrafast, multi-frame, digital X-ray imaging system. It features a time-gated hybrid-complementary metal oxide semiconductor sensor with burst mode and nanosecond gate times to capture multiple snapshots of the inside of targets, called hohlraums, consisting of fuel capsules suspended inside hollow metal cylinders. The faster frame rate reduces motion blur, while multiple frames provide a temporal history of an evolving experiment.

Icarus2, the latest iteration in the series of ultra-fast X-ray camera imagers for application-specific needs, consists of a photodiode array bonded to a radiation-hardened custom readout integrated circuit with half a million 25μm pixels. The ultra-fast X-ray imager's hybrid sensor enables user-selectable exposure times as short as 2 billionths of a second — making it the fastest multiframe X-ray imager in the world. Efforts to develop the radiation-hardened, complementary metal-oxide semiconductor technology resulted in a novel diagnostic technology that successfully recorded critical data during the recent National Ignition Facility experiment.

Marcos Sanchez, electronics engineer and member of Sandia's ultra-fast X-ray imager system team said, "The latest high yield shot at NIF has quite a few folks abuzz with excitement. There are LDRD-funded projects in development at Sandia now with the potential to help increase the sensors' sensitivity, lower energy signals and increase the X-ray energy."



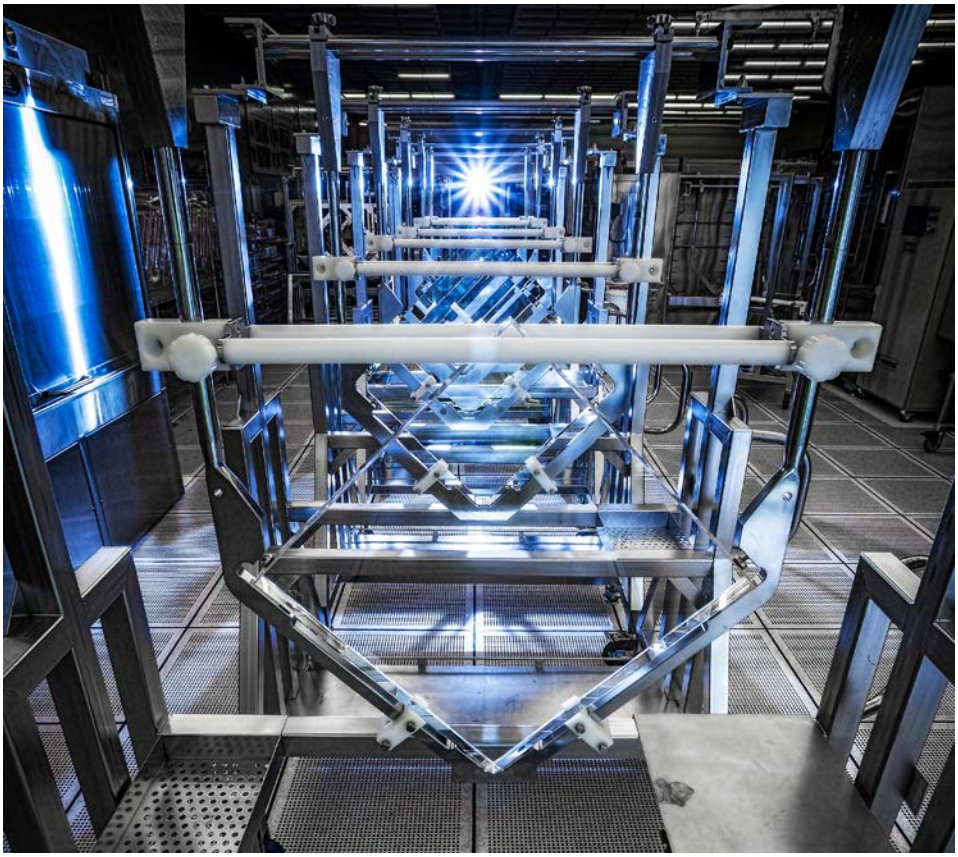
QUICK LENS — The first in-situ diagnostic images were captured using Sandia's ultra-fast X-ray imaging framing camera. The images above are hybrid complementary metal oxide semiconductor camera X-ray images on the National Ignition Facility, captured in 2015, at 2 nanoseconds temporal resolution. The initial application was to measure the time-history of the laser entrance hole of a National Ignition Facility hohlraum.



LASER FOCUS — A National Ignition Facility operator installs an opacity target assembly. The hohlraum, top, holds and heats the sample. The X-ray collimator pinhole is in the middle and the X-ray backlighting source is on the bottom. The tiny capsule becomes a bright broadband X-ray emitter when hit by National Ignition Facility lasers.

Target design, optics, laser-plasma interactions research at Lawrence Livermore National Laboratory

Hohlraum targets, designed and fabricated to meet precise specifications for fusion each experiment, play a major role in successful outcomes. Over the last decade, Laboratory Directed Research and Development-funded work at Lawrence Livermore National Laboratory yielded novel materials and nanoscale fabrication techniques to assemble structures measuring less than

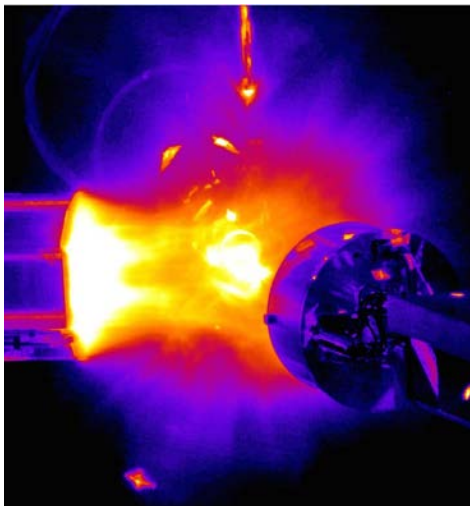


POWER UP — National Ignition Facility optics.

100 nanometers and also provided the ability to manipulate the material and carefully control the thickness of the target's layers. Another project enabled fabrication of a high-density carbon diamond material with unprecedented precision for use as the fuel capsule's shell. These innovative techniques were used for the target fabrication in the recent high-yield National Ignition Facility experiment.

Laboratory Directed Research and Development further boosted the National Ignition Facility lasers' power and energy. One innovation yielded an advanced mitigation process that utilizes chemical etching to remove fine scratches or impurities on an optic's surface during the final phases of fabrication. In a **follow-on Laboratory Directed Research and Development study**, investigators modified wet chemical processing methods used during optics fabrication and improved the amount of energy that can pass through an optic without causing damage.

Another Laboratory Directed Research and Development team focused on the laser-plasma interactions that occur when the National Ignition Facility's high-energy lasers strike the inside walls of a hohlraum target and generate an electrically charged plasma that interacts with the laser beams and drains the laser energy before it can be effectively coupled to the hohlraum. As a result of the project, the team provided ways to not only mitigate the backscatter and instabilities, but to leverage the laser-plasma interactions for a positive result.



BEST SHOT — High-energy lasers strike the inside walls of a hohlraum target at the National Ignition Facility.

Doug Rotman, Laboratory Directed Research and Development program director at Lawrence Livermore National Laboratory, said the recent high-yield National Ignition Facility experiment will no doubt spur further innovations and

The National Ignition Facility and Z machine

The National Ignition Facility at Lawrence Livermore National Laboratory and the **Z Pulsed Power Facility** at Sandia are DOE's largest and most powerful high energy density science facilities. Both can generate high temperatures, high pressures and powerful X-rays, but scientists use different mechanisms to do so.

Z machine, the world's largest pulsed power machine, uses hundreds of large capacitors and dozens of transmission lines to direct and focus powerful bursts of electrical energy onto a target. National Ignition Facility, the world's largest laser, uses thousands of optical components, such as lenses, mirrors and crystals, to direct and focus powerful bursts of light onto a target. Both facilities ensure the reliability of the nuclear deterrent, while opening new frontiers in numerous scientific fields, including inertial fusion energy, which is why the National Ignition Facility and Z machine are used by researchers from across the NNSA Laboratory Directed Research and Development laboratories. For example, researchers in Sandia's Radiation & Electrical Science Center and the Pulsed Power Sciences Center are currently running experiments at the National Ignition Facility, and likewise, Lawrence Livermore and Los Alamos national laboratories scientists are leveraging Z machine to conduct research ideally suited for Sandia's facility.

future Laboratory Directed Research and Development-funded study in inertial confinement fusion.

Nevada National Security Site scientists help develop spectrometer

Site-Directed Research and Development funding enabled scientists at the Nevada National Security Site to help design and build a broadband X-ray opacity spectrometer. This diagnostic tool can be used to measure a material's opacity, or its ability to absorb and re-emit radiation, including the opacity of a sample inside a National Ignition Facility hohlraum target. In addition, they helped analyze and validate data generated by the spectrometer, enabling researchers to measure the transmission of radiation through hot, dense materials — data that helps scientists improve simulation codes used in fusion research at the National Ignition Facility.

Los Alamos National Laboratory researchers advance National Ignition Facility technology

Laboratory Directed Research and Development investments at Los Alamos National Laboratory played a key role in developing diagnostic capabilities and expertise that enabled researchers to better understand exactly what's happening during a National Ignition Facility implosion. Shortly after the multilab neutron imaging team at the National Ignition Facility made its first successful image of a nuclear fusion experiment in 2011, a Laboratory Directed Research and Development-funded team at Los Alamos National Laboratory created neutron time-of-flight diagnostics that measure neutron energy and drift velocity and the gamma reaction history diagnostic, measuring emission of target-produced gamma rays with respect to time, thereby providing key information regarding thermonuclear burn.

Mileposts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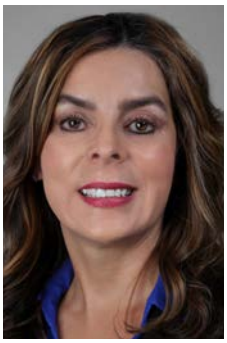
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COVID-19 and the Navajo Nation

President Jonathan Nez updates Sandia on the nation's COVID-19 journey and recovery

By **Stephanie Holinka**

Navajo Nation President Jonathan Nez addressed the impacts of the COVID-19 pandemic on the Navajo Nation and thanked Sandia for its efforts to raise awareness and funding at a critical time for tribal communities during Community Involvement's Community Engagement Speaker Series, hosted in collaboration with Government Relations.

Sandra Begay, Indian Energy Program lead and Navajo Nation citizen, began the event with a traditional tribal custom, identifying her tribal clans in a ritual intended to help other tribal members understand possible relationships to the speaker.

"There are many new employees, who are now a part of Sandia. It is vital for them to know more about the communities of people surrounding the Labs' sites," Sandra said.

Laurence Brown, Sandia's tribal government relations manager and Navajo Nation citizen, provided context for the visit, stating that there are 574 federally recognized tribes in the United States with 23 of those tribes in New Mexico, and that they have been highly impacted by the pandemic.

In late April, Laurence said a grassroots effort initiated by Sandia's workforce sparked a Labswide fundraising drive for New Mexico's hard-hit tribal communities, which accounted for disproportionate numbers of COVID-19 cases. Community Involvement, Government Relations and the American Indian Outreach Committee coordinated The Need is Now fundraising drive to the Native American Relief Fund through United Way.

Its initial goal was $25,000. It had raised $25,000 by the end of the first day, $121,000 at the end of the second day and a final total of $250,000. The Need is Now donations were leveraged to gain additional funds for grants, providing more than $350,000 for food, water and personal protective equipment for the Navajo Nation.

Deputy laboratories director and chief technology officer for nuclear deterrence Laura McGill provided background on the Community Engagement Speaker Series and the importance of the American Indian Outreach Committee, identifying the Navajo Nation as the largest U.S. tribe, with lands as large as West Virginia that span the states of Arizona, New Mexico and Utah. She welcomed Nez and thanked him for participating in the forum.

Nez, the first Navajo president to address Sandia employees, described how the tribe used daily radio broadcasts, town halls and social media to let tribal members know what was going on during the pandemic.

"In time immemorial, we have shared stories of the figures who protect the Navajo people. One in particular is the hero twins, sent to Earth to protect us from the monsters that attack the Navajo people. Fast forward to today and the modern-day monsters are hunger, poverty, vice, alcoholism, drug addiction, diabetes, suicide and now the COVID-19 monster," Nez said.

Nez said the hero twins were given armor and weapons to fight off these monsters. During the pandemic, the armor were masks and the weapons were information from the Centers for Disease Control and Prevention and vaccines. The community chose to frame the COVID-19 battle in this way, so the elders were able to understand and contribute to reinforcing the need for vigilance against the virus that snuck into homes, communities and the nation.

"A lot of the elders have helped in sharing that story of the twins, fighting off monsters, and the younger generation related to that and put on the armor and the protection that is needed to fight COVID-19," Nez said.

Sandia and other organizations, volunteers and the nation reached out to all the Navajo outlying communities, including those isolated by long distances, and provided support in terms of food, supplies and personal protective equipment.

STRONG LEADER — Navajo Nation President Jonathan Nez visited Sandia to present an update on COVID-19 and other challenges within the Navajo Nation on Nov. 8. His presentation is part of the ongoing Community Engagement Speaker Series.

Photo courtesy of the Office of the President of Navajo Nation

"It is a story of the resilience of our people," Nez said. "People counted us out. Some leaders said the virus may wipe away tribal nations. But we turned that around, with your help, here on the Navajo Nation," Nez said.

Starting last summer, into the winter holidays, Nez said the Navajo Nation was No. 1 in COVID-19 cases. Now, more than 70% of its eligible residents have been fully vaccinated. With a government mandate for vaccination, 97% of its government employees are fully vaccinated.

Laura thanked Nez for his visit, and said she was pleased to serve as the executive host for the presentation.

"I am always impressed at the level of engagement that the AIOC brings to the Labs and their communities. Thank you to President Nez and to Sandra and Laurence for their remarks and their ongoing dedication to making a difference at Sandia and in our communities," Laura said.

Celebrating native culture at Sandia during Native American Heritage Month

Stan Atcitty discusses tribal energy sovereignty

For over 25 years, Sandia's tribal technical assistance has enabled participating tribes to realize their energy vision. Stan Atcitty, leader of Sandia's Energy Storage Power Electronics subprogram and Navajo Nation citizen, discusses his experiences and the value of tribal professionals assisting tribal communities. **Watch video**

Photo courtesy of DOE

Pueblo red chile stew and potato salad recipe

Sandian brothers John and Cheston Bailon shared a traditional recipe on their YouTube channel that their family has enjoyed for many years. Pueblo red chile stew has a long history at the table of Native American families, and potato salad is a cool complement to hot red chile. **Watch video**

Photo and video courtesy of John Bailon

Upcoming events

Hosted by the ***American Indian Outreach Committee***

NOV 23 From Reservation to Space Exploration

Aaron Yazzie, Navajo
Tuesday, Nov. 23, noon MST

Aaron Yazzie is a citizen of the Diné (Navajo) Nation and a mechanical engineer at the NASA Jet Propulsion Laboratory. He designed mechanical systems for NASA's robotic space research missions, focusing on Planetary Sample Acquisition and Handling.

His interest in space and science was influenced by traditional stories he was told as a child of how landforms and constellations came to be. As a professional member of the American Indian Science and Engineering Society, he works to increase the representation of indigenous peoples in the fields of science, technology and engineering.

NOV 30 Finding Purpose Through Community

Dylan Moriarty, Navajo
Tuesday, Nov. 30, noon MST

Strong familial bonds are an integral part of many Native American communities. They define who we are — and affect who we become. In this talk, Dylan Moriarty will share personal experiences about finding his purpose through community, overcoming challenges and the benefits of creating collaborative communities in a research environment.

While this talk is presented from a Native American perspective, many of the topics and concepts discussed can be applied to the outreach, recruitment and retention of other underrepresented groups.

Recent Patents

July – September 2021

- **John Cates, Jerry D. Strother, Michael Randolph Satches and Cody M. Washburn:** Additive manufacturing print-heads for exotic material applications. Patent #11084211
- **Thomas Dewers and Edward N. Matteo:** An engineered nano-modified methyl methacrylate polymer for repair of 30 microm microcracks. Patent #11066592
- **Eric A. Shaner:** Apparatus and methods to measure semiconductor optical absorption using microwave charge sensing. Patent #11125700
- **Robert Meagher:** Check valves for microfluidic systems and methods thereof. Patent #11130129
- **Caleb Loverro, William M.S. Stout and Vincent Urias:** Cloud forensics and incident response platform. Patent #11113388
- **Timothy J. Boyle:** Colorimetric radiation detector. Patent #11086028
- **Jeffery A. Greathouse, Mark K. Kinnan and Dorina F. Sava Gallis:** Degradation of chemical agents using metal-organic framework compositions. Patent #11077327
- **Jonathan Joseph Coleman and Adam M. Rowen:** Electroplated au for conformal coating of high aspect ratio silicon structures. Patent #11053601
- **Patrick L. Feng and Heidi A. Smartt:** Fluorescent compositions. Patent #11084978
- **Casey Eugene Burr, Stephen Neidigk and Stephen N. Sanderson:** Inductive circuit sensor system and method. Patent #11074795
- **Jon David Bradley, John L. Russell and Daniel E. Small:** Infrared intrusion detection system (irids). Patent #11100651
- **Khalid Mikhiel Hattar:** Integrated transmission electron microscope. Patent #11081314
- **David Robinson:** Metal film for additive metal manufacturing. Patent #11117217
- **Sung Nam Choi:** Methods for communicating data utilizing sessionless dynamic encryption. Patent #11070532
- **Matthew G. Blain and Christopher Nordquist:** Microfabricated ion trap chip with in situ radio-frequency sensing. Patent #11056332
- **Ronen Polsky and Philip Rocco Miller:** Microneedle-based electrical impedance sensor to monitor plant water status in real time. Patent #11060989
- **Stephen Buerger, Adam James Foris and Jiann-Cherng Su:** Modular anti-rotation drilling. Patent #11131167
- **Christipher D. Jenkins:** Moving target defense for a serial communications system. Patent #11133927
- **Seema Singh:** Novel promoters and uses thereof. Patent #11098306
- **Keir Gonyea:** Preload apparatus. Patent #11131407
- **Carlton F. Brooks, Paul C. Galambos, Lorenzo Gutierrez, Nathan Price and Aaron Powledge:** System, algorithm, and method using short pulse interrogation with neutrons to detect and identify matter. Patent #11061164
- **Walter Gill, Kathryn N. Gabet Hoffmeister and Enrico C. Quintana:** Temperature dependent x-ray fluorescence. Patent #11079287
- **Steven Branda, Raga Krishnakumar and Kelly Porter Williams:** Therapeutic phages and methods thereof. Patent #11066691

Note: Patents listed here include the names of active Sandians only; former Sandians and non-Sandia inventors are not included.

Following the listing for each patent is a patent number, searchable at the U.S. Patent and Trademark Office website (uspto.gov).

CHAMPIONED — The Veterans Day event was organized by Sandia's Military Support Committee, which supports and engages veterans, active military personnel, guardsmen and reservists, along with nonmilitary employees who have family members deployed.

Veterans Day celebration honors service members

Sandia awarded Platinum Medallion by HIRE Vets program

By **Troy Rummler**

Sandia leadership expressed gratitude to past and present military service members during a special virtual ceremony in recognition of Veterans Day.

Sandia's Military Support Committee organized the annual event.

The ceremony began with The Star-Spangled Banner as recorded by the Sandia Singers, a volunteer choral group.

Brian Carter, executive director for Sandia's Human Resources and Communications division and executive champion of the Military Support Committee, next thanked Sandia's many veterans for the contributions they make at the Labs. He then announced that Sandia has received the Platinum Medallion award through the U.S. Department of Labor's Honoring Investments in Recruiting and Employing American Military Veterans program. HIRE Vets grants the award to organizations showing exceptional achievement in veteran employment. About 10% of Sandia employees are veterans.

Rep. Eric Swalwell of California and Col. Jason Vattioni, commander of the 377th Air Base Wing and installation commander at Kirtland Air Force Base, also took turns thanking Sandians for their contributions to the nation in recorded statements.

The keynote speaker was Maj. Gen. Heidi Brown, a retired Army officer who, in the course of her career, broke down gender barriers, such as being the first woman to command a combat arms brigade. Most recently, she served as director of global operations for the U.S. Strategic Command at Offutt Air Force Base in Nebraska.

Among the inspirational stories she related were her professional experiences learning about missile defense and the nation's nuclear deterrence mission. She said in preparation for this Veterans Day event, she read **70 Ways Sandia has Changed the Nation** and grew appreciative of Sandia's work in these and many other national security fields.

HONORED — **"**I believe you have positively impacted the lives of all Americans, and they should be — and I certainly am — grateful," retired Army Maj. Gen. Heidi V. Brown said during Sandia's livestreamed Veterans Day celebration. **Photo courtesy of the U.S. Army**

"I read through the document several times. What you and the men and women before you have done to safeguard the nation is incredible. Prolonging the life of our nuclear weapons resonates with me knowing what I know now," she said.

"The more I read about Sandia leading up to today," Brown said, "the more I learned not just about how you really changed our nation but how much what I did through nearly 36 years of serving in uniform was influenced by you."

The event concluded with the anthems of each of the U.S. military branches.

Because the event was held virtually, veterans are invited to contact the **Military Support Committee** to receive a commemorative challenge coin, a Sandia Veterans Day tradition.

Ethics Corner

Navigating gift exchanges during the holidays

By **Aimee Richardson-Zadra**

The holiday season has begun, and Sandians have started thinking about the perfect gifts for co-workers, friends and families. Before browsing online or braving the mall to purchase a gift for an upcoming office party, keep a few things in mind.

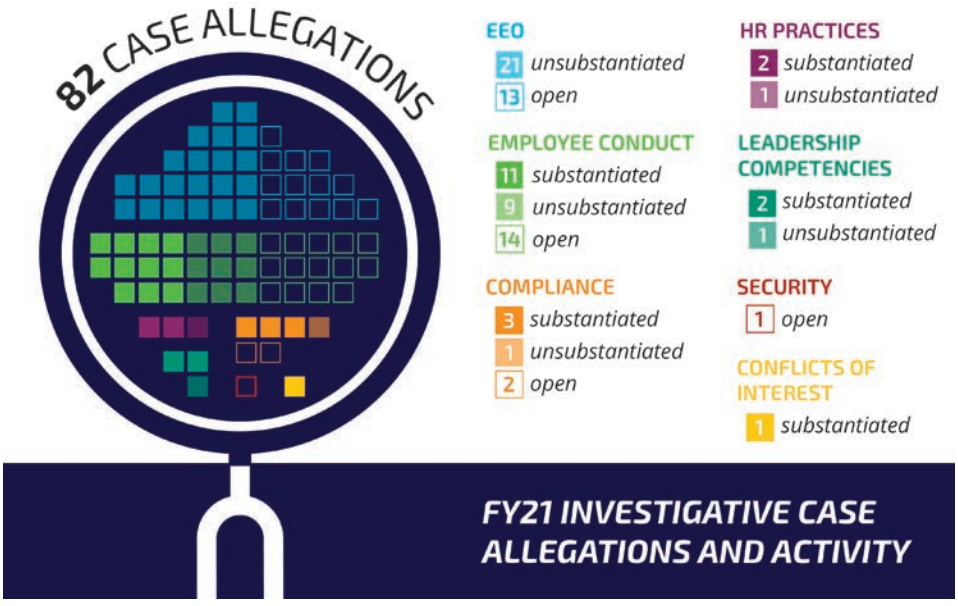
Giving and receiving personal gifts in the workplace is a great way to express thoughtfulness and thanks. Sandians should remember the rules listed to the right if they choose to exchange gifts with co-workers. These rules apply to gift exchanges among employees, but different rules apply when giving a gift to a colleague who works outside Sandia. Other employees are limited by their employer's rules. For example, federal government employees are limited to accepting gifts that are $20 or less, not to exceed $50 in one year from Sandia. Giving gifts to foreign officials, foreign firm employees or their families can be complicated, so consult legal and the prime contract in these situations.

Finally, during the holiday season, giving or receiving business courtesies may become more prevalent. The guiding principle in these situations is to ensure business courtesies are not made with the intention of influencing the recipient. Sandia highly restricts its procurement personnel in this regard, as business transactions and relationships should be free from even the appearance of favorable treatment. It's always best to consult IAEB003, **Exchange of Business Courtesies, Gifts, Hospitality, and Honoraria Policy**, or contact Ethics and Equal Employment Opportunity Advisory and Investigative Services at 505-845-9900 or **ethicsteam@sandia.gov** with specific questions on what you can give or receive.

The holidays are a great opportunity to reflect on and celebrate our organizational accomplishments and our work friendships. Remember these gift giving rules when enjoying end-of-year festivities.

Ethics accomplishments

In fiscal year 2021, the Ethics and Equal Employment Opportunity office received 756 calls on its anonymous helpline. The majority of those calls were resolved informally by Ethics officers providing guidance to callers or conducting a brief inquiry into complaints to determine if a policy or code violation occurred. During fiscal year 2021, the Ethics and Equal Employment Opportunity team opened 71 investigations into 82 allegations. Investigations sometimes include more than one allegation, and decisions are reached on each allegation investigated. See the graphic for the outcome of the 82 allegations investigated. Corrective actions were the result of all substantiated allegations.



Graphic by Stephanie Blackwell

Ethics at Sandia
A catalyst for a better Sandia

Gift-giving reminders

- Gift-giving should never be coercive. If you are organizing a gift exchange, please be sure participation is voluntary. No one should feel pressured to participate if they don't want to.
- Gifts should never be solicited. While it's nice to get something you really want, please don't ever pressure someone to purchase a gift for you.
- Use your own money. Personal gifts need to be paid for with personal funds or resources.
- Gifts need to be of nominal value.
- Limit any use of Sandia IT resources to plan holiday parties and gift exchanges. If your team is getting together for some online festivities, do so using personal technology platforms.
- Consider any conflict of interest. A conflict of interest exists when giving a gift or receiving a gift compromises an employee's judgment or creates actual or perceived favoritism. While not prohibited, gifts between managers and employees could create a conflict of interest. Please use caution in these circumstances. Managers, however, may recognize their organizational or team achievements through NTESS Fee. Consult **FIN012, NTESS Fee Policy**, and your ALD's office for their specific approval process.

Contact the Ethics and Equal Employment Opportunity Advisory and Investigative Services.
If in doubt, reach out to Ethics with questions.
505-845-9900 • **ethicsteam@sandia.gov**

Container tests

CONTINUED FROM PAGE 1

"These containers were welded shut and heated to 2,000 degrees, so we assumed that they were going to split open, but they developed small pinholes instead," said Walt Gill, the test director and Sandia mechanical engineer. "We think the material inside reacted with the container itself and produced the pinholes in the container. These tiny holes let out all of the superheated gas without the containers pressurizing and pulling themselves apart."

The series of 10 tests were designed to mimic a hypothetical raging-hot fire burning at a DOE facility and engulfing a container that had been knocked on its side and left outside of its insulated packaging, which protects it from heat. Since these containers are not designed to withstand such a fire, the goal of the test was to determine how much, if any, material stored within the container would be released into the air during such an accident, said Walt and Austin Baird, the test engineer.

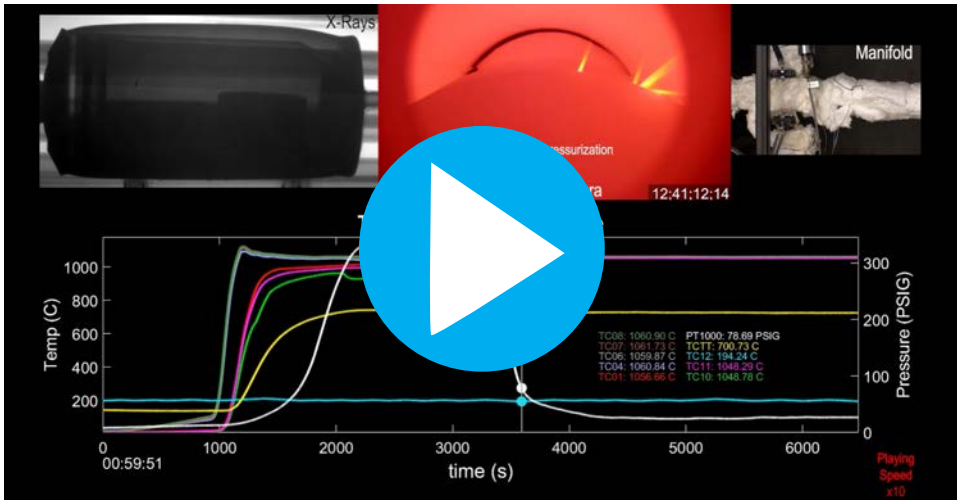
Because the container is a complex, layered system of steel containers, hopefully any material that gets out through a pinhole would be contained or reduced by an outer layer. In 2018, the team conducted similar tests assessing the safety of similar containers.

This information will be used by policymakers to determine safety regulations to protect employees and the environment.

Nested containers for storage and handling

The stainless steel containers are nested in one another as part of a complex layered system, said Austin. There is an inner stainless steel container with a pop-on lid like a cookie tin called a convenience can. Then there are two stainless steel containers that are welded shut: an inner container and an outer container. These three containers are placed within another package for shipping. The containers are used throughout the DOE complex.

The test series started last fall and was conducted at Sandia's Thermal Test Complex. The Thermal Test Complex performs fire safety tests for a variety of programs from weapon systems to shipping containers, Walt said. The complex also has the capability to design and build custom heating chambers for those tests, as well as integrating the results from field tests with advanced computational modeling.



HOT, HOT, HOT — Watch a video showing a test where a stainless steel container designed for the storage and transportation of hazardous materials is heated to 2,000 degrees Fahrenheit for four hours. The container did not catastrophically fail, instead small pinholes formed relieving the intense pressure. On the upper left-hand corner is an X-ray video from outside the container. The top middle image is a video from a pinhole camera inside the test chamber. The upper right-hand corner shows the outside of the test chamber. The bottom graph shows the pressure inside the container (white line) and the temperature of the container (in degrees Celsius) from nine different places (colored lines) during the test.

Video courtesy of Sandia

For the tests, the engineers heated the steel containers to 2,000 degrees Fahrenheit in five minutes, and then held the containers at that scorching temperature for four hours in a custom-built cylindrical heater. This set of times and temperatures is designed to mimic a fire inside a building. Many things from construction materials and fire-proof safes are put through similar tests, Walt said.

"One of Sandia's capabilities is that we have quality assurance under which we can conduct tests," said Victor Figueroa, the quality-assurance coordinator for the test series. "I think that's the biggest reason a lot of consumers, like Savannah River, come to us. We have the highest-grade quality-assurance administrative framework necessary to qualify items involved in storing and transporting hazardous material."

Los Alamos National Laboratory was also involved in the test series. They loaded the predetermined mixture into the containers, Austin said. This mixture contained aluminum oxide — which is used in sunscreen, paints and glass manufacturing — different salts and water in various proportions. The Savannah River Site constructed the pressure manifold for the test and Savannah River National Laboratory tested the containers for leaks.

Since the containers did not breach, like anticipated, the team and their scientific collaborators are analyzing what happened, said Austin. One theory is that the mixture inside the containers reacted with the stainless steel and formed pinholes that allowed the release of pressure without a catastrophic failure. Another theory is that the superheated steam seeped through the thin stainless steel container walls, reducing the pressure inside the containers.

Austin added, "Since the results were very different than what we thought would happen, we're looking at the gas compositions before and after to determine what kind of chemical reactions took place inside the containers."

Top-shelf test technology

The Sandia engineering team started planning for the tests about two years ago, which included spending time designing and building the custom test setups. The fire tests also required a lot of specialized recording equipment to collect all the data necessary to inform policymakers.

QUALITY INSPECTION — Victor Figueroa, a quality-assurance coordinator, inspects a test container prior to heating it to 2,000 degrees Fahrenheit to ensure the safety of the container for the storage and transportation of hazardous materials. **Photos courtesy of Sandia**

A BIT WORSE FOR WEAR — A test container after being heated to 2,000 degrees Fahrenheit for four hours. While the container did swell, it did not split open. The team conducted additional leak testing to determine locations of pin hole leaks.

Each container was outfitted with 18 temperature-sensing thermocouples and two pressure sensors, said Austin. Additionally, the team used real-time, X-ray imaging and a pinhole video camera to monitor what was happening inside the heating chamber. They also had a video camera outside the heating chamber.

The team collected all this data with Sandia's Mobile Instrumentation Data Acquisition System, in partnership with data-acquisition experts.

"The pinhole camera to look inside the test was a big deal," Victor said. "We were actually able to see, in some cases, and get some idea of how big the pinholes were. We haven't been able to do it in the past, due to the harsh test environments. As technology gets better, we're able to make better assessments regarding safety."

The fire tests are only one part of a suite of safety tests the nested containers, in their shipping configuration, must undergo to mimic the conditions of an accident, said Walt. The shipping packages are designed to withstand a hypothetical accident scenario without any release of material from the containers inside. After installing the container in the shipping package, the package is crashed into a hard surface, crushed by a heavy falling weight, punctured, dunked into 50 feet of water and, of course, burned in a fully engulfing fire.

To be certified by regulators, the whole package must complete all these tests with satisfactory results. He added, "These packages get really abused during the qualification test sequence to show that they're safe."

Victor added that the DOE has supported fire testing and qualification of a wide variety of packages for decades at Sandia.

"These packages go on the road and are used at sites across the U.S.," Victor said. "We, as well as the industry, have to make sure that we design and rigorously test the packages such that they are safe. We have to make sure that we look out for the safety of DOE site workers and the general public."

Multicultural Sandia program in fusion energy attracted interns' eyes

Personal attention, outstanding equipment offers new possibilities

By **Neal Singer**

A bold plan paid off this past summer when Sandia staff members LaRico Treadwell and Khalid Hattar combined their passions for increasing inclusion of minorities with developing new materials to ultimately derive energy from nuclear fusion.

Standing to benefit were three undergraduate interns from North Carolina Agricultural and Technical State University, one of America's historically black colleges and universities. They interned at Sandia to tackle difficult problems in fusion energy science and raised their career goals to the next level.

Raised vistas for interns

"This internship has opened my eyes to so many things in science that I did not know," said Bria Cook, a senior chemistry major at the university. "It made me realize that I want to go to graduate school to get my Ph.D., which was never in my plan after my undergraduate degree."

Lester Coney, a sophomore in computer science at the university, is already using information he learned during his summer Sandia internship at school this fall, working with Linux clusters and Python scripting, and running high-performance environment computing.

Eryal Reinhart has decided to change her major from aerospace engineering to materials science, retaining her ambition to work in the aerospace industry using her material science degree.

Sandia senior manager Dawn Flicker, who facilitated the pilot project, said that "the Sandia experience exposed these students to the excitement of helping deliver fusion energy, which could substantially power modern society while mitigating climate change. We felt this early-college experience could help influence their career choices and even whether to attend graduate school."

Planting seeds for greater growth

While the three students' shifting interests aligned more with an eventual position researching fusion, none outrightly declared fusion research as their intended workplace goal.

"This year our goal with this program was to plant the seed and influence their future decision processes," said Dawn.

Lester Coney's accomplishments:

- Ran molecular dynamics simulations of helium and hydrogen implantation and bubble growth in tungsten carbide.
- Utilized high performance computing resources at Sandia to perform atomistic simulations.
- Learned a variety of new computer science skills include bash terminal commands and python.

Eryal Reinhart

Bria Cook

Eryal Reinhart and Bria Cook's accomplishments:

- Investigated a novel route to fabricate alloys with inclusions using a hot isostatic press.
- Utilize spectroscopy tools to investigate the surface and microstructures of 3D-printed metal alloys to directly compare to alloys produced by hot isostatic press.
- Gained exposure to gamma- and ion-irradiation facilities, as well as advanced electron microscopy approaches.
- Worked with Sandia chemist LaRico Treadwell to prepare the Advanced Materials Lab for a science day for 200 Albuquerque fourth graders, who visited from screens. The lab's primary focus is on the synthesis, characterization, processing and manufacturing of materials.

"Our future summer internship program may focus on students closer to graduation or even entirely on graduate students with majors more aligned with the fusion energy discipline."

The plan to broaden the pool of minority students interested in entering fusion research was simple and direct, said Dawn. The student interns from historically black colleges and universities would help deal with one of the most complex issues of a future fusion power plant: the design of components designed to directly face plasma so hot that it exceeds the temperature of the sun.

How to help design a future fusion power plant

A white paper authored by LaRico and Khalid explains the situation in a sentence: "Understanding the materials science of component response to the extreme conditions of a fusion reactor and to develop materials that can survive these environments for extended time is one of the critical technology issues facing the fusion program."

To even begin to achieve a workable surface, the paper continues, "understanding the microstructural evolution that results in the degradation of the tungsten alloys used as plasma-facing components is critical for the success of most proposed future burning-plasma devices under consideration."

To that end, the students performed atomistic simulations, experimented with ion implantation and heavy-ion irradiation, and observed their work in both scanning and transmission electron microscopes at Sandia's Advanced Materials Lab and other locations under the mentorship of a number of Sandia employees, notably Mary Alice Cusentino, Jim Carny and LaRico.

More time in the fires of education

The work proved exciting enough for Cook to decide to continue her education when she graduates in spring 2022. Instead of stopping at a bachelor's degree, she is applying to elite graduate schools. "The very nice mentors at the [Advanced Materials Lab]," she said, "educated me on polymer and composite chemistry and the different opportunities available if I were to pursue a Ph.D. in chemistry."

Reinhart sees her summer internship as a welcome part of her life experiences from which she'll eventually come up with the career direction she wants to go.

Flicker acknowledges that asking for a commitment to fusion research after the experience of a single summer "might be too much to ask. But as a society, we benefit if historically black college and university students are energized and better qualified to pursue any science, technology, engineering or mathematics career, which we did."

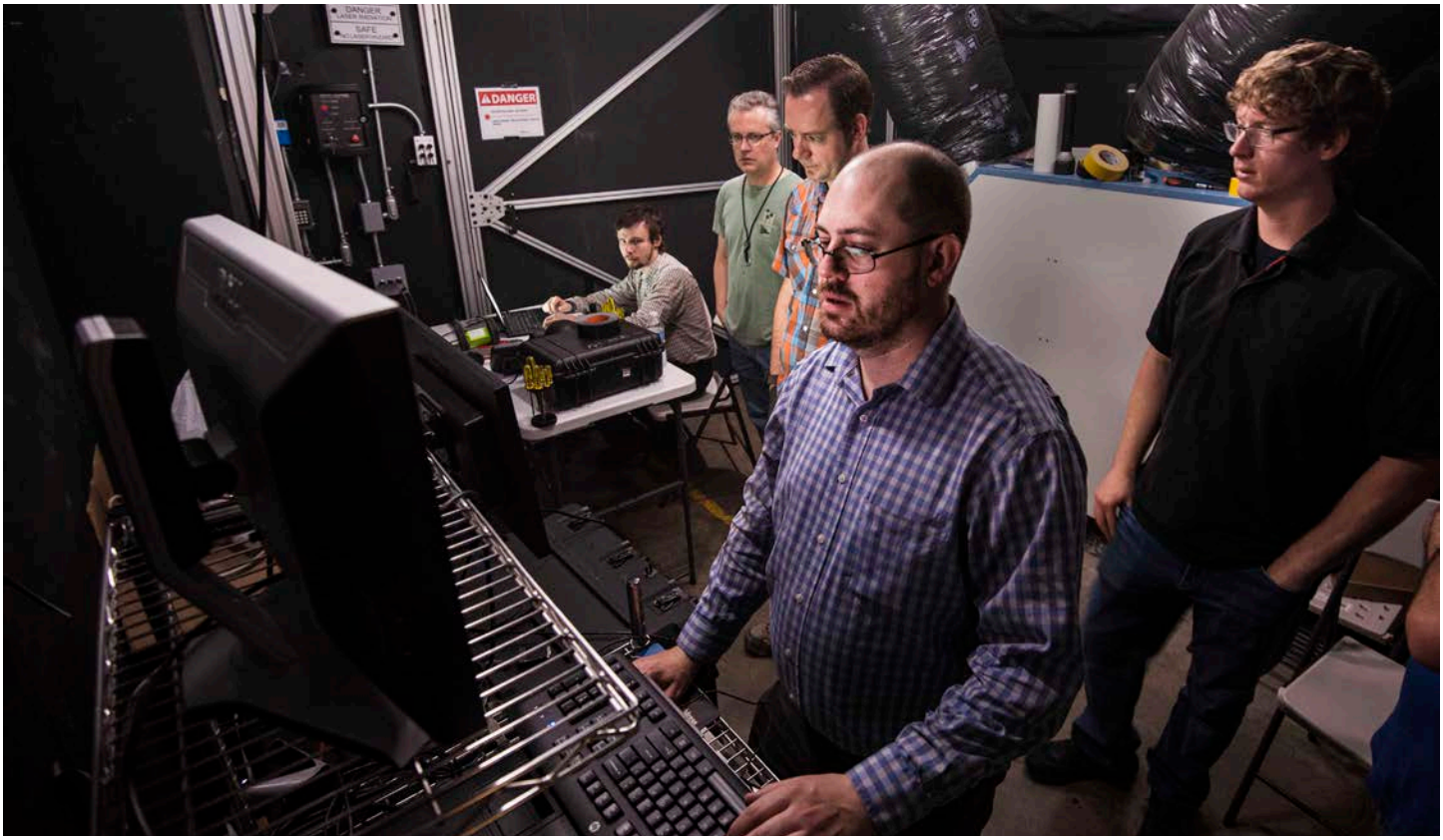
She's already planning to heighten intern awareness of the promise and challenge of fusion if the program is funded next year.

"Aspects of this pilot may be grown into a bigger national plan," Flicker said.

As noted in the recent report of the DOE's Fusion Energy Sciences Advisory Committee, the multidisciplinary workforce needed for fusion energy and plasma science requires a healthy climate of diversity, equity and inclusion, which will benefit the community as a whole and the mission of the program.

"This kind of work by the scientific community at Sandia Labs is sure to strengthen multicultural American science in the current decade and bring us closer to controlling nuclear fusion for energy purposes as well," said James Van Dam, Fusion Energy Sciences associate director.

The Sandia summer intern pilot project was funded by the Fusion Energy Sciences program.



CONTROL ROOM — The research team reviews data coming in from a test in Sandia's fog chamber.

Fog chamber

CONTINUED FROM PAGE 1

"It's important to improve optical sensors to better perceive and identify objects through fog to protect human life, prevent property damage and enable new technologies and capabilities," said Jeremy Wright, optical engineer.

Built in 2014, Sandia's fog chamber is 180 feet long, 10 feet tall and 10 feet wide. The chamber is lined with plastic sheeting to entrap the fog.

When the team begins a test, 64 nozzles hiss as they spray a custom mixture of water and salt. As the spray spreads, the humidity builds and thick fog forms. Soon, an observer inside won't be able to see the walls, ceiling or entrance through the aerosol, and people and objects a few feet away will be obscured or completely hidden.

Sandia's researchers carefully measure properties of fog over time to understand how it forms and changes. By adjusting environmental parameters, the researchers can change the fog properties to better match naturally occurring fog.

"Our team can measure and completely characterize the fog that we produce at the facility, and we can repeatedly generate similar fog on different days," said Andres Sanchez, chemical engineer. "Having consistent and measurable conditions is important when we're testing how sensors perform in fog."

Enabling safe all-weather operations for self-flying vehicles, planes and drones

Researchers from NASA's Ames Research Center recently visited Sandia to perform a series of experiments to test how commercially available sensors perceive obstacles in fog. The Revolutionary Aviation Mobility group is part of the NASA Transformational Tools and Technologies project.

"We tested perception technologies that might go into autonomous air vehicles," said Nick Cramer, the lead NASA engineer for this project. "We want to make sure these vehicles are able to operate safely in our airspace. This technology will replace a pilot's eyes, and we need to be able to do that in all types of weather."

The team set up a stationary drone in the chamber as a target and then tested various sensors to see how well they could perceive the drone in the fog.

"The fog chamber at Sandia National Laboratories is incredibly important for this test," Cramer said. "It allows us to really tune in the parameters and look at variations over long distances. We can replicate long distances and various types of fog that are relevant to the aerospace environment."

Cramer said one of the challenges of self-flying technology is that there would be a lot of small vehicles flying in close proximity.

"We need to be able to detect and avoid these small vehicles," Cramer said. "The results of these tests will allow us to dig into what the current gaps in perception technology are to moving to autonomous vehicles."

Fog facility helps prove technology

Teledyne FLIR has tested its own infrared cameras at Sandia's fog facility to determine how well they detect and

classify pedestrians and other objects. Chris Posch, automotive engineering director for Teledyne FLIR, said the cameras could be used to improve both the safety of today's vehicles with advanced driver-assisted systems features such as automatic emergency breaking and autonomous vehicles of the future.

"Fog testing is very difficult to do in nature because it is so fleeting and there are many inherent differences typically seen in water droplet sizes, consistency and repeatability of fog or mist," Posch said. "As the Sandia fog facility can repeatably create fog with various water content and size, the facility was critical in gathering the test data in a thorough scientific manner."

Sandia and Teledyne FLIR conducted multiple performance tests with vehicle safety sensors including visible cameras, longwave infrared cameras, midwave infrared cameras, shortwave infrared cameras and lidar sensors.

Posch said the results showed that Teledyne FLIR's longwave infrared cameras can accurately detect and classify pedestrians and other objects in most fog, where visible cameras are challenged.

New research to detect, locate and image objects through fog

A team of Sandia researchers recently published a paper in Optics Express describing current results from a three-year project to use computational imaging and the science behind how light propagates and scatters in fog to create algorithms that enable sensors to detect, locate and image objects in fog.

"Current methods to see through fog and with scattered light are costly and can be limited," said Brian Bentz, electrical engineer and project lead. "We are using what we know about how light propagates and scatters in fog to improve sensing and situational awareness capabilities."

Brian said the team has modeled how light propagates through fog to an object and to a detector — usually a pixel in a camera — and then inverted that model to estimate where the light came from and characteristics of the object. By changing the model, this approach can be used with either visible or thermal light.

Brian says the team has used the model to detect, locate and characterize objects in fog and will be working on imaging objects during the project's final year. The team has been using Sandia's fog facility for experimental validations.

Parallel to this research, the Sandia team created two bench-top fog chambers to support a project at Academic Alliance partner, West Lafayette, Indiana-based Purdue University.

Sandia is studying and characterizing the fog generated by its new bench-top fog chamber, while Purdue is using its twin system to perform experiments.

Purdue professor Kevin Webb is leading research to develop an imaging technology based on how light interferes with itself when it scatters and using those effects to detect objects.

The Sandia team has recently presented its work at SPIE and CLEO. The computational imaging and academic alliance research was funded by Laboratory Directed Research and Development.

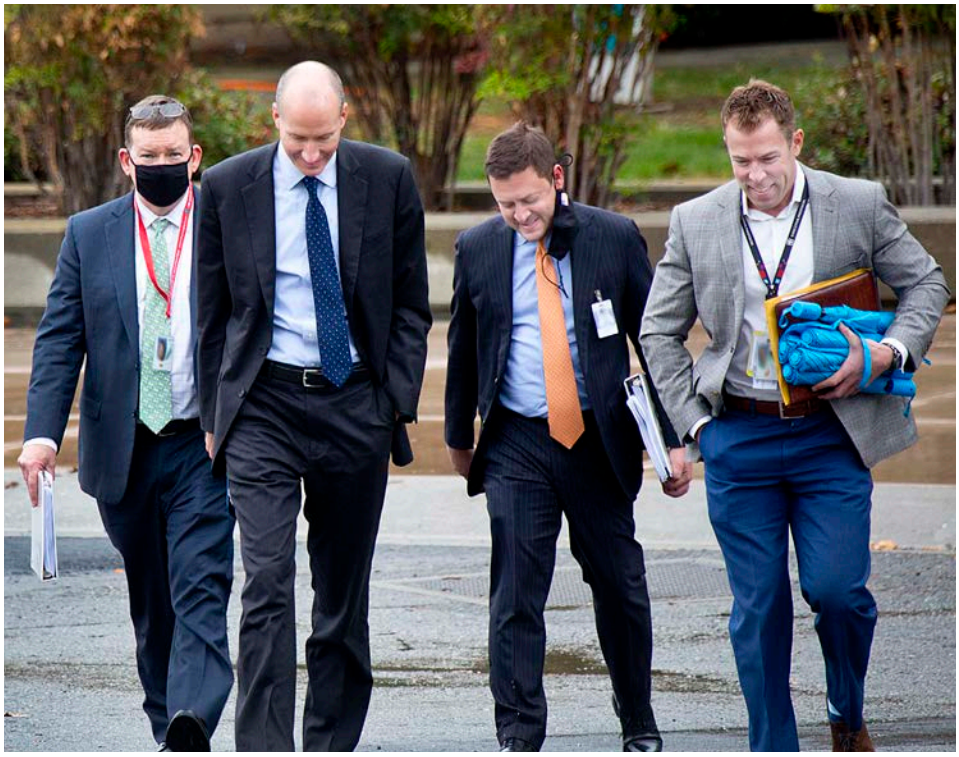
SETTING UP — Members of Sandia's fog chamber research team gathers inside the facility after setting up for an experiment.

DOE Deputy Secretary David M. Turk visits California site

Photos by **Dino Vournas**

Sandia leadership welcomed DOE Deputy Secretary David M. Turk for briefings on the Lab's work in nuclear deterrence modernization, biosecurity and sustainable transportation energy during a visit to the California site Nov. 1.

LEADERSHIP — Sandia Labs Director James Peery, right, welcomes David M. Turk, DOE deputy secretary to Sandia's California site on Nov. 1.



ENERGY ENVOY — Sandia protocol officer Matt Green, right, escorts distinguished guests during their Nov. 1 visit. From left, Capt. Sean Muth, senior adviser for nuclear security, U.S. Navy; Turk; and Tarun Chabra, senior director for technology and national security at the National Security Council.

LONG-TIME COLLEAGUES — Pictured from left, James, Turk, Associate Labs Director for Integrated Security Solutions Andy McIlroy, and NNSA Administrator and DOE Under Secretary for Nuclear Security Jill Hruby.

CALIFORNIA WELCOME — Sandia Executive Chief of Staff Hae-Jung Murphy, right, greets Turk, left, as James and Hruby welcome other distinguished guests.