LOS ALAMOS NATIONAL LABORATORY ◇ SPRING 2021

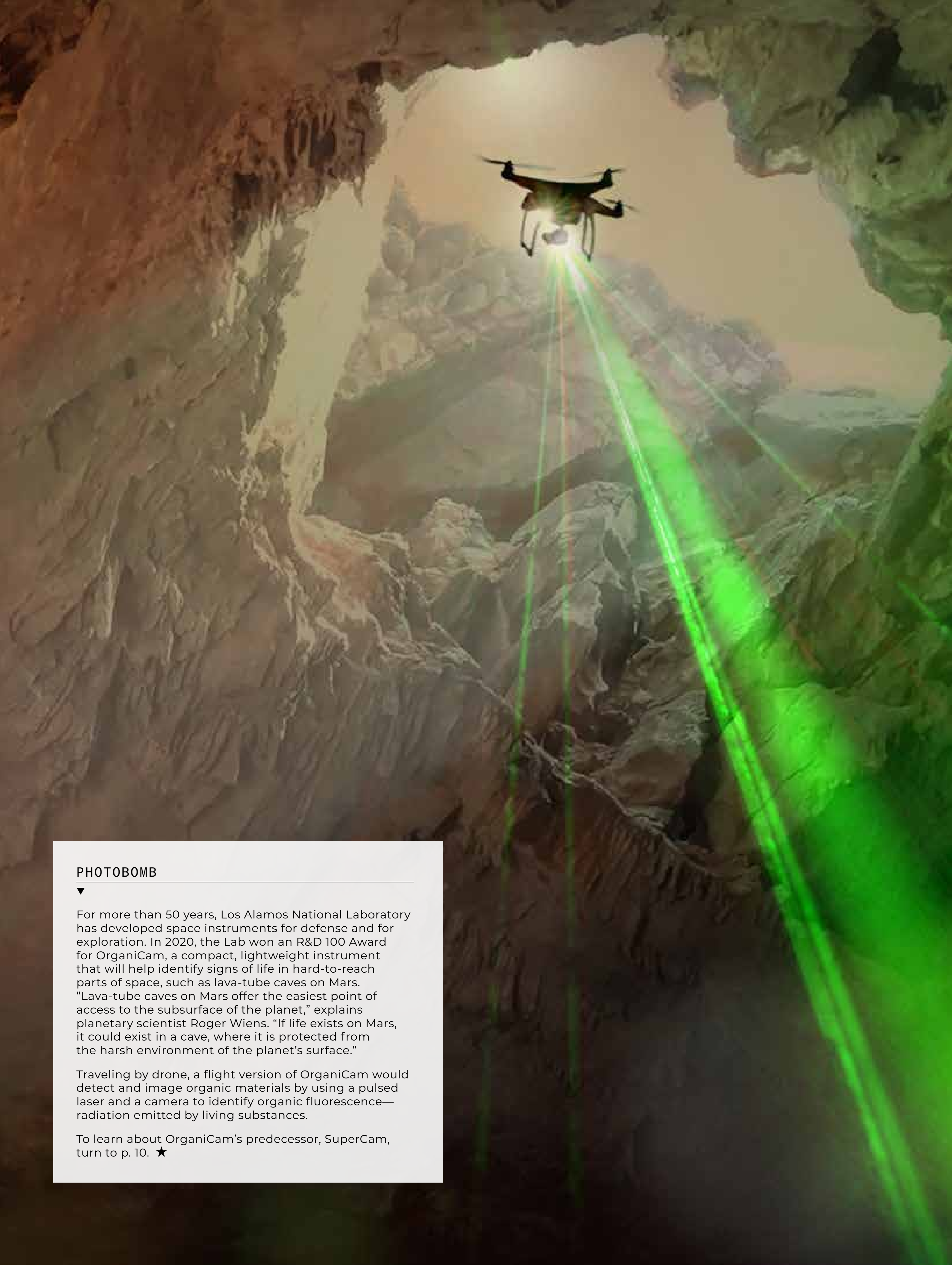
NATIONAL ★ SECURITY SCIENCE

THE WOMEN'S ISSUE

- **Her-story:** Women have always been a crucial part of the Los Alamos workforce.
- **Bridging Divider:** Four women pivot from underground nuclear testing to small-scale, non-nuclear experiments.
- **Women in weapons science:** Meet 40 women who are working hard to keep America safe.

+PLUS:

Lab-designed SuperCam looks for life on Mars	Q&A with Lisa Gordon-Hagerty, former administrator of the National Nuclear Security Administration	An Arctic expedition reveals national security challenges



PHOTOBOMB

For more than 50 years, Los Alamos National Laboratory has developed space instruments for defense and for exploration. In 2020, the Lab won an R&D 100 Award for OrganiCam, a compact, lightweight instrument that will help identify signs of life in hard-to-reach parts of space, such as lava-tube caves on Mars. “Lava-tube caves on Mars offer the easiest point of access to the subsurface of the planet,” explains planetary scientist Roger Wiens. “If life exists on Mars, it could exist in a cave, where it is protected from the harsh environment of the planet’s surface.”

Traveling by drone, a flight version of OrganiCam would detect and image organic materials by using a pulsed laser and a camera to identify organic fluorescence—radiation emitted by living substances.

To learn about OrganiCam’s predecessor, SuperCam, turn to p. 10. ★

About the cover: "Los Alamos National Laboratory is such a culturally diverse place to work," says radiation control technician Crystal Alarid, who is pictured on the cover wearing personal protective equipment at the Laboratory's Plutonium Facility. Like 45 percent of the Laboratory's female workforce, Alarid is Latina. "I am tremendously grateful for the opportunity to work at a place where I feel like I fit in," she says. "I take pride in being a Latina woman and in showing young Latinas that anything is possible—todo es posible."

IN THIS ISSUE

FEATURES

THE WOMEN'S ISSUE

When it comes to ensuring America's national security, count on the women of Los Alamos National Laboratory to get the job done.

JOHN SCOTT
DIRECTOR, OFFICE OF NATIONAL SECURITY AND INTERNATIONAL STUDIES

In December 2020, Los Alamos National Laboratory was named as a top company for women researchers by InHerSight, a web-based platform that collects data to measure how well companies support women employees. Taking into consideration factors like flexible work hours, maternity and adoptive leave, salary satisfaction, management opportunities for women, and female representation in leadership positions, InHerSight ranked Los Alamos second on its list of the "20 best research companies to work for" for women.

This comes on the heels of *Latina Style* magazine selecting the Laboratory as one of the Top 50 Best Companies for Latinas to Work for in the United States in 2020. Los Alamos placed 33rd on the list of companies, all of which were recognized for hiring and promoting high numbers of Latinas and offering mentoring and educational opportunities.

While the Laboratory welcomes these accolades, individual experiences will vary and the Laboratory must continually strive for a fair, diverse, and supportive workplace. That being said, we have come a long way. To glimpse how things have changed for women at the Lab, turn to p. 16, where "Her-story" highlights some of the Laboratory's trailblazing women since its inception in 1943.

In October 1992, the United States entered a moratorium on further testing of nuclear weapons. Thus began the era of science-based Stockpile Stewardship, a program to ensure a high level of confidence in the safety and reliability of stockpiled nuclear weapons, including the conduct of a broad range of effective and continuing experimental programs and the development of significant modeling capabilities with modern-day supercomputing. On p. 30, four women share their experiences of transitioning to stockpile stewardship.

And on p. 40, you can meet 40 women who continue that stockpile stewardship work today. These women are welders, engineers, managers, and everything in between. Some have worked at the Laboratory for only a couple years, others have spent decades here. All of them are inspired and motivated by the Lab's national security mission. As one woman—engineer Anna Maria Vigil—said, "Being a tiny, tiny part of something that makes such a difference on a larger scale—national security—is extremely fascinating, rewarding, and, of course, pretty cool."

As you'll read on p. 6 (a profile of Nancy Jo Nicholas, head of Global Security) and on p. 68 (a Q&A with Lisa Gordon-Hagerty, former administrator of the National Nuclear Security Administration [NNSA]), this mission transcends the Lab's Weapons program and reaches all corners of not just the Lab but also the entire NNSA enterprise. "We have a mission and an obligation in NNSA to execute vitally important missions that are truly one of a kind," Gordon-Hagerty says. "There's nothing the dedicated men and women of the NNSA labs, plants, and sites can't take on and manage to be successful at." ★

MASTHEAD

EDITOR Whitney Spivey
ART DIRECTOR Brenda Fleming
STORY EDITOR Lisa Kisner
COPY EDITOR Sheila Molony
WRITERS Katharine Coggeshall, Virginia Grant, Maureen Lunn, J. Weston Phippen, Octavio Ramos, Brye Steeves
ILLUSTRATOR Michael Nudelman
PHOTOGRAPHERS Kevin Sutton, Carlos Trujillo
EDITORIAL ADVISORS Kirk Otterson, Michael Port, John Scott

National Security Science (*NSS*) highlights work in the weapons and other national security programs at Los Alamos National Laboratory. *NSS* is unclassified and supported by the Lab's Office of National Security and International Studies. Current and archived issues of the magazine are available at lanl.gov/magazine. Unless otherwise credited, all images in the magazine belong to Los Alamos National Laboratory.

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LA-UR-21-20425

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NSS STAFF SPOTLIGHT

During the COVID-19 pandemic, the *NSS* weekly staff meeting is held via Webex. Pictured here from their homes are (clockwise from top left) Whitney Spivey, Brenda Fleming, Katharine Coggeshall, Virginia Grant, and J. Weston Phippen.

▲ Edith Warner and Atilano Montoya in 1948.

REMEMBERING EDITH WARNER

The woman who fueled Manhattan Project scientists at her tea room is recalled fondly by J. Robert Oppenheimer.

In the late 1950s, writer Peggy Pond Church was researching Edith Warner, who, during the Manhattan Project, lived next to the Otowi suspension bridge above the Rio Grande, about halfway between Santa Fe and Los Alamos, New Mexico. Warner would often host meals for scientists in her tea room. "Along with her partner, Atilano Montoya, an elder of the San Ildefonso Pueblo, Warner represented an intersection between the local culture and the lives of the scientists," according to the Atomic Heritage Foundation. "Both communities accepted her as a part of their own."

In this letter, dated November 21, 1958, J. Robert Oppenheimer, scientific director of the Manhattan Project, recounts for Church his first "unforgettable meeting" with Warner. Church compiled this and other stories into her 1959 book *The House at Otowi Bridge*. ★

Dear Mrs. Church:

Thank you for your letter of November 19th. I am glad that the little book about Edith Warner is coming along. We were very, very fond of her, and I am hesitant to add to your account any words of appreciation that go beyond that.

As for the factual matters, they are fairly straightforward. The rumor that Mr. Dickey heard is wrong, and Dorothy essentially right. I first knew the Pajarito Plateau in the summer of 1922, when we took a pack trip up from Frijoles and into Valle Grande. We came back to it often from our ranch in the Pecos. In the summer of 1937 I first stopped at Edith Warner's tea room. I was on a pack trip with my brother and sister-in-law, but came on ahead of them because one of the horses we had with us got away and I had to go after him. We had tea and chocolate cake and talk; it was my first unforgettable meeting. I remember that in the summer of 1941 I brought my wife over to introduce her to Edith. By early 1943 we came to Los Alamos, and very early we stopped to talk with her, and try to reassure her. We saw her regularly after that, and for the last time in the summer before her death, after she had moved to the new house.

With all good wishes,

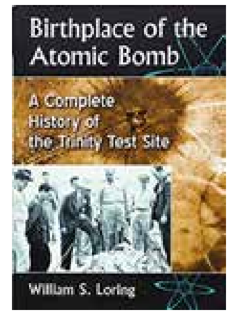
Robert Oppenheimer

Robert Oppenheimer

LETTERS TO THE EDITOR

Here's what our readers have to say.

"Having just received the winter 2020 *National Security Science*, I must say that I am aghast that 'Must-read books about Lab history' overlooks a recent book about Los Alamos, the Manhattan Project, and the Trinity site: *Birthplace of the Atomic Bomb*. It has been well reviewed, though I am a bit biased, as I am the author of said book. I think it a worthy book that should be read by all. Well, OK, maybe not all, but by those interested. You guys keep up the good work!"
—William "Bill" Loring ★



QUEEN OF THE HILL

Learn more about Jane Hall in a new *National Security Science* podcast.

"Jane Hall: Queen of the Hill," originally published in the October 2018 issue of this magazine, is now an episode of the *National Security Science* podcast. Listen and subscribe anywhere you download podcasts to learn more about the Laboratory's first female assistant director, who brought smarts, style, and a steady hand to Los Alamos. ★

INFOGRAPHIC

THE INTERSECTION

Science and culture converge in Northern New Mexico —and beyond.

In 2012, former Jeopardy! host Alex Trebek talked to reporters before the landing of the Mars Curiosity rover, which hosts several Los Alamos–designed technologies. Trebek spoke about how he had been influenced by NASA and the exploration of space.

The Laboratory's 2020 employee giving campaign raised more than $2.4 million. More than $2 million of that went to charitable organizations based in Northern New Mexico.

Congratulations to Kim Budil, the new director—and first woman director—of Lawrence Livermore National Laboratory. In this role, Budil will work with the directors of Los Alamos and Sandia national laboratories to annually assess the state of the nuclear weapons stockpile.

In July 2019, Congresswoman Deb Haaland visited the Laboratory along with other members of the House Science and National Labs Caucus. "Our national labs in New Mexico are at the forefront of innovation while playing a major role as job creators and economic drivers," Haaland said at the time of the visit. Haaland was recently nominated to be the Secretary of the Interior. If confirmed, she will be the first woman and first Native American to hold that position.

Los Alamos NATIONAL LABORATORY

In December 2020, the Laboratory unveiled a new logo. "This modern logo reflects the strength and the future of our Laboratory, especially our global impact, as reflected in the new shape," says Laboratory Staff Director Frances Chadwick. "It will be instantly recognizable across many platforms and media."

Geophysics group leader David Coblentz receives some surprising motivation at the end of his run at the Wildlands 52K in September 2020.

CULTURE

SCIENCE

QUOTED

"Now, more than ever, young women need more-seasoned women to provide that encouragement to take a risk, to go for it. Once a glass ceiling is broken, it stays broken."

— **Jennifer Granholm**, who was nominated to be the 16th Secretary of Energy in December 2020. If confirmed, she will be the second woman to lead the Department of Energy since its creation in 1977. In this role, Granholm will be responsible for maintaining the country's nuclear weapons arsenal and for operating 17 national labs—Los Alamos included. ★

Photo: Wikipedia Commons; TechCrunch

ATOMIC WOMEN

The employee resource group dedicated to supporting women in STEM thrives at the Laboratory.

BY OCTAVIO RAMOS

"The original objective of Atomic Women was to connect female students with female Lab employees in the Weapons program and to recruit and retain more women in STEM [science, technology, engineering, and math] fields," remembers Olga Martin, of the Laboratory's Nuclear Engineering and Nonproliferation Division Office, who co-founded the group in 2007. "The group was meant to last only that first summer, but the results were so rewarding that the Atomic Women continues to this day as an employee resource group. We have no officers, no dues, and no paperwork—our goal is to help women thrive at work, at home, and in the community."

Today's Atomic Women are involved in everything from book discussions to speed networking. "We also reach out to alma maters and professional societies to connect with students and professors, sharing information about Laboratory internships and employment opportunities," explains Laura McClellan of Performance Assurance. "We even led a Wikipedia edit-a-thon to boost coverage of notable Los Alamos women scientists on the online encyclopedia."

The underlying goal of all these activities is to support diversity and inclusion efforts for women at the Laboratory. These efforts are more than addressing gender bias and diversity issues—the Atomic Women are involved in mentoring and career development, cultivating leadership skills, facilitating workplace communication, and ensuring work-life satisfaction.

"Our members work to cultivate a supportive work environment, address issues that concern the group, and encourage and support members in their careers," Martin says. "We help attract and recruit the next generation of female scientists and engineers, support the Laboratory in its retention efforts, and bolster awareness of work-environment issues."

McClellan stresses that Atomic Women is open to everyone. "*Anyone* can join the Atomic Women," she says. "We encourage everyone to join, as we know that it takes male advocates partnering with us to advance recruitment and retention of women at the Laboratory." ★

Laboratory employees interested in joining the Atomic Women should email atomic-women-leaders@lanl.gov.

▲ Members of the Atomic Women after a speed networking event.

BY THE NUMBERS

WOMEN AT LOS ALAMOS

Associate Laboratory Director Nancy Jo Nicholas

GLOBAL SECURITY

MINIMIZING THE THREAT

Nancy Jo Nicholas, associate Laboratory director of Global Security, reflects on her path at Los Alamos, from Star Wars to arms control.

BY VIRGINIA GRANT

As a graduate student in physics at George Washington University, Nancy Jo Nicholas came to Los Alamos National Laboratory to gather data for her thesis experiment. "Working as part of an accelerator user group for a whole summer was amazing," she says, "but I never really saw any of the rest of the Laboratory." Nonetheless, she moved to Los Alamos after graduation and took a position in the Advanced Nuclear Technology group.

"The position I was offered was in the Star Wars missile defense program," Nicholas remembers. "It required a Q clearance and sounded really exciting. But by the time I got a Q, the project was canceled, and I was assigned to work on detector development for waste assay because it was well-funded." Although the excitement level of measuring waste paled in comparison to working on Star Wars, Nicholas learned a lot from that experience, specifically that even if the work is following the funding, some exciting science can come out of it. "I learned a lot about gamma-ray and neutron-based detectors," she says, "which I was later able to apply to international safeguards and arms control verification missions."

Nicholas had two early-career changes of stations, which are short-term assignments away from Los Alamos—one at the Rocky Flats Plant in Colorado and one at the National Nuclear Security Administration (NNSA) headquarters in Washington, D.C. After she returned to Los Alamos, Nicholas eventually became a deputy group leader, the first step in her path to her current position, associate Laboratory director of Global Security.

Now, Nicholas heads the Global Security directorate, defending against the nuclear threat from foreign adversaries. "Sometimes we work with other friendly nations," she explains, "but sometimes it's collaborating with the intelligence agencies doing traditional spy work."

As part of her recent work with friendly nations, Nicholas became a founding board member of the World Institute for Nuclear Security, an international nonprofit based in Vienna, Austria. "Being on the board of directors not only gave me a platform for helping a cause I care deeply about—strengthening nuclear security globally by sharing best practices—but it also afforded me the opportunity to engage with leaders around the world and taught me a lot about nonprofits and international finance and fundraising," she says.

The Lab's Global Security program often involves getting different—sometimes seemingly unrelated—areas of the Lab to collaborate. For example, Global Security has funded some work in nuclear forensics that involves scientists from the Lab's Chemistry Division as well as the Weapons directorate. "We work across an extraordinary span of security levels," Nicholas says, "and maintain operational research environments."

▲ At the 2019 Global Security Medal Award ceremony, Nancy Jo Nicholas is pictured with (from left) NNSA Deputy Administrator for Defense Nuclear Nonproliferation Brent Park, award recipient Stephen Yarbro, and Laboratory Director Thom Mason.

While part of Nicholas' work involves reading about and promoting the science of the Laboratory (and occasionally contributing to technical papers), she misses the days of doing her own science. "I'm an experimentalist by training, so I really miss being in the lab and getting to do hands-on work," she says, "but in the role I'm in now, I get to facilitate that work, which is great." One of her favorite parts of the job is going around the Lab to see the work being done and talking with the scientists. This is something Nicholas has missed during the long months of telework made necessary by the coronavirus pandemic. "We aren't seeing nearly as many people, and I'm not doing much travel at all. I miss being out in the world and maintaining relationships."

Nicholas also works to recruit and develop scientists and leaders at Los Alamos. Before the pandemic, she gave an invited talk at her alma mater, George Washington University, before the Division of Nuclear Physics of the American Physical Society. She spoke about careers in physics beyond academia and encouraged early career physicists to consider Los Alamos and the national laboratories.

One of the milestones of Nicholas' career was in 2017 when she became the first female principal associate director at any of the University of California–operated laboratories. Her journey to this position was inspired by the female role models Nicholas saw when she was beginning her work as a physicist at Los Alamos. "For me, as a young graduate student and early career scientist," she says, "it was so important to see women role models." When she started at the Lab, Nicholas saw women leading the Physics Division, the Biology Division, and the Weapons Engineering directorate. "I don't think I would have stayed if I hadn't seen role models like that."

Now that she has become one of those role models, Nicholas focuses heavily on mentorship at Los Alamos. "I'm quite passionate about leadership development—investing for the future through leaders and managers," she says. "In Global Security, we're working on this at many levels through some really active early career working groups." And she herself mentors participants in the Laboratory Operational Leadership Academy. "I'm really committed to making sure the Lab has strong technical leaders and managers," she says.

As for her own leadership style, Nicholas considers herself an ambassador. "I've always been passionate about building and nurturing relationships," she says. "I'm loyal to Los Alamos National Laboratory, and I like to remain engaged in the broader community." ★

■ An essential tool for testing new technologies for DUNE, ProtoDune has been online since 2018 at CERN in Geneva, Switzerland.

SPACE

THE WORLD'S BIGGEST NEUTRINO CATCHER

The Deep Underground Neutrino Experiment may transform physics and unravel mysteries of the universe.

BY KATHARINE COGGESHALL

When a star reaches the end of its life, it cools off, collapses in on itself, and explodes in a spectacular show of light that can be seen across the universe. Although these supernovae events are phenomenal, they are also quite rare. Prior to a supernova event in 2020, the most recent supernova in the Milky Way was more than 300 years ago.

Scientists look to supernovae for greater understanding of another, much more massive explosion—the Big Bang—a one-time event that created the universe. Studying the former could offer insights into a fundamental question in physics: Why does our universe exist at all? The creation of the universe actually goes against what modern physics would predict, and it comes down to post-explosion particles.

Most of the energy from supernovae transforms into particle pairs consisting of neutrinos and anti-neutrinos. With equal mass but opposite charge, these particles annihilate—returning to pure energy—when they come back together. There is a mathematical balance, or so it's thought. The existence of the universe (which is made of matter) boldly contradicts this idea of balance because it couldn't exist unless the particles were in unequal quantities. Clearly, something doesn't add up, and scientists around the world want to know why.

Researchers from 30 countries, including physicists from Los Alamos, have come together to solve this matter-antimatter paradox through a new experiment—the Deep Underground Neutrino Experiment, or DUNE. The plan is for DUNE to detect neutrino and anti-neutrino particles, which are challenging to find in abundant quantities in nature. Although DUNE is equipped to detect these particles via a supernova event (which acts as a surrogate for the Big Bang), the researchers opted to design DUNE with its own particle-generating beam. This is because supernovae

are rare, occurring once in a galaxy only every century or so, and because the energy from supernova signals pales in comparison to what the accelerator beam can consistently produce. This frees the experiment from having to rely on a once-in-one-hundred-years supernova event, but if one does occur close by, DUNE will detect it.

Looking at the quantity and behavior of these particles will likely transform our understanding of physics.

“Neutrinos are peculiar particles that oscillate between three types, or flavors: electron, muon, and tau,” says Los Alamos physicist Sowjanya Gollapinni. “DUNE will help us compare the neutrino (matter) oscillation behavior to that of anti-neutrinos (antimatter).”

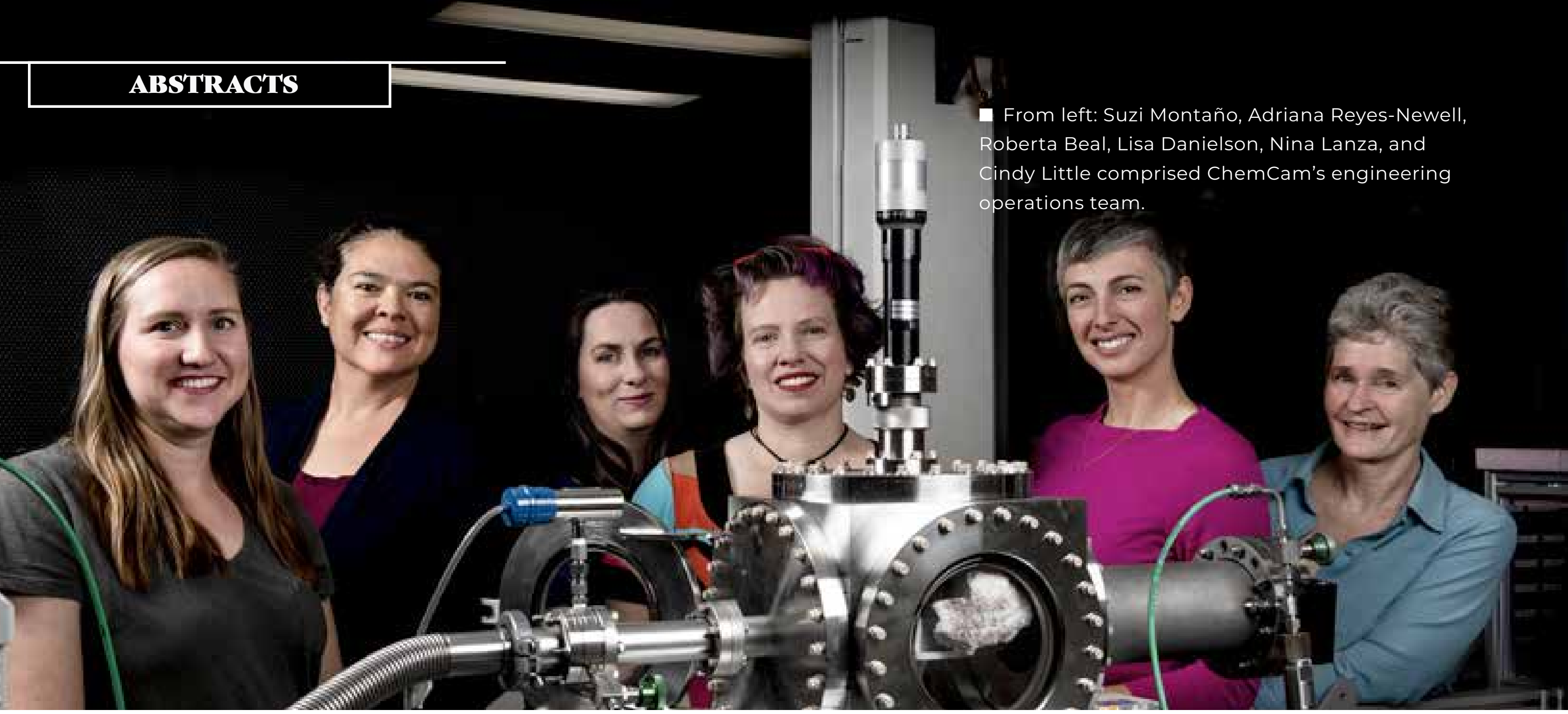
If the behavior is different, it could help explain why energy from the Big Bang converted into matter (i.e., a universe) and not antimatter.

DUNE is composed of a near-detector located underground at the Fermi National Accelerator campus in Illinois and a far-detector located 800 miles away, deep underground at the Sanford Underground Research Facility in South Dakota. The particle-generating beam, produced in Illinois, travels underground to South Dakota. “The DUNE far-detector will be the largest cryogenic detector ever to be built, containing 70,000 tons of liquid argon as target material for neutrinos to interact with,” Gollapinni says. The neutrino and anti-neutrino oscillations will be analyzed before and after their approximately 4-millisecond trip between detectors.

“Designing these state-of-the-art detectors was a significant accomplishment,” Gollapinni says. “What we learn from this experiment will be groundbreaking, and that will be applied to everything from national security to astrophysics.”

Next-generation neutrino experiments such as DUNE can provide valuable inputs to nuclear security applications, especially in the context of anti-neutrino detection and characterization. Developing such detection technology for monitoring nuclear reactors from distances of tens of kilometers away is ongoing, with the potential to improve safety.

Officially, ground has already been broken on the DUNE project. Excavation of the far-detector main cavern is underway, but detector installation isn’t expected until 2024. DUNE’s design and construction are massive undertakings, but the result holds the potential to unravel the mysteries of the universe. ★



From left: Suzi Montaño, Adriana Reyes-Newell, Roberta Beal, Lisa Danielson, Nina Lanza, and Cindy Little comprised ChemCam's engineering operations team.

SPACE

LOOKING FOR LIFE ON MARS

Lab-designed SuperCam will use a laser and a microphone to identify signs of life on the red planet.

BY J. WESTON PHIPPEN

The Mars rover Perseverance was launched on July 30, 2020, from Florida's Cape Canaveral Air Force Station and landed in the red planet's Jezero Crater on February 18, 2021. The car-sized rover is equipped with SuperCam, a "Swiss Army Knife" of instruments that can help detect signs of past and present life on Mars. SuperCam was designed and built at Los Alamos with help from the Institut de Recherche en Astrophysique et Planétologie in France.

SuperCam looks for signs of life in rocks using a laser beam. One of the laser beam's wavelengths is in the infrared spectrum and, from 25 feet away, blasts a pencil-tip-size hole into rocks on the surface of Mars. The second beam, in the green wavelength, uses Raman and luminescence spectroscopy, which makes organic material—life—glow. Both are helpful in identifying manganese, a kind of varnish on rocks that forms in arid environments. On Earth at least, tiny microorganisms that live in the cracks of a rock's structure, even beneath the outer rock layer, help create this manganese varnish. So on Mars, the thinking is that where there's manganese, there may have once been life. Or, possibly, there may even still be life.

Adriana Reyes-Newell is SuperCam's laser-blasting specialist. At Los Alamos, Reyes-Newell has spent years zapping a variety of rocks in a pressure chamber that's designed to simulate the Martian environment, so that the scientists operating the Mars lasers will have data from Earth they can compare to what's found on Mars.

"That way," Reyes-Newell says, "if we shoot a target on Mars that says it has a high percentage of manganese, we can validate those findings from our past experiments here at the Lab."

Reyes-Newell, together with colleagues Nina Lanza and Ann Ollila, has also spent years working on SuperCam's predecessor, ChemCam, which deployed on the Curiosity rover in 2012 and still roams the red planet.

This trio, alongside Carene Larmat and Erin Dauson, are working together on a Laboratory Directed Research and Development team, studying the acoustics of laser zaps at Martian pressure. "Women tend to have a different life experience working in the sciences," Lanza says of this all-female team, "and they bring those experiences to solving problems. At Los Alamos, that helps because it's all of our jobs to solve problems in new ways that have never been done before."

The women are getting plenty of data from another feature on SuperCam: a microphone that, for the first time, relays to Earth sounds from the Martian planet. When the SuperCam laser zaps a rock, it creates a supersonic shockwave. By analyzing the wavelength recorded by SuperCam's microphone, the team found that different chemicals in rocks make different snaps or pops when blasted with the laser. They hope to compile a kind of library of these sounds, represented in wavelength data for a sequence of 30 zaps, that can be used to verify the chemical makeup of what SuperCam is zapping.

This could become helpful when it's time for Perseverance to return rock samples to Earth. There are only 43 rock sample tubes on Perseverance, and each is coveted. But because Perseverance will relay data back about once every day on Mars, if Reyes-Newell and Lanza can correctly identify the sound of manganese rock layers popping, it will help scientists across the world decide which rocks to gather based on which have the greatest chance of containing microbes.

"There's no smoking gun to be able to say 'this is life,' or 'this was life' on Mars without returning samples to Earth," Lanza says. But with this novel approach to listening to rock layers being vaporized, scientists will have a better chance of finding a rock that just might contain life from Mars. ★

ICE, AHOY!

The largest Arctic expedition in history provides unprecedented data for national security decisions.

BY KATHARINE COGGESHALL

■ Jessie Creamean collects sea water and marine organisms that live beneath the ice. The organisms can end up in the atmosphere, playing a key role in regulating the climate.

Los Alamos National Laboratory operations manager David Chu is a modern hunter-gatherer, only his game is data. With the Department of Energy's Atmospheric Radiation Measurement (ARM) mobile observation facility made up of state-of-the-art instruments, Chu travels to the ends of the Earth collecting climate data to help scientists and policy makers understand how climate change will affect national security.

In September 2019, Chu and ARM instrument expert Jessie Creamean loaded their high-tech instruments aboard an icebreaker, the *Polarstern*, and headed for the Arctic. They were two of the 300 researchers from 20 countries participating in the first year-long research expedition in the Arctic—one of the most extreme environments on Earth.

"It's beautiful—the Arctic—but it's a really challenging environment where you are constantly fighting the elements," Chu says.

Something as simple as tightening a nut on an instrument can take three times as long in the Arctic because of the cumbersome personal protective equipment and the need to constantly watch for lurking polar bears.

"Once, my glasses fogged up when I was on bear guard," Creamean says, "and because it gets so cold in the Arctic, my glasses just shattered into pieces!"

Curious bears and plunging temperatures are some of the reasons a dearth of data from the northernmost point on Earth still exists. However, that data holds the key to many national security issues. For one, the Arctic is considered the bellwether for climate trends in North America. Retrieving Arctic data, such as sea ice volume and ice cracks, will help climate scientists create better climate models that can predict weather and natural disasters, which down our power grids, erode our shores, and cost our nation billions of dollars in repairs. Right now, there isn't enough data to conclusively say that climate change causes an increase in extreme weather events. Scientists need to know more: how does the warming climate impact environmental processes, and how do those processes feed back on each other to create more change?

The Arctic has changed more rapidly in the past few years, and scientists don't know how that will impact the world. However, they do know that as more Arctic ice melts, new routes for shipping and retrieval of natural resources will open up, leading to another national security issue. Who will be in charge of the Arctic? Who will have right-of-way?

"It's kind of a free-for-all at the moment," Chu says, "and expanding Arctic Ocean sovereign claims complicate the international response to ice and ocean changes."

The Arctic data that Chu and Creamean helped gather will go a long way toward aiding decision makers in how to go about accessing and regulating those Arctic resources: fishing, oil, and gas, for example.

"It may be a harsh environment, but it's also a really delicate ecosystem," Creamean says. "Altering it in any way can really impact our nation, and we still can't predict exactly how."

Although the *Polarstern* finished its Arctic mission on October 12, 2020, the full data set won't be ready until 2023. This gives researchers time to clean and submit their data to the public repository. The goal as a data hunter-gatherer is to bring back the highest-quality data possible, and that isn't something that should be rushed.

"People will be analyzing and publishing conclusions based on this data set for years and years," Creamean says. "It's incredibly valuable, and the first of its kind." ★

FELLOWSHIP

THE LEGACY OF A LABORATORY LEGEND

The Darleane Hoffman Postdoctoral Fellowship continues the work of a groundbreaking scientist.

BY VIRGINIA GRANT

The Darleane Christian Hoffman Distinguished Postdoctoral Fellowship provides three years of funding for one female scientist at Los Alamos National Laboratory. The fellowship is named after the first woman to be leader of a scientific division at the Laboratory—Darleane Hoffman. The fellowship, previously named for Nobel Laureate Marie Curie, "recognizes, encourages, and rewards outstanding scientific and engineering contributions by women." The Laboratory renamed it in 2017 to honor Hoffman's 31-year career at Los Alamos.

Hoffman began work at the Laboratory in 1953 in the Field Testing Division. After 25 years, she left Los Alamos to work as a Guggenheim Fellow at Lawrence Berkeley National Laboratory. She returned to Los Alamos in 1979 as the leader of the Chemistry and Nuclear Chemistry Division. In 2014, Hoffman received the Los Alamos Medal—one of the highest honors the Laboratory bestows.

Hoffman's most notable work at Los Alamos was her discovery of spontaneous fission in the early 1970s. Fission is the splitting of an atom. At the time, scientists were aware of atoms splitting because of outside forces such as another particle hitting them or because of radioactive decay—processes that were key to the success of the atomic bombs of 1945. But Hoffman discovered the atoms of the element fermium (named after Los Alamos scientist Enrico Fermi) could spontaneously split. The implications of her work in spontaneous fission were particularly pertinent for studies of nuclear waste storage. Changing radioactive materials, like those capable of spontaneous fission, are unstable, and Hoffman's discovery aided how scientists could determine safe ways to prevent radioactive material from leaking.

After leaving Los Alamos for Berkeley, Hoffman was part of the team that discovered a new element—seaborgium (named for chemist Glenn Seaborg). She received myriad awards, including the National Medal of Science. Hoffman, now in her mid-90s, lives in Palo Alto, California.

A recent recipient of the Hoffman fellowship is Beth Lindquist, a computational chemist. As the Hoffman fellow, Lindquist's primary project is modeling nonequilibrium phenomena. "If we have a mixture of molecules and nothing is acting on it, we know how to model that on a computer," she explains, "but if we have some driving force or weird dynamics, we might not know how to make good predictions for that." Lindquist uses machine learning and statistical inference to map these nonequilibrium systems to learn more about how they behave.

▲ Hoffman at the Laboratory in 1975.

In 2020, Lindquist accepted a permanent position in the Lab's Theoretical Division, where she is able to use funds from the Hoffman fellowship to continue her work in modeling. Lindquist also works in high-explosives research, predicting the behavior of certain materials under extreme conditions.

Although Hoffman's work was more traditional chemistry in a laboratory, and Lindquist works more with physics on a computer, they share an interest in the multifaceted research opportunities that Los Alamos offers. "The thing I really like about the Lab," Lindquist says, "is that it's a big institution with a lot of different things going on, so it seems very common for people to evolve and grow and do different things. I don't know what I'm going to be doing in ten years, and that's a good thing. There will be so many options and opportunities." ★

▲ Darleane Hoffman
Photo: U.C. Berkeley

▲ Beth Lindquist

STREAMLINING SATELLITE DATA

A new technology will allow researchers to quickly compare data from different satellites to better assess changes on Earth.

BY J. WESTON PHIPPEN

Amanda Ziemann

After any natural disaster—such as a flood, wildfire, or hurricane—one way to assess destruction and coordinate relief is to use satellite imagery for large-scale change detection, which uses a location's past and present satellite imaging data to understand what was there before that isn't there today.

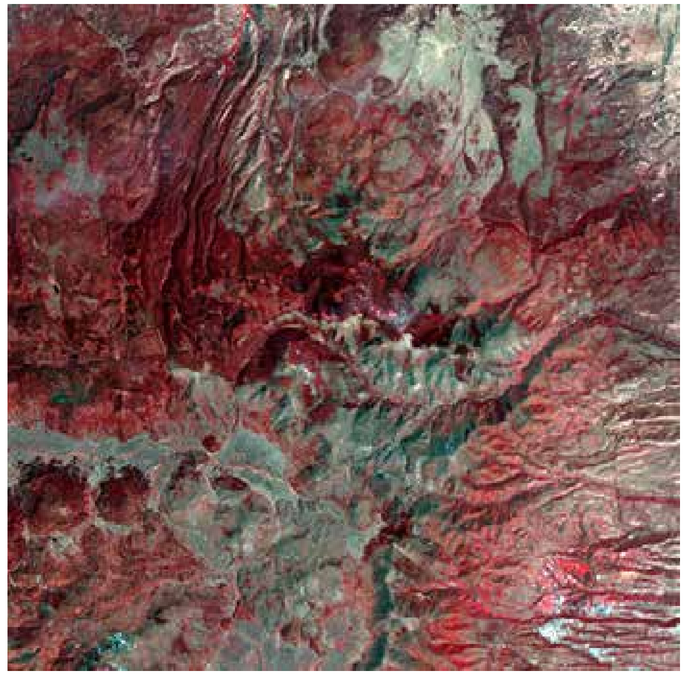
"The easiest way to think of change detection is to imagine two images taken from above," says Amanda Ziemann, a member of the Space Data Science and Systems group at Los Alamos National Laboratory. "The process of detecting changes digitally layers those images and looks for differences on the ground."

For example, in before and after photos of a house in the middle of the woods, the before picture might show a reflective, metal roof and the green canopies of pine trees. The after photo, taken when a fire has already burned the area, might show a charred structure and matchstick tree trunks. A computer then calculates values at each pixel in each image, then calculates the differences between the two images. Wherever the difference is highest, scientists can expect a significant change to the environment.

But measuring changes through satellites has always suffered from an Achilles' heel: the information gathered by one satellite often can't be compared to the information gathered by another satellite because satellites gather images in different ways.

Some satellites with multispectral imaging use green filters to take images of plants and blue filters to measure coastal erosion. Infrared satellites create images from temperature. Others use synthetic aperture radar to measure changes in surface height. The change detection method of computing values at each pixel, then measuring the difference, doesn't work when two images are comprised differently. It would be like trying to compare numbers to letters or musical notes. Additionally, different satellite cameras are equipped with different numbers of signal measurements, or channels. So even if two satellites both have multispectral imaging cameras, they need the exact same number and type of color channels to compare data.

As a result, scientists often use the same satellite to collect data of an area once every orbit. In an emergency, however, waiting up to two weeks for the satellite to return to position means change detection is often too slow to be of immediate help.



▲ A false color composite from a multispectral satellite image emphasizes vegetation (the red areas) across Northern New Mexico's Valles Caldera National Preserve (center) and the town of Los Alamos (lower right). Multispectral images can be used to quickly and easily assess vegetation health. The image was taken in May 2020 by the Landsat 8 satellite, which is operated by NASA and the United States Geological Survey.

Recently, Ziemann and her team developed a new approach called multi-sensor anomalous change detection (MSACD), essentially a universal satellite data translation device. It's an idea so innovative that when Ziemann explained it to her former doctoral advisor at the Rochester Institute of Technology, he replied, "What? That doesn't even sound possible."

But Ziemann knew that although images might be comprised differently, what was being measured—a geospatial area—was the same. So using a computer algorithm, MSACD translates data from satellites and plots it on a joint distribution graph, which has an X and Y axis and is used to compare random variables. Wherever the dots vary widely, the most change has occurred.

In the future, scientists could aim a variety of satellites at a wildfire, for example. Within hours, MSACD could send automatic updates to emergency operations and aid groups that show how the fire changed direction or how many buildings were destroyed.

"We'll be able to detect changes to the environment faster than ever before," says Ziemann, noting that MSACD is in prototype demonstration stages of development. (It received funding in 2018.) "That has many applications—assessing damage to flooded coastal communities, detecting an adversary's clandestine military base, spotting illegal loggers thinning the rainforest, determining the damage from a wildfire, and much more." ★

HISTORY

WHAT WAS OPPENHEIMER'S FIRST NAME?

More than 100 years after he was born, we're still not quite sure.

BY BRYE STEEVES

Physicist J. Robert Oppenheimer is known as the father of the atomic bomb. However, 117 years after his birth on April 22, 1904, his first name—what the letter J may or may not stand for—is still a mystery.

By far, most sources—including Oppenheimer's own birth certificate—state that Oppenheimer's first name was Julius. According to the Pulitzer Prize–winning biography *American Prometheus*, Oppenheimer was named after his father, a Jewish textile importer. This could be considered unusual, however, because naming a baby after a living relative is contrary to European Jewish tradition.

Forty years later, a letter from the War Department that granted Oppenheimer his security clearance states "Julius" as his first name.

Numerous other people, though—including Oppenheimer himself—insisted the J didn't stand for anything at all. In a 1946 letter to the U.S. Patent Office, Oppenheimer wrote: "This is to certify that I have no first name other than the letter J, and that my full and correct name is J Robert Oppenheimer."

Oppenheimer's obituary, which was published in *The New York Times* a day after he died at the age of 62 from throat cancer, explains that "J. (for nothing) Robert Oppenheimer lived the remainder of his life [after the 1945 Trinity test] in the blinding light and the crepusculine [sic] shadow of the world's first manmade atomic explosion, an event for which he was largely responsible."

Regardless of whether he was Julius or just the letter J, many called him by the nickname he earned in his mid-20s that stuck for the rest of his life: Oppie. (Though it may be Oppy or Opje.) ★

▲ Oppenheimer visits with Dorothy McKibbin (left) and another friend. For more on McKibbin, see p. 18.

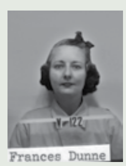
EXPLOSIVES

▲ In the spring of 1945, Frances Dunne's leg broke when it was hit by a snapped cable. No worse for the wear, Dunne is pictured here at the Twomile Mesa explosives site with her colleague Howard Phanstiel.

FRANCES DUNNE, EXPLOSIVES TECHNICIAN

The only woman in the Manhattan Project's Explosives Assembly group inspired the name of a current Lab explosives testing facility.

BY VIRGINIA GRANT



In the early days of World War II, Frances Dunne began studying to become an airplane mechanic. In 1944, she was working at Kirtland Air Force Base in Albuquerque, New Mexico, when she met physicist George Kistiakowsky.

Kistiakowsky had left a job as head of the National Defense Research Committee's Explosives Division and by 1944 was hard at work on development of the atomic bomb at Project Y—the Los Alamos branch of the Manhattan Project. He recruited Dunne for explosives work at Los Alamos not only because of her knowledge of mechanics but because of her small hands, which he thought would be able to reach inside bombs to set the triggers.

Dunne thus became the only female member of the Manhattan Project's Explosives Assembly group, and she was the only woman to work on the assembly crew of the Gadget, the nuclear device that was detonated in the Trinity test on July 16, 1945. Following World War II, Dunne went to work for the Federal Bureau of Investigation.

In 2018, Los Alamos National Laboratory opened the Frances Dunne Test Firing Facility for explosives testing, diagnostics, and data analysis. Built on the ground of a former outdoor firing site, the Frances Dunne facility has an indoor, weather-proof firing area that allows for year-round testing and data gathering. ★

SAFETY

LESSONS LEARNED

The Lab's Evelyn Mullen reflects on the cleanup of a contaminated Seattle building.

Evelyn Mullen, chief operating officer for Global Security at Los Alamos National Laboratory, was among the many professionals who responded to a cesium contamination emergency at the University of Washington (UW) in Seattle in May 2019. Little did Mullen know that the incident at the University's Research and Training Building would dominate her professional life for the next 18 months—and counting.

▲ Experts in protective gear prepare to sweep the University of Washington's Research and Training Building for cesium contamination. Photo: NNSA

The event occurred when a contractor for the National Nuclear Security Administration's (NNSA's) Off-Site Source Recovery Program attempted to remove an irradiator with a cesium-137 source as part of the Cesium Irradiator Replacement Program. During the operation, the contractor inadvertently breached the sealed source, resulting in the release of radioactive cesium and the contamination of the facility. Thirteen people were impacted by the release and medically evaluated. The level of exposure to those individuals did not pose a health risk to them or to the general public.

In response to the breach, Mullen worked with others at UW, NNSA, Los Alamos, the Washington Department of Health (WDOH), and Pacific Northwest National Laboratory to understand the extent of contamination and to plan its cleanup. Their initial response stabilized the cesium source and ensured no additional contamination could occur, but remediation in the building proved to be a long-term effort. The radioactive material had to be cleaned up using elaborate decontamination methods. The multi-step process includes significant oversight, survey and sampling work, and documentation to ensure the building will be remediated to WDOH standards.

"I would not have been able to do this without Evelyn Mullen as a partner," says Kristin Hirsch, Director of NNSA's Office of Radiological Security. "She has been incredible to work with. Having good partners in unusual and unique situations makes everything easier and more manageable."

Not only has Mullen applied her technical skills to the cleanup effort, but she has also interacted with local stakeholders affected by the accident. For example, staff at a nearby women's shelter expressed concerns about whether the cesium contamination had traveled beyond the initially contaminated building. Mullen met with them virtually to let them know that continuous monitoring of the air in and around the building showed the contamination did not spread into the neighborhood.

"This incident has impacted people in ways that are well beyond the technical issues," Mullen says. "As technical experts, we tend to worry about the technical problems, but working to address stakeholder needs with patience and empathy can lead to stronger partnerships."

As the cleanup effort wraps up, Mullen is confident that a similar event will not occur again. In a report released in March 2020, NNSA concluded that the incident was preventable and was the result of weak and partially implemented processes.

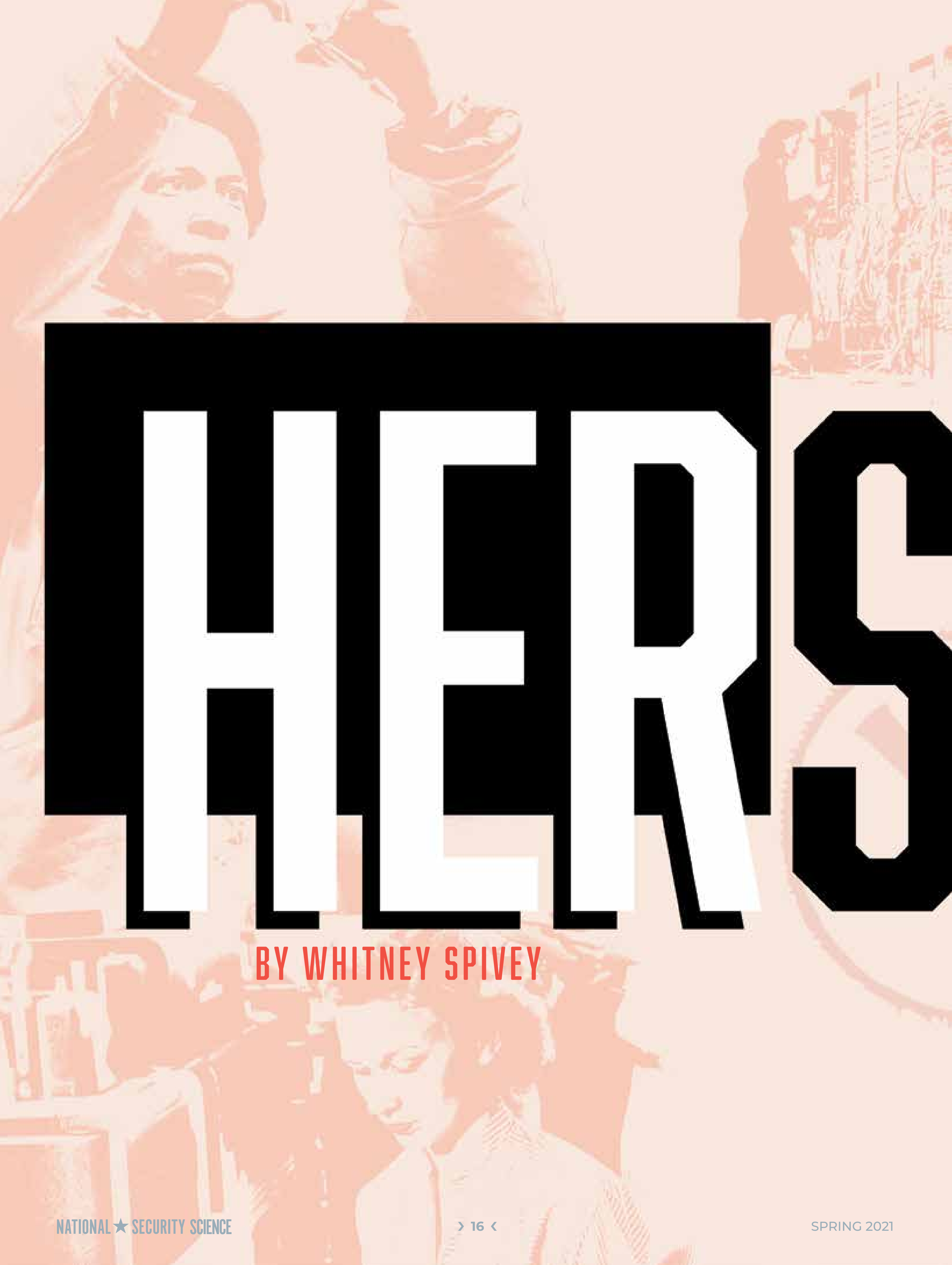
"Everyone is responsible for safety, and a questioning attitude about safety is crucial," Mullen says. "This incident was avoidable, which sounds trite, but it is true. We all should question our assumptions about what can go wrong in our work." ★

A version of this article was published by the NNSA in December 2020.

QUOTED

"When I became an assistant group leader, I heard one man didn't much want to work for a woman. But the group leader reminded him he worked for his wife, and apparently that ended the discussion."

—Beth Plassmann of the Lab's Weapons Subsystem group, as quoted in the Laboratory's July–August 1974 issue of *The Atom* magazine ★



HERS

BY WHITNEY SPIVEY

BETTER SCIENCE =
BETTER SECURITY

For 78 years, women have helped the Laboratory successfully execute its national security mission.

STORY

Women have always been a crucial part of the Laboratory workforce—because of their contributions to national security and because they've helped the Lab evolve into a more inclusive place to work.

IN 1944, CHEMIST Lilli Hornig conducted plutonium research at Project Y—the Los Alamos, New Mexico, branch of the Manhattan Project—where she was physically segregated from her male colleagues. "I worked in a cubbyhole … I was really just cut off from everything else," she told a Laboratory historian many years later. "I don't know if that was because we were women or because we were doing work that we had to be segregated, but I suspect the former because it wasn't the only place that it happened to me."

Hornig felt that many men at that time were "not fond of women scientists generally" and often treated them as assistants rather than equals. "I was being asked to produce the readings, the data would go to someone else," she remembered. "If I asked questions, that was all right … but I never engaged anybody in what we could call a technical discussion, and I resented that very much … I was unhappy, and that was the working situation."

Although common, this working situation was not true for all women at Los Alamos in the early days. In 1943, for example, nuclear physicist Jane Hamilton Hall received a raise "to bring her salary in line with those of comparable physicists," according to her division leader. In 1946, Hall's performance review states that she was "not of secondary importance" on a project that she worked on with her husband. Hall went on to become the Laboratory's first female assistant director.

During the Manhattan Project, 640 women worked at Los Alamos—about 11 percent of the total workforce. Today, women comprise 34.9 percent of the Lab's workforce—3,311 of 9,493 employees. Women hold nearly a third of management positions, and women are 20.4 percent of the professional research and development workforce.

The following timeline highlights notable women at the Laboratory and their achievements, as well as changes in federal legislation and the workplace that continue to make Los Alamos a great (but always improving) place for women to work.

WOMEN'S ARMY CORPS

1943: The first Women's Army Corps (WAC) detachment arrived in Los Alamos on August 24, 1943. A significant portion—about 40 percent—of women employed at Los Alamos through the end of the Manhattan Project were members of the WAC and were commonly referred to as "WACs". At its peak in August of 1945, the Los Alamos detachment had about 260 WACs. Many worked as medical staff, cooks, and librarians; others took on roles traditionally held by men, such as drivers, supply clerks, researchers, and scientists. The detachment was deactivated on October 19, 1946.

1940

DOROTHY McKIBBIN

1943: Dorothy McKibbin was a 45-year-old single mother and bookkeeper when J. Robert Oppenheimer hired her to be the first point of contact for Manhattan Project scientists before they headed "up the hill" from Santa Fe to Los Alamos. Known as the "first lady of Los Alamos," McKibbin was stationed in a nondescript adobe building at 109 E. Palace Avenue in Santa Fe, a position she held until the office closed in 1963.

ELDA ANDERSON

1943: Physicist Elda Anderson joined the Laboratory after earning a doctorate from the University of Wisconsin–Madison. Working in the cyclotron group at Los Alamos, Anderson focused mainly on spectroscopy and neutron cross-section measurements. Her work led her to produce the Lab's first sample of nearly pure uranium-235.

MARY FRANKEL

1943: In the spring of 1943, Mary Frankel arrived at Los Alamos. With degrees in psychology and mathematics, Frankel became a junior scientist in the Computation group. She became an expert in using numerical methods to solve physical equations and was in charge of setting up the problems for the staff to run on desk calculators.

COMPUTERS

1943: In the 1940s, a "computer" was a person—usually a woman—whose job it was to perform calculations by hand, sometimes with the aid of a mechanical calculator. Women with degrees in mathematics and the sciences often took jobs as computers because of discrimination in their fields. Many of the women who became computers were vastly overqualified for their positions. At Los Alamos, approximately 20 computers worked in the Computation group by the end of the summer of 1943.

CHARLOTTE SERBER

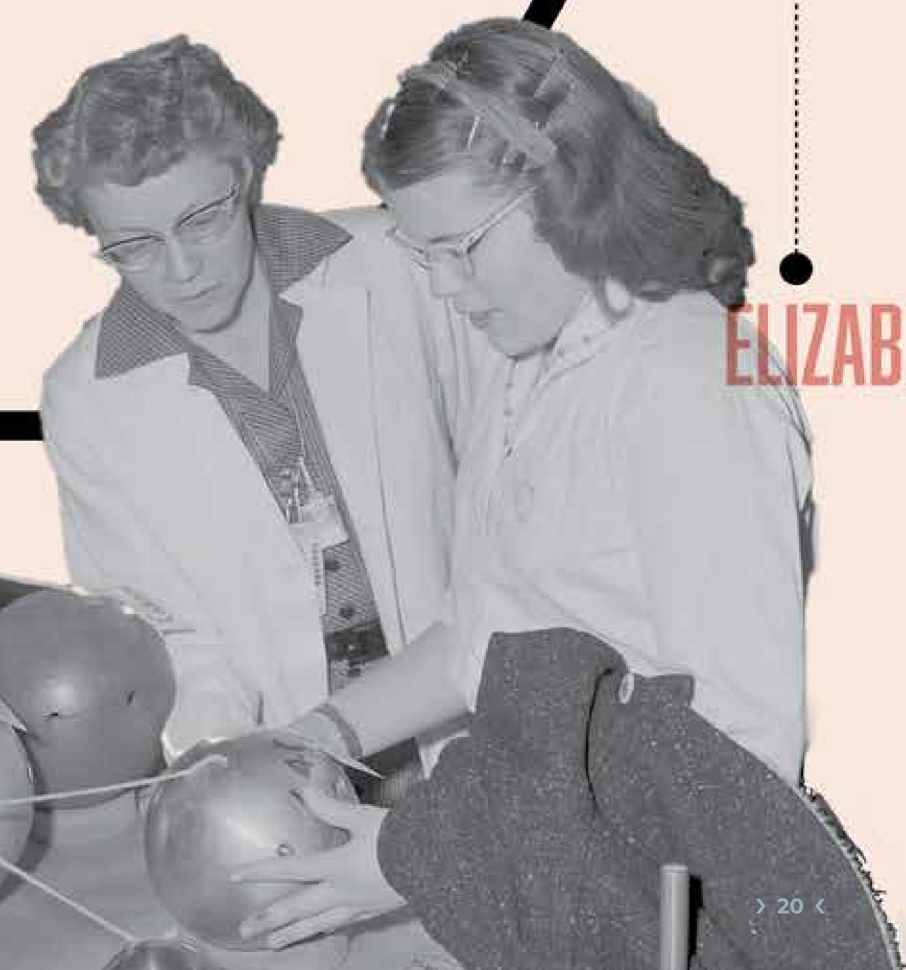
1943: Librarian Charlotte Serber was the only female group leader of the Manhattan Project. As such, she organized and protected secret documents in a space that featured a document room, a vault, and a ditto (copying) machine. In addition to its official purpose, Serber later said the library was a "center for gossip" and a "hangout" space.

JANE HEYDORN

1944: A Manhattan Project WAC, Jane Heydorn arrived in Los Alamos in 1944 and began work as a telephone operator, monitoring calls for leaks of classified information. She later developed bomb-testing equipment as an electronics technician and then went on to operate Clementine, the world's first fast-neutron nuclear reactor.

FRANCES DUNNE

1944: Explosives technician Frances Dunne was recruited to work at Los Alamos in 1944 and was part of the assembly crew for the Trinity test the following year. The only woman in the Explosives Assembly group, her small hands and manual dexterity were key because she could adjust weapons parts more easily than her male counterparts. (See p. 14 for more on Dunne.)



ELIZABETH GRAVES

1945: Nuclear physicist Elizabeth "Diz" Riddle Graves came to Los Alamos with her husband, Al Graves. Her primary work involved selecting a neutron reflector to surround the core of an implosion device. On July 16, 1945, Graves, then seven months pregnant, watched the Trinity test from a cabin 40 miles away. Five years later, she became a group leader in the Experimental Physics Division, where she researched neutron interactions with matter and material.

MARIA GOEPPERT MAYER

1945: German-born American theoretical physicist Maria Goeppert Mayer came to Los Alamos in 1945 to work with Edward Teller on the development of the atomic bomb. After World War II, Goeppert Mayer continued working with Teller at the University of Chicago and eventually developed a mathematical model for the structure of nuclear shells, for which she was awarded the Nobel Prize in Physics in 1963.

NORMA GROSS

1945: By May, Norma Gross was one of about 30 women included in the Lab's estimated 1,700 technical or scientific staff. Gross, a trained chemist with a master's degree, was stationed in Los Alamos as part of the WAC. Gross worked in the Chemistry and Metallurgy (CMR) Division, which conducted experiments that studied shockwave behavior to support the design of the Fat Man bomb. After the war ended, Gross was honorably discharged from the WAC, and the Lab hired her as an associate scientist in CMR.

BEVERLY WELLNITZ

1945: Beverly Wellnitz was a group secretary who quickly determined the technical staff members she supported could benefit from access to the work of their predecessors. Of her own initiative, she began meticulously processing and cataloging all the trackable classified documents passing across her desk. Today, these documents are referred to as the Wellnitz Vault and the highly respected Wellnitz Collection.

MARJORIE DEVANEY

1951: After earning a mathematics degree in 1931, Marjorie Devaney came to Los Alamos because it was one of the few places in the world with an electric computer. She joined the MANIAC (Mathematical Analyzer, Numerical Integrator, and Computer) group of the Theoretical Division as one of the MANIAC's first programmers, then called "coders." She went on to have a 40-year-long career at the Laboratory.

FLOY AGNES NARANJO LEE

1946: Floy Agnes "Aggie" Naranjo Lee, a member of New Mexico's Santa Clara Pueblo, worked as a technician in the hematology lab at Los Alamos. She collected and examined blood samples from Manhattan Project scientists, including Louis Slotin after he was exposed to a fatal dose of radiation in 1946. After the war ended, Enrico Fermi, with whom she played tennis, encouraged Lee to continue her studies at the University of Chicago. She eventually earned a doctorate in biology and went on to work at Argonne National Laboratory. In a Voices of the Manhattan Project interview, Lee described how Manhattan Project officials told the local public a cover story that Los Alamos was a "hideout for pregnant WACs. Santa Fe loved that story—they believed it," she said.

ARIANNA ROSENBLUTH

1951: Not long after she earned a doctorate in physics at the age of 21, Arianna Rosenbluth began working at Los Alamos in 1951. There, she verified analytic calculations for Ivy Mike—the first full-scale test of a thermonuclear bomb. Her ability to program early computers opened the door for a collaboration with physicists Marshall Rosenbluth (her husband), Nicholas Metropolis, Edward Teller, and mathematician Augusta Teller. Together they came up with the Metropolis algorithm, a technique for generating random samplings that is a foundation of understanding large quantities of data.

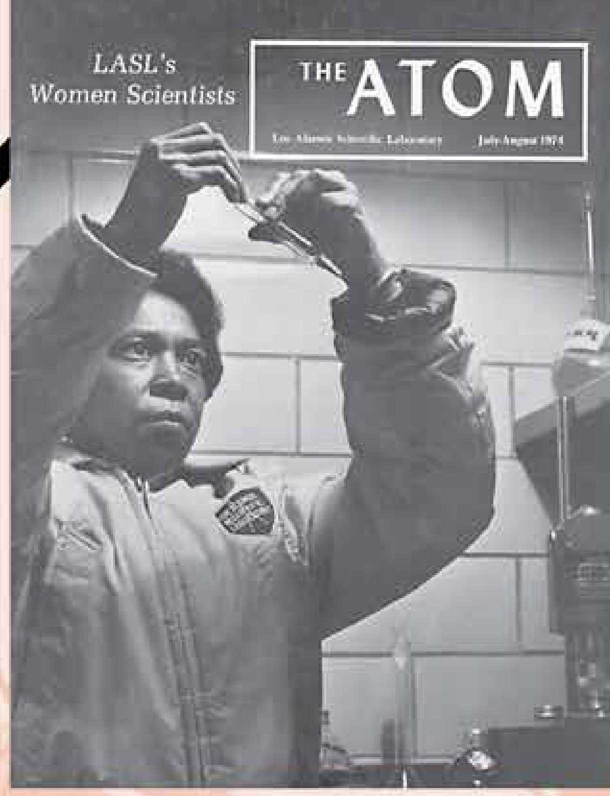
MARY TSINGOU

1955: Los Alamos scientists Enrico Fermi, John Pasta, and Stanislaw Ulam published "Studies of Nonlinear Problems," which detailed the methods and results of a mathematical physics problem run on the MANIAC, the Laboratory's first electronic computer. The problem, which launched the field of nonlinear science, was originally called the Fermi-Pasta-Ulam Problem, despite the fact that mathematician Mary Tsingou's programming of the MANIAC was imperative to the work. In 2008, members of the physics community renamed it the Fermi-Pasta-Ulam-Tsingou Problem to reflect Tsingou's involvement. For more on Tsingou, see the winter 2020 issue of this magazine.

1963: Congress passed the Equal Pay Act, which promised equal pay for equal work, regardless of the race, color, religion, national origin, or sex of the worker. The Equal Pay Act was the first U.S. legislation targeted to eliminate gender-based pay inequities, thereby ushering in a new norm of gender equality in the workplace.

1964: The Federal Civil Rights Act passed, including Title VII, which guaranteed equal opportunity (no discrimination) in employment. The Civil Rights Act also created the Equal Employment Opportunity Commission to enforce workplace equality.

1960



JULIA HARDIN

1964: African American biochemist Julia Hardin joined the Laboratory in 1964 to research and study mutations—genetic changes—that occur in DNA when it is exposed to radiation. "There was a big effort then to recruit blacks, and for the first time in my life it became obvious to me that I was a statistic," she said in 1984. "I've probably been a statistic here in Los Alamos, but I've never felt like one. With a personality and attitude like mine, you overcome color and people become people." Hardin later became the director of the Historically Black Colleges and Universities Education Program, and recruited many African American science and engineering students for summer internships at the Laboratory. For more on Hardin, see p. 75.

JANE HAMILTON HALL

1955: After working for the Manhattan Project in Hanford, Washington, nuclear physicist Jane Hamilton Hall joined the Laboratory in 1945. She and her husband, David, worked together on Clementine, the world's first fast reactor. In 1955, she became the Lab's first female assistant director, and in 1966, President Lyndon Johnson appointed her to the General Advisory Committee of the Atomic Energy Commission. For more on Jane Hall, see the October 2018 issue of this magazine or listen to the *National Security Science* podcast.

1965: President Lyndon Johnson's Executive Order 11246 prohibited sex discrimination by government contractors and required affirmative action plans for hiring women. The order also required contractors to "take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex or national origin."

1967: President Lyndon Johnson issued Executive Order 11375, which expanded affirmative action policies to cover discrimination based on sex. As a result, federal agencies and contractors must take active measures to ensure that women, as well as minorities, have the same employment and educational opportunities as men.

1979: Chemist Darleane Hoffman came to Los Alamos with her husband, a physicist, in 1953. "There is often some initial shock when I am introduced, and Dr. D.C. Hoffman turns out to be a woman," she told *The Atom* magazine in 1974. "But so often, I think it is not so much discrimination as the bald fact that too many girls are trained from grade school in the belief that there are certain suitable occupations for women and that they should aspire no further. I think it is appropriate for girls to develop appropriate images so they don't think of women scientists as freaks. You can follow a scientific career and still have a home and family."

In 1979, Hoffman became the first woman to lead a scientific division—the Chemistry and Nuclear Chemistry Division—and in 1993, while working at Lawrence Berkeley National Laboratory, she helped confirm the existence of element 106, seaborgium. In 2014, she was honored with the Los Alamos Medal, the highest award given by the Laboratory. Read more about Hoffman on p. 12.

DARLEANE HOFFMAN

1970

1973: August 26 became Women's Equality Day. The date was selected to commemorate the 1920 certification of the 19th Amendment to the Constitution, which granted women the right to vote. The day recognizes women's continuing efforts toward equal rights for all citizens.

19

1978: The Pregnancy Discrimination Act banned employment discrimination against pregnant women. The act also mandated that employers provide the same benefits to women at any stage of pregnancy, delivery, or recovery from delivery when they are medically unable to work as to all other employees with temporarily disabling conditions.

1980: President Jimmy Carter designated March 2–8 as National Women's History Week. "From the first settlers who came to our shores, from the first American Indian families who befriended them, men and women have worked together to build this nation," Carter said in his message to the nation. "Too often the women were unsung and sometimes their contributions went unnoticed. But the achievements, leadership, courage, strength, and love of the women who built America was as vital as that of the men whose names we know so well."

1987: Congress declared the entire month of March as National Women's History Month. A special presidential proclamation is issued every March that honors the achievements of American women.

1990

1993: The Family and Medical Leave Act (FMLA) went into effect for large employers, who must grant a maximum of 12 weeks of unpaid, job-protected leave to expecting employees for the birth or adoption of a child. Not only did the FMLA Act protect women's jobs should they decide to have a baby, it also left the FMLA open to men should they want to take leave or remain home to care for a spouse, child, or parent with a serious illness.

JILL TREWHELLA

1995: Jill Trewhella was named the first female Laboratory Fellow in 1995 after coming to Los Alamos in 1984 to launch a biological neutron-scattering program. Fellows are limited to 2 percent of the Laboratory's technical staff. Upon naming her leader of the Lab's Bioscience Division in 2000, Lab Director John Browne said, "Jill is one of those unique scientists who come along only about once every decade, who combine their passion for science with their excellence in research and their leadership skills to make a true difference in an organization."

Other female Lab Fellows are **Michelle Thomsen** (1997), **Merri Wood-Schultz** (2001, see p. 30), **Bette Korber** (2002, see p. 26), **Carol Burns** (2003, see p. 27), **Jane Nordholt** (2006), **Joyce Guzik** (2006, see p. 30), **Antoinette Taylor** (2009), **Brenda Dingus** (2011), **Cheryl Kuske** (2013), **Jaqueline Kiplinger** (2014), **Jennifer Hollingsworth** (2016), **Dana Dattelbaum** (2019, see pp. 29, 45), **Anna Hayes** (2019, see p. 46), **Laura Smilowitz** (2019, see p. 64), and **Vania Jordanova** (2020).

80

TINITIA OLIVER

1987: Tinitia Oliver started at Los Alamos in 1987 as a radiation control technician and has since worked as a maintenance coordinator, team leader, and currently as a work execution manager. Oliver oversees seven craft superintendents, and together they manage the craft teams—carpenters, painters, electricians, pipefitters, mechanics, laborers, insulators, and sheet metal workers—who maintain Lab facilities.

1999: Earle Marie Hanson joined the Laboratory in 1976 after receiving a doctorate in chemistry from the Massachusetts Institute of Technology. She made many significant contributions to weapons engineering and, from 1999–2003, served as the first female division leader of an engineering division—the Engineering Science Applications Division—where she oversaw approximately 900 full-time employees.

EARLE MARIE HANSON

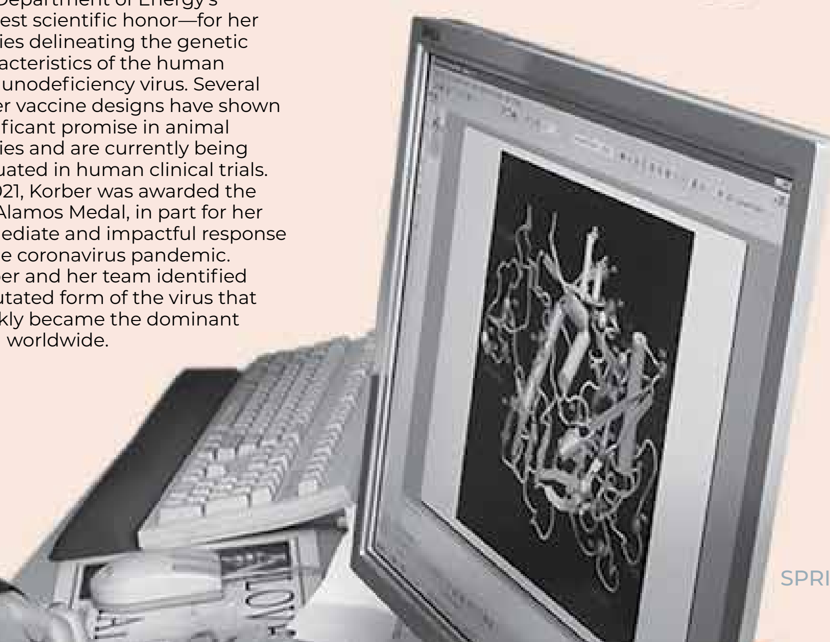
2000

CAROLYN MANGENG

2003: Program manager Carolyn Mangeng studied energy and environmental assessments, military systems, and nuclear weapons before serving as deputy associate director of the Nuclear Weapons directorate from 2002–2003, during which time she had specific oversight of stockpile management activities. She became Los Alamos' first female deputy Laboratory director (acting) in 2003 and worked as the deputy associate director for Environmental Programs before her retirement in 2006.

BETTE KORBER

2004: Theoretical biologist and Laboratory Fellow Bette Korber has spent her career understanding viral evolution and vaccine design. In 2004, she received the E. O. Lawrence Award—the Department of Energy's highest scientific honor—for her studies delineating the genetic characteristics of the human immunodeficiency virus. Several of her vaccine designs have shown significant promise in animal studies and are currently being evaluated in human clinical trials. In 2021, Korber was awarded the Los Alamos Medal, in part for her immediate and impactful response to the coronavirus pandemic. Korber and her team identified a mutated form of the virus that quickly became the dominant form worldwide.



MY HANG HUYNH

2007: My Hang Huynh received an E. O. Lawrence Award from the Department of Energy for her exceptional work in chemistry. Huynh was also named a MacArthur Fellow for her development of novel techniques for synthesizing highly energetic compounds, such as explosives, that substitute benign elements for environmentally toxic heavy metals and improve the safety of workers and military personnel who handle these materials.

2010: The Affordable Health Care Act was signed into law. Under this law, private health insurance companies must provide birth control without co-pays or deductibles. The law also requires private insurance companies to cover preventive services.

PATTI BUNTAIN

2012: In 2012, Patti Buntain was named the first female manager of a life extension program (LEP) at Los Alamos. (LEPs address aging and performance issues in nuclear weapons; Buntain was involved with the B61 gravity bomb LEP.) Buntain earned a degree in mechanical engineering from the University of New Mexico and has held several positions in the Laboratory's Weapons programs. In 2014, she received the Order of the Nucleus Award from the U.S. Air Force, which is given to individuals who have made a significant contribution to the Air Force nuclear enterprise.

2010

KARISSA SANBONMATSU

2005: Biophysicist Karissa Sanbonmatsu is a transgender woman who researches how DNA is reprogrammed during life, how genes are switched on and off, and how gigantic RNA molecules affect the switches. In 2012, Sanbonmatsu and her team published the first structure of such a molecule. In 2005, Sanbonmatsu became the first woman at the Laboratory to receive the Presidential Early Career Award in Science and Engineering.

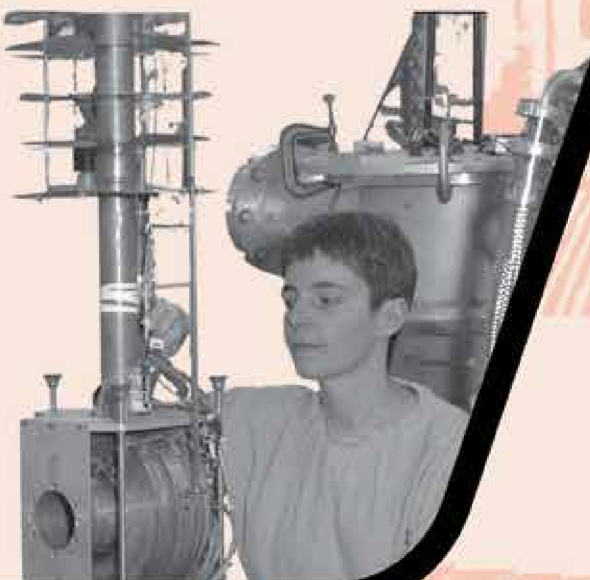
The award, established by President Bill Clinton in 1996, is the highest honor bestowed by the United States government on science and engineering professionals in the early stages of their independent research careers. Additional winners from Los Alamos include: **Jennifer Martinez** (2007), **Evgenya Simakov** (2010), **Amy Clarke** (2011), and **Abigail Hunter** (2018).

CAROL BURNS

2013: Chemistry Division Leader Carol Burns was named Deputy Principal Associate Director for the Science, Technology, and Engineering (STE) directorate. Today, Burns is the executive officer for the STE directorate. Burns was raised in Los Alamos and said her appreciation for "the eminent women we see throughout the history of Los Alamos" started with her schoolmates' moms who were employed at the Lab.

SUSAN SEESTROM

2013: Physicist Susan Seestrom joined the Lab in 1986 as a nuclear physicist and eventually became the first woman leader of the Physics Division and the Weapons Physics directorate. In 2013, she was the first woman to become a Senior Fellow at the Laboratory. Seestrom is also the first (and only) woman to chair the Nuclear Science Advisory Committee for both the Department of Energy and the National Science Foundation.



CAROLYN ZERKLE

2018: Carolyn Zerkle became the Laboratory's executive director on January 1, 2018.

Previously, Zerkle was the associate director for the Business Innovation directorate, a new organization at the Lab that combined business services and information technology to enhance efficiency and bolster quality and speed of service. "I really think we're seeing this seismic shift—not only at the Laboratory, but throughout the country," she says. "We're seeing positions where, previously, women weren't represented in any real way to seeing them in sizeable numbers and in positions of power and authority. It's heartening to witness and is a trajectory that I think will continue."

2017: In an ongoing effort to support employee health and wellness, Mamava pods, which provide privacy for nursing mothers, were installed at locations across the Laboratory. Los Alamos was the first place in New Mexico to install a Mamava pod, which is essentially a prefabricated unit equipped with electrical outlets, USB ports, benches, tabletops, motion-activated lighting and vents. The Fair Labor Standards Act states that large employers are required to provide adequate time and space for nursing employees to express milk.

2016: The Laboratory was named for the first of several times as a top-50 employer for Latina women by *Latina Style* magazine. "If you had told me as a young Hispanic girl growing up in Northern New Mexico that I would one day serve in an important role for a world-renowned institution in support of the national security mission, I would have thought it unattainable," says Human Resource's Leah Sanchez (pictured in the white jacket with Tatiana Espinoza of the Environmental Stewardship group). "Los Alamos National Laboratory provided me that opportunity."

2018: A dedicated phone number was created to report sexual harassment, and a Sexual Harassment Officer was appointed to facilitate the investigation process. Shortly after becoming Laboratory director, Terry Wallace reiterated the Laboratory's zero-tolerance sexual harassment policy and encouraged anyone experiencing harassment in the workplace to speak up. "Under no circumstances should anyone be made to feel like they are at risk for reporting something that never should have happened in the first place," he said.

NANCY JO NICHOLAS

2018: As the Lab's first female principal associate director, Nancy Jo Nicholas led Laboratory programs with a special focus on developing and applying the scientific and engineering capabilities to address complex national and global security threats. "I'm surrounded by strong, intelligent, and dedicated women at the Lab all the time," she says. "To see women rise to leadership positions seems really natural to me, and I'm glad I can be part of it." Nicholas is currently the associate Laboratory director for Global Security; read more about her career on p. 6.

2018: Laboratory employees who become new mothers receive paid maternity leave. (Previously, they were required to use sick time and go on disability.)

2019: The Director's Diversity Council is formed. The council, which comprises the chairs from the Laboratory's various employee resource groups (including Atomic Women—see p. 5—and the Women's Employee Resource Group), meets quarterly with senior leadership. "We try to make diversity part of how we manage the Lab," explains Frances Chadwick, Laboratory staff director.

2019: Paid parental leave is now available to parents (women and men) when they have a baby or adopt a child. "Bringing a new child into your life is an important event," said Laboratory Director Thom Mason. "Recognizing that you need time to bond with your new family member, I am pleased to introduce a new paid parental leave benefit. This valuable benefit is being introduced to help address the needs of our workforce and to make Los Alamos National Laboratory one of the best places to work."

BARBARA LYNN

2020: Human resources generalist Barbara Lynn was appointed to the Public Safety and Law Enforcement subcommittee of the New Mexico Governor's Council for Racial Justice. The council was formed by New Mexico Governor Michelle Lujan Grisham to monitor state institutions and as they take action to end systemic racism, and to ensure that all people receive fair and equal treatment and opportunities. Lynn is a former director of the Office of Equal Opportunity Services at Los Alamos.

2021: The Laboratory enhanced its benefits program to cover preauthorized infertility treatments. "Employees have expressed interest in this benefit for years, and we are excited to now provide it with no significant impact to rates," says Melinda Olswang, Human Resources Benefits group leader.

TODAY

FRANCES CHADWICK

2018: When Triad National Security, LLC, took over the Lab contract in November, Frances Chadwick became the Laboratory's staff director. In this role, she manages the organizations that report to the director's office—Legal, Communications and External Affairs, Audit and Ethics, Counterintelligence, and the Office of National Security and International Studies.

2018: Los Alamos became the first national laboratory to join Gender Champions in Nuclear Policy, which brings together heads of organizations working in nuclear policy who are committed to breaking down gender barriers and making gender equality a working reality in their spheres of influence.

DANA DATTELBAUM

2021: In January, Dana Dattelbaum received an E. O. Lawrence Award for her contributions to the Department of Energy's national security and nonproliferation missions. Dattelbaum was honored for her "transformative scientific and intellectual achievements," including providing physical insights into shock and detonation physics, developing the equations of state of a spectrum of energetics and polymers, and providing critical data for hydrodynamic simulations essential to the nuclear weapons program. For more on Dattelbaum, see p. 45.

BETTER SCIENCE = BETTER SECURITY

The modern Stockpile Stewardship Program incorporates legacy data from underground nuclear tests to help evaluate the health of nuclear weapons.

◆ The Divider test rack is hoisted into position for lowering down-hole at the Nevada Test Site in September 1992. Divider was the last full-scale underground nuclear test conducted by the United States.

BRIDGING DIVIDER

Four Los Alamos women share their memories of working at the Laboratory during the early 1990s—when, to maintain its nuclear weapons stockpile, the Lab pivoted from underground nuclear testing to small-scale, non-nuclear experiments.

BY VIRGINIA GRANT

On September 23, 1992, at the Nevada Test Site (now the Nevada National Security Site), an underground nuclear test named Divider was conducted by Los Alamos National Laboratory. The test was the 1,054th nuclear test executed by the United States; it was also the last.

From July 16, 1945, when the world's first atomic device was detonated at the Trinity site, to a period of test preparation that continued after Divider, Los Alamos was the world's top producer of nuclear weapons tests. Among the many Los Alamos scientists, engineers, and workers who made those 1,054 tests possible were Merri Wood-Schultz, Wendee Brunish, Lynne Kroggel, and Joyce Guzik—experts not only in nuclear testing, but also in the development of methods, tests, strategies, and ideas for how to maintain weapons superiority and national security in the decades since testing ended.

Thawing the Cold War

Between 1945 and 1992, the Soviet Union and the United States combined conducted 1,769 nuclear tests. Nuclear devices, sometimes more than one per test, were detonated from towers (as in the Trinity test), underwater, in the air after being dropped by aircraft, and even in outer space. Although the

Limited Test Ban Treaty of 1963 banned nuclear weapons testing in space, the atmosphere, and underwater, underground nuclear tests continued for almost three decades afterward.

The end of the Cold War, solidified by the fall of the Soviet Union in 1991, gave a sense of relief to Americans, who had been wrought with anxiety since the launch of the Soviet satellite Sputnik in 1957. The end of the Cold War also enabled the long-sought ban on nuclear weapons testing that had been a back-and-forth between the United States and the Soviet Union for decades.

“THE DIAGNOSTICS GIVE YOU A PEEK INSIDE OF WHAT IS HAPPENING.”

—MERRI WOOD-SCHULTZ

In 1991, the Soviet Union announced a moratorium on all nuclear testing. The United States made its own similar announcement soon thereafter, and each country began to ramp down its testing schedule. The Soviet Union conducted its last nuclear test on October 24, 1990, the United States ended its testing with Divider.

The United States and 70 other countries signed the Comprehensive Nuclear-Test-Ban Treaty (CTBT) on September 24, 1996; currently, the CTBT has the signatures of 185 states. Of those 185, 16—including the United States—have not ratified the treaty.

Amid all of this political back and forth, Los Alamos scientists and engineers worked tirelessly to maintain American superiority in nuclear weapons development and to make sure the U.S. nuclear stockpile was safe, secure, and effective, both during and after testing. Los Alamos scientists from many different backgrounds, including women such as Wood-Schultz, Guzik, Brunish, and Kroggel, conducted a great deal of this work at Los Alamos and Nevada.

Testing nuclear weapons

“I was recruited as part of the affirmative action program,” says Wood-Schultz, a physicist and Laboratory Fellow who was lead designer for six nuclear tests and co-leader on a seventh. Wood-Schultz was a doctoral student in physics at Georgia Tech in 1977 when a recruiter began to talk with her about jobs at Los Alamos. After an initial visit, she was hired before she even completed her doctorate. “Affirmative action got me the interview, but I don’t believe it got me the job,” she says. She was thrilled both for the scientific opportunities and the opportunity to work at the laboratory that had, she believed, saved her father and other soldiers in World War II from being killed in Japan. Wood-Schultz’s career at Los Alamos began in the theoretical design of weapons, which quickly became her specialty.

In April 1984, Brunish arrived in Los Alamos with a Ph.D. in astrophysics. She went to work on the containment of underground tests, making sure that no radiation would leak from underground when the tests were detonated. Radiation leakage, known as venting, was prevented by studying the geophysical properties of the test site and determining the best method of stemming—the process of filling in the hole around the test rack (a giant metal structure that held the test device and its diagnostics).

Work in containment wasn’t the stretch from astrophysics that it might seem; the Los Alamos containment program was officially started in 1970 by astrophysicist Bob Brownlee, whom Brunish describes as “a mentor to all of the Los Alamos containment scientists who came after him.” From that point forward, it was common for astrophysicists to work in the program. “In astrophysics,” Brunish explains, “you’re basically looking at nuclear processes in stars and how that affects what’s going on around them; in underground testing, you’re looking at nuclear processes in the weapon and what’s going on around that.”

After graduating from the New Mexico Institute of Mining and Technology, Kroggel began her career at Los Alamos in 1986 as a contractor with a subsidiary of Pan Am Corporation that provided a number of support services to the Laboratory, such as engineering and maintenance. Working as a quality engineer, Kroggel traveled often to the Nevada Test Site to inspect items used in underground testing.

In 1987, Guzik, another astrophysicist, began working at Los Alamos as a doctoral student under the mentorship of others in testing, including Wood-Schultz. After being taken on tours of the Nevada Test Site and being apprenticed in nuclear testing, Guzik became a staff scientist in 1989 and was part of the last generation of scientists to work on nuclear tests.

Firing a shot

An underground nuclear test has a particular sequence of events. First, the nuclear device detonates, creating a shock wave that emanates from the device. In less than a second, the container of the device and all the rock around it are vaporized, creating a cavity where the detonation occurred. The shockwave travels beyond that cavity, crushing rock until its force decreases and it dies out. A few seconds later, the molten rock around the detonation cavity settles in the bottom of cavity, where it begins to cool and solidify. Finally, the gas created by the pressure of the detonation begins to decline, and the rock around the cavity collapses, then a chimney is created by the progression of a rubble column up through the hole and the surrounding geologic material. This last event usually only takes a few hours, but it can take up to several months. Once the test site has stabilized, scientists can retrieve their diagnostic equipment to study the data of the explosion.

But before any of this could happen, there were months of careful planning, negotiation, and collaboration. Each test was a huge cooperative effort across disciplines at the Laboratory.

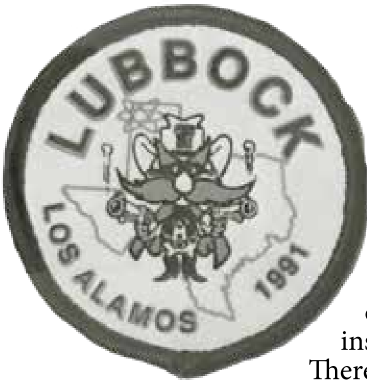
“The rack drove the schedule,” Wood-Schultz remembers. “Without the rack, nothing happened.” The rack, which could be as big as 10 feet in diameter and 100 feet tall, was loaded with the nuclear device itself and all the diagnostic equipment used to study the explosion and its effects.

“I was on top of one” for the test named Amarillo, Kroggel says. “They were preparing it to go down-hole, and we stood on top of it.” The racks were lowered far into the ground, sometimes as deep at 4,000 feet below the surface—that’s a hole more than twice as tall as One World Trade Center in New York City.

“From a designer standpoint,” Wood-Schultz says, “you do the test to get the diagnostics.” For an underground test, those diagnostics could vary widely, from seismic

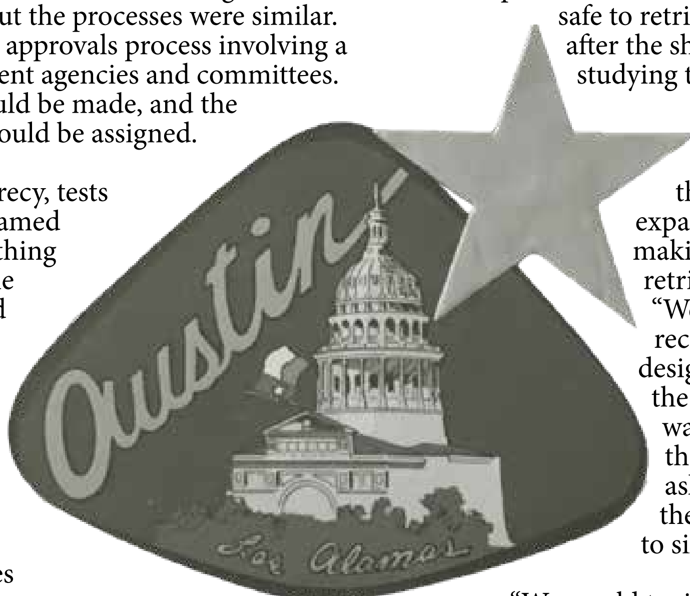
“I WOULD LOOK SPECIFICALLY AT ORDERS TO ENSURE WE HAD THE CORRECT ENGINEERING STANDARDS TO MEET THE REQUIREMENTS PUT FORTH BY THE RACK ENGINEERS.”

–LYNNE KROGGEL



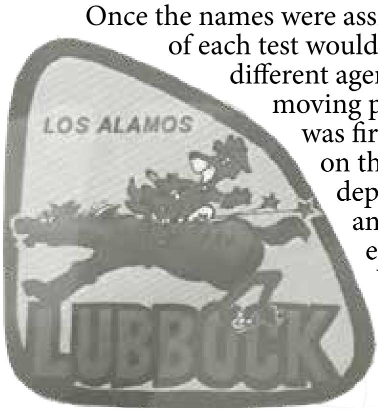
readings to measurements of gamma-ray output. "Part of those diagnostics is having the yield [size] of the explosion, which is certainly necessary, but the diagnostics give you a peek inside of what is happening. There are different ways of looking at things, depending on how you design your diagnostics."

For underground nuclear tests, the designs could be radically different, but the processes were similar. There was a detailed approvals process involving a number of government agencies and committees. Then a schedule would be made, and the names of the tests would be assigned.



For security and secrecy, tests were purposefully named to distract from anything actually related to the tests themselves, and they were usually grouped together by subject. Divider, for example, was a name chosen from a list of tools. At one point, Los Alamos chose names of wine grapes while Lawrence Livermore National Laboratory, which also conducted underground nuclear tests, paired those names with a series of tests named after cheeses. Wood-Schultz requested that the name Amarillo, one of a series of Texas city names, was assigned to a shot she was working on because, she says, "every time we drove through Amarillo, our car would break down."

Once the names were assigned, the specific designs of each test would begin. Different teams had different agendas, and there were many moving parts before the shot—the test—was fired. The different diagnostics on the rack changed frequently depending on time, budget, and priority. "We couldn't put everything on every shot," Wood-Schultz explains. "So if there was something that was really needed, someone could make the case for why that diagnostic would be particularly valuable in this particular shot." Management would make tradeoffs for what some shots could or could not have, and all the diagnostics had to be determined and designed before the engineers could design and build actual racks.



▲ Each test had its own logo, which was often printed on patches.

For Brunish, the focus was on containment—making sure no radiation whatsoever leaked above ground from the test. "The Nevada Test Site was a big, dreary, barren area with crappy dorms," she says, "but I loved going out there. The work was so fun, and it was really exciting." As a containment physicist, Brunish was responsible for telling the other scientists when it was safe to retrieve their data from the equipment after the shot. Part of containment was studying the data transmitted through cables embedded in the material packed into the test hole. Brunish studied that data to determine whether the cavity around the rack, which expanded at detonation, had collapsed, making the area safe for scientists to retrieve their diagnostic equipment. "We'd be in this big war room," she recalls, "with all these controllers and designers and diagnostics physicists, and the shot would go off and we would wait about five or ten minutes, and then everyone would turn to me and ask, 'When can we go back in?'" To their dismay, the wait was usually two to six more hours.

"We would typically be about 10–20 miles away when the shot went off," Brunish says, "but you could feel the ground move." To scare away animals, such as antelope, that might walk over the site as the ground started to move, very loud horns would sound right before the shot.

Guzik was present for one particularly dangerous incident. During the 1990 test named Houston, she says, "we saw a guy walking out to ground zero right before we were going to fire the test. Some protesters had shown up at the test site, hiked in from somewhere, and were going to stand on ground zero and try to stop the test." The test had to be placed on hold for a few hours while police came to remove the protesters.

Guzik was an apprentice designer in training for much of her work in testing, and she became a staff scientist in the last few years of testing. She

"WE WERE PUSHING CUTTING EDGE PHYSICS AND DESIGN, AND WE WERE REALLY CONTRIBUTING TO MAKING OUR NATION AND THE WORLD SAFER."

–WENDEE BRUNISH

modeled data from previous and related tests and then compared that data to tests happening at the time. Guzik also helped decide some specific testing features, such as the masses and compositions of particular materials used in the tests.

As a quality engineer, Kroggel examined testing equipment, checking the components used to build the tests and making sure they were ready before the shot was fired. "I would look specifically at orders" of materials for the tests, she says, "to ensure we had the correct engineering standards to meet the requirements put forth by the rack engineers." For example, for a specific type of rope needed for testing, she says, "I would get on a flatbed and actually look at that wire rope."

Wood-Schultz worked in design, determining how to achieve the desired data from a given nuclear test. Some tests were performed to determine something specific about the stockpile; others were performed to learn something about physics. "A test that was associated with a stockpile device," Wood-Schultz explains, "could serve as a partial demonstration that it would satisfy the military requirements placed on it, and the resulting data would contribute to an assessment of the reliability of the available simulation capabilities to predict the operation of that device."

Wood-Schultz preferred the physics tests, which gave her the opportunity, she says, "to try to look at something from a different angle so that I can either get new information or an unrelated look at the sorts of things that we don't understand." So the products of testing were often related to weapons development or national security, but they also often produced advances in more fundamental science.

The end of an era—and a career path

"When I interviewed to become a staff scientist, back in 1977," Wood-Schultz says, "they brought up the issue that not everybody was in favor of testing and the ability to test might go away. So that was there from day one."

No one was shocked when testing ended; some were, however, surprised when it didn't resume. "Most of us thought the moratorium would last a year," says Brunish. "We didn't think it would be forever."

For some time after Divider, Los Alamos continued to plan for future tests. In fact, one of the last tests Guzik worked on remained on the schedule for years after Divider. "A lot of people thought I should leave" the Laboratory when testing ended, she remembers, "because I was early in my career. But I didn't want to leave."

Men prepare the Divider test rack at the Nevada Test Site. Photo: National Archives

◆ Preparations are made for the Amarillo test, which was detonated on June 27, 1989.

She recalls learning that, of the many different types of weapons in the stockpile, after testing, all were to be discarded except for about seven. "That was going to be our work," she remembers, "to maintain those seven or so systems" without underground testing.

This work became known as the Stockpile Stewardship Program, the program that continues today at Los Alamos as the Laboratory's primary mission. "In conjunction with historical nuclear test data," Wood-Schultz explains, "this program develops and utilizes enhancements in research, non-nuclear explosives tests, and computer simulations to support and certify the nation's nuclear stockpile without nuclear explosive testing." The primary techniques of stockpile stewardship were already used alongside nuclear testing long before the moratorium. Now they are the primary means of determining the validity of the weapons in the stockpile.

Many of the scientists who worked on nuclear testing transitioned to work in stockpile stewardship. That transition was natural for many employees, including Wood-Schultz. She began working on quantifying uncertainty—looking at the small components of a larger issue and determining the degree of uncertainty in those individual components, plus the uncertainty that results from a comprehensive study of those parts combined. "That became even more important when we didn't have a final integrated test," she says. "Determining whether a bomb will work without testing it is a much harder job because every little thing has its own uncertainty, and they all add up."

For Brunish, the transition from testing to other national security work was mostly organic. "When I was working on underground nuclear tests, I had to understand how the rock would be affected, what the phenomena of the test would look like," she says. "When we stopped testing, we flipped that and said, 'If China or India is testing, what signals will come out of that nuclear test? How can we detect what another country is doing?'" Brunish used data and knowledge of American nuclear tests to examine what other countries were doing to learn about whether they were testing and, if so, what kinds of tests they were conducting.

WHAT IF A COUNTRY HAS X AMOUNT OF PLUTONIUM? WHAT COULD THEY MAKE WITH IT?"

–JOYCE GUZIK

Guzik's current work is similar. "We are trying to figure out what countries could be doing or what their stockpiles look like," she explains. Her team looks at data from old U.S. nuclear tests of the 1950s, 1960s, and even 1970s as models of the earliest nuclear test data. "Those are predecessors to modern, more advanced designs," she says, "so another country might go through that same phase." Looking for data that resembles later American tests might cause intelligence agencies to miss nuclear testing in countries with nascent nuclear programs. Guzik and her colleagues also hypothesize what countries might be able to accomplish by looking at what the United States was able to do in the earlier years of nuclear weapons. "What if a country has X amount of plutonium? What could they make with it? I've been having a great time working in that more creative area."

For Kroggel, the end of testing marked a significant transition in her career—she moved from contractor with Pan Am to a quality engineer working directly for the Laboratory. "I became the Department of Energy technical quality standards manager for the Lab at that time," she says.

When testing was no longer an option, ensuring the efficacy of the nuclear stockpile without testing became of the utmost importance. "Anything not in its lowest energy state," such as a nuclear warhead, Wood-Schultz explains, "is not going to stay stable. That doesn't mean it will blow up," she says, but the molecules of it will naturally change. "That aspect of the work kept going after testing."

In support of stockpile stewardship, Laboratory scientists and engineers develop modern methods, such as plutonium aging models, and experiments to determine the efficacy of the current stockpile. Based on the data collected from those methods and experiments,

together with data from past nuclear tests, the weapons in the stockpile may undergo life-extension programs to address aging and performance issues, enhance safety features, and improve security. Los Alamos may also conduct alterations (changes to a weapon's systems, subsystems, or components) and modifications (changes to a weapon's operational capabilities).

"The stockpile will eventually be composed of updated systems that have never been fully tested," Guzik says. But through stockpile stewardship, Los Alamos rigorously examines these updated weapons without nuclear testing to ensure they are as safe, secure, and effective as the older, tested weapons.

Legacies

Wood-Schultz, Brunish, Kroggel, and Guzik have all paved the way for the many women who currently work in weapons at Los Alamos. For example, "One of my goals was to be the first female chair of the Containment Evaluation Panel," says Brunish of the position she currently holds. The panel, which used to assess and review the containment plans of an underground nuclear test, is now called the Containment Evaluation Review Panel and continues to evaluate experiments. "We evaluate any activities at the Nevada National Security Site that involve explosives and special nuclear materials," Brunish says. "There is currently a very active subcritical experiment program at the site, and we rigorously review all of those experiments prior to execution."

On being a woman in a male-dominated field, Wood-Schultz looks back, "It was easier for me than it might have been for other people because there weren't many women at Georgia Tech; I started just a couple of years after they started admitting women."

The later generation of women in testing had mentors to emulate. "I didn't really think of it as a male-dominated field because there were always women around me," Guzik says. "Merri Wood-Schultz was definitely a mentor to me." Guzik once observed Wood-Schultz overseeing the assembly of a device before a test. "She modeled what you need to do, how you can't stand around and be passive when observing an assembly," Guzik recalls. "I hung on every word. I did the same thing later myself." Wood-Schultz told Guzik and other young scientists stories of times that she asked what she thought was a "dumb" question only for it to lead to an engineer realizing a mistake needed to be corrected. "I now have some of these stories of my own to pass on," Guzik says.

The future of national security

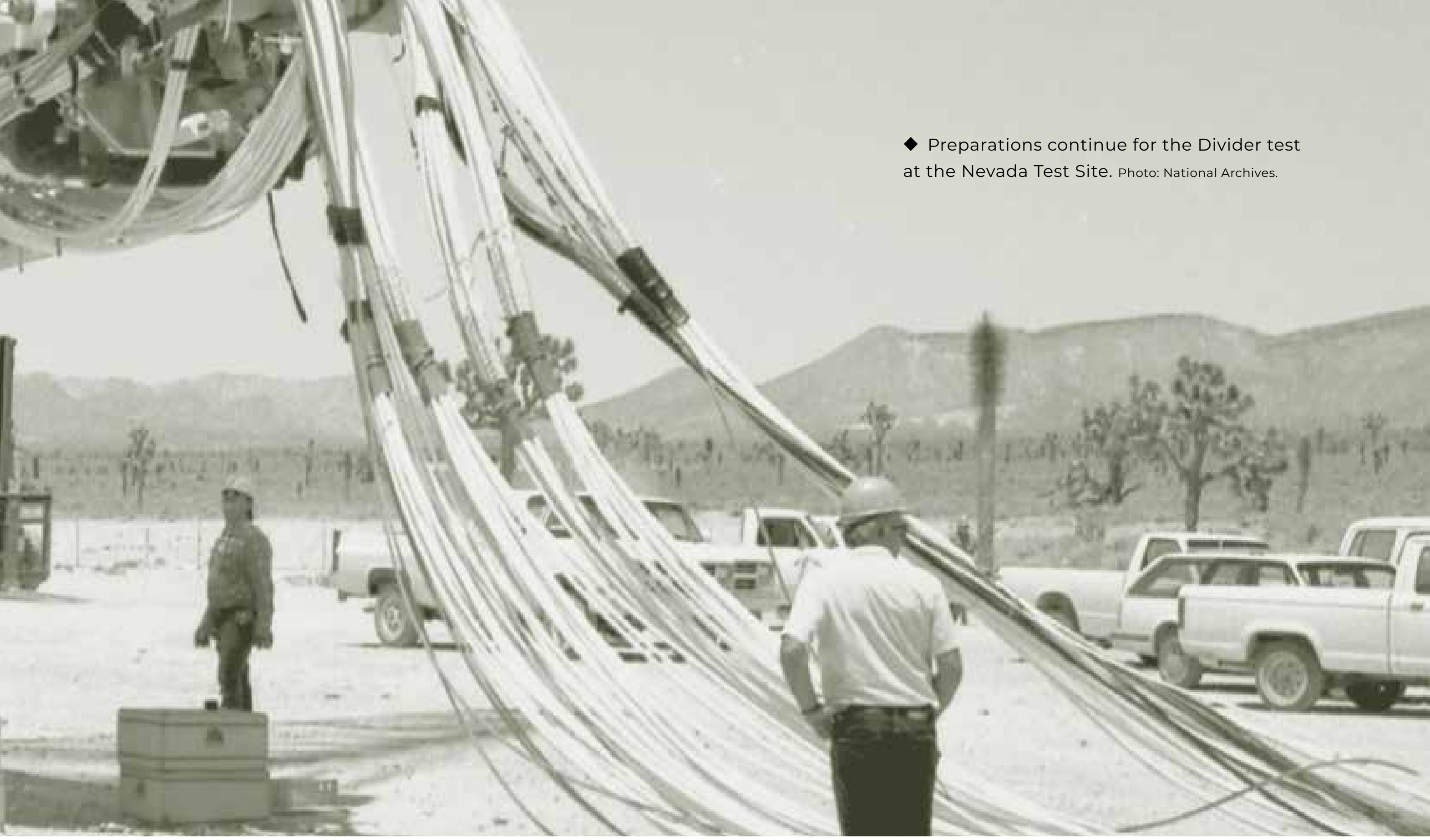
From all four women, there is an overwhelming sense of pride and joy in their work in nuclear testing. Working in testing, Brunish says, "was the best thing I've ever done. The most fun, the most interesting, the most impactful, and also extremely collaborative and team-driven—not just with the team I worked on, but with people all across the Lab. Engineers, physicists, designers, everyone worked together and had a shared fate. It was really an amazing thing to be part of because everybody wanted to do the job, get it done as well as they could. It was an amazing thing that I haven't seen since we stopped testing."

For Kroggel, working on the testing racks was the best part of her job because she viewed the testing as so critical to national security at that time in history.

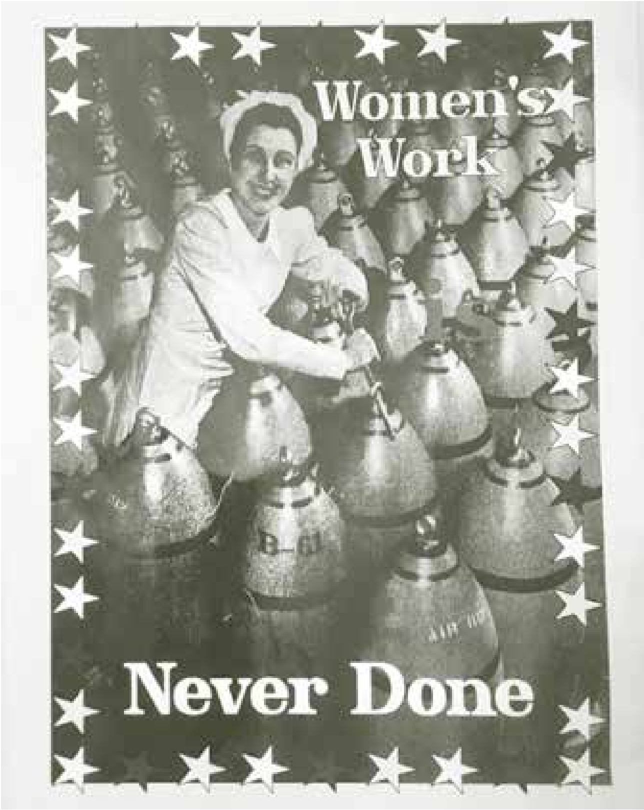
For Guzik, it was a time when she was able to learn a great deal about weapons—knowledge that she carries with her now as a Lab Fellow.

Brunish agrees. "We were pushing cutting-edge physics and design, and we were really contributing to making our nation and the world safer," she says. She is also proud of the shutout record her team holds against radiation leaks. "The Los Alamos containment program mission was to never have an underground test leak radiation into the atmosphere, and we were able to fulfill that mission 100 percent over more than 20 years, and we are still proud of that record."

For Wood-Schultz, working in testing was incredibly rewarding with results that other projects couldn't match.



◆ Preparations continue for the Divider test at the Nevada Test Site. Photo: National Archives.



■ Merri Wood-Schultz gave these posters to the women working in underground nuclear testing, many of whom posted them on their office doors; this is the one she gave to Joyce Guzik.

"There was a solid bottom line," she says, "and that's what testing provided. It wasn't unclear whether you did a good job or not, and it wasn't something for your boss to decide. It was about doing good quality work. If you just got lucky, and everything behaved better than you could have expected, that's always fun, of course, but it's not the same thing as doing a good job."

There are very few people still working at the Laboratory who worked directly on nuclear testing. Wood-Schultz and Brunish in particular find ways to share their knowledge of nuclear testing with others at the Laboratory and beyond. Wood-Schultz serves on multiple committees, including the Nuclear Forensics Science Panel for the Department of Homeland Security.

In addition to chairing the Containment Evaluation Review Panel, Brunish is a lecturer for the Underground Nuclear Weapons Testing Operations Program, a sort of summer school for people from the Intelligence Community, the Department of Energy, and the Department of Defense. The program teaches how underground tests were conducted, how other countries have conducted them, and what to look for when analyzing intelligence on underground test programs.

"I tell people," Brunish says, "that if in 30 years you want to return to testing, I'll come in with my walker and tell you how we used to do it in the old days." ★

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By Brenda Fleming, Virginia Grant, Maureen Lunn, J. Weston Phippen, and Whitney Spivey

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BETTER SCIENCE =
BETTER SECURITY

The Laboratory's Weapons program ensures the safety, security, and effectiveness of America's nuclear weapons stockpile.

Women make up nearly 30 percent of the Laboratory's Weapons program—and their contributions are essential to America's national security. Meet 40 women who are working hard to keep America safe.

GABRIELLE AMBROSIO

MATERIALS RECOVERY AND RECYCLE R&D ENGINEER

Dressed in anti-contamination coveralls, Gabrielle Ambrosio works in a glovebox in the Lab's Plutonium Facility. As the nation's Plutonium Center of Excellence for Research and Development, Los Alamos serves as the National Nuclear Security Administration's (NNSA's) production agency for plutonium pits—triggers for nuclear weapons—and has been tasked to produce at least 30 pits per year during 2026.

Ambrosio's job is to process the "leftovers" of pit production. "Essentially, our team takes an undesirable waste stream and uses aqueous chemistry to create a more stable product for storage and eventual reuse," she explains. "As an engineer for the team, I help make the process as efficient as possible and keep the system running smoothly."

Ambrosio came to Los Alamos in 2016 after completing her degree in chemical engineering at the University of Arizona in Tucson. Since then, she's truly grown to appreciate the significance of her work's mission. "Supporting pit production safeguards our country's national security and promotes global stability," she says.

For young women like herself, Ambrosio encourages confidence. "I often feel like I'm out of my depth whenever I start a new venture," she says. "I start to doubt my skills, abilities, and accomplishments. My advice to others—and myself—is: Do not have imposter syndrome; you have earned the right to be where you are."

◇◆ Ambrosio enjoys hiking across the Southwest.

◇◆ Barraza at the 2019 SkillsUSA New Mexico State Competition, where she chaired the welding fabrication event.

ALEX

W88

ENGINEER AND PROJECT-PROGRAM DIRECTOR

Like many parents during the pandemic, Anita Carrasco-Griego has learned to juggle work and home life. She's become a part-time teacher to her two children, one who's in kindergarten, the other in second grade. And although it's been difficult, she prefers to consider the silver lining: She gets to see her kids more often, and in her role as project director for the W88 Warhead Program, she's seen members of her team adapt and show resilience that maybe they didn't know they had.

First developed in the 1970s, the W88 is one of four nuclear warhead systems overseen by the Lab. Much of Carrasco-Griego's work involves maintaining this weapon system in case it's ever used by the Department of Defense. A lot of the work requires classified testing activities, so everyone involved has had to find ways to be more efficient with their limited office time.

"I try my best to keep my group engaged, motivated, and productive," Carrasco-Griego says. "I have worked with, and for, some incredible people who helped to lift me up to places I never thought were possible. Now I hope to do the same for others during my time here."


Carrasco-Griego with her youngest son, Uriah, in 2016.

ANITA CARRASCO-GRIEGO

YIA BARRAZA

HEAT SOURCE TECHNOLOGIES

R&D WELDING ENGINEER

Some of the things Alexyia Barraza welds in the Lab's Plutonium Facility end up on Mars. Barraza's group produces radioactive power sources—such as heat from the natural decay of plutonium-238—to generate electricity and keep vehicles like NASA's Curiosity and Perseverance rovers moving.

"I see myself as only a small piece in this very complex puzzle," Barraza says. "I come to work ready and willing, knowing that my efforts are contributing to the Laboratory's national security mission."

Barraza started at the Lab as a student intern in 2011. After a few years working for the Weapons program, she went back to school to earn a master's in welding engineering and a trade degree in manual arc welding.

An active member of the American Welding Society, Barraza says the professional organization has been key to her success. "The women and men in the trade industry showed me that mastering a skill is not gender specific, but it takes hard work and dedication," she says. "I look forward to talking to new generations of women interested in the welding industry and hopefully providing that same inspiration."

Barraza also says her family has been supportive of her welding career. "I'm thankful for the strong foundation my parents established for me. They really enabled me to chase my dreams."

◇◆ Cheng hikes near Moab, Utah, in 2019.

BAOLIAN CHENG

PLASMA THEORY AND APPLICATIONS

WEAPONS PHYSICIST

When the United States stopped nuclear testing in the early 1990s, physicists like Baolian Cheng began certifying the nuclear stockpile using small-scale science experiments and computer simulations. "The science being done at the Lab is so fascinating," Cheng says. "It allows you to pursue important solutions for what, why, when, where, and how that affect national security."

Cheng earned a doctorate in theoretical astrophysics from the University of Illinois at Urbana-Champaign and came to Los Alamos shortly thereafter. In the 27 years she's been at the Lab, Cheng has acquired some impressive accolades: three Distinguished Performance Awards, three Defense Program Awards, four Los Alamos Achievement Awards, and one Lab Fellow prize award. Cheng was praised by Los Alamos award committee members for her "unusual creativity and breakthroughs on the theoretical understanding of a nuclear device," and for playing a "critical role in the Laboratory's primary physicist capabilities in maintaining the nation's stockpile."

The attention has resulted in offers to work at prestigious universities and other national labs. But she's never been swayed from Los Alamos. "The Lab has a great history," she says. "I've always admired this place, and it's a wonderful environment to enjoy nature and family, while the work provides a platform for leading-edge science."

ENKEL

◇◆ Dervishi-Whetham with her sons and dog in Los Alamos.

◇◆ Dattelbaum prepares a target sample at a Laboratory gas gun facility.

DANA DATTELBAUM

DYNAMIC EXPERIMENTS

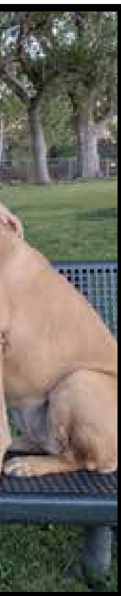
SHOCK PHYSICIST

Dana Dattelbaum, program manager for the Dynamic Materials Properties program, divides her time between talking with scientists, planning experiments, and writing about or performing experiments of her own. “The best part of my day,” she says, “is discussing science and seeing the scientists in the program succeed.”

Dattelbaum has worked at the Lab for 21 years, since she was a graduate student. “I chose to stay because I am excited by the national defense mission of the Laboratory and the opportunity to perform experiments that are unique to the national labs.” Those experiments are unique because of the large size of the teams that work on them and the complexity of high explosives. “The types of experiments we are able to perform at the Laboratory can only be done in a few places in the United States,” she says.

Dattelbaum’s research is focused on the study of chemical reactions in the initiation and detonation of high explosives. This is important to the Lab’s mission, she says, “to ensure the balance of safety with reliable performance. Being more predictive about how explosives initiate and release energy will mean spending less time performing trial-and-error experiments, and will result in safer options for the military.”

LEDA DERVISHI-WHETHAM



FINISHING MANUFACTURING SCIENCE

SCIENTIST

Enkeleda Dervishi-Whetham came to the Lab in 2012 on a Marie Curie Distinguished Postdoctoral Fellowship (now the Darleane Christian Hoffman Distinguished Postdoctoral Fellowship, see p. 12) to work at the Lab’s Center for Integrated Nanotechnologies. “I came here for the job, not knowing a lot about Los Alamos and New Mexico, and I fell in love with the town,” she remembers. “I decided to stay on as a scientist because I love the diversity, the environment, the challenges, and working with some of the best and the brightest scientists in my field.”

Now, nine years later, Dervishi-Whetham is a staff scientist working in the Sigma Division, which develops materials and components using engineering and metallurgical science in support of national security. As part of the Electrochemistry and Corrosion team, Dervishi-Whetham focuses on multi-functional coatings for mission-related projects. One recent development has been a new way to coat stainless steel that is resistant to shock, wear, and radiation.

“I bring a unique perspective to solving problems and looking at them in a different way,” says Dervishi-Whetham, noting that she encourages the students who work for her to think this way as well. “When you are in the room and you are different from everyone else, it can be intimidating. But believe in yourself and embrace your differences. Use that to push forward and become successful.”

JENNIFER DONLEY

INTEGRATED DESIGN AND ASSESSMENT

SCIENTIST

Jennifer Donley and her husband—each doctors of astronomy—came to Los Alamos because they could both work at the Lab. "We found the Lab's national security mission and collaborative work environment to be both challenging and rewarding while also offering a better work-life balance than academia," she remembers. "Los Alamos has been a great place to both work and live, and I feel so lucky that we landed here."

Donley is a project leader for the Verification and Validation program in the Lab's Advanced Simulation and Computing Program. "My work helps to ensure that we are using the best physics models available to model nuclear and non-nuclear experiments, and that we are prepared to meet the needs of the future nuclear stockpile," she explains. "As long as we continue to field nuclear weapons, we need to make them as safe, secure, and reliable as possible, and I am proud to contribute to that mission."

Donley says that throughout her nine years at the Lab, she's leaned on her colleagues to navigate life at Los Alamos. "Do everything you can to surround yourself with supportive colleagues, mentors, and managers—both women and men," she advises. "They can make all the difference."

Donley and her kids during a summer camp out.

ANNA HAYES

NUCLEAR AND PARTICLE PHYSICS, ASTROPHYSICS, AND COSMOLOGY

THEORETICAL PHYSICIST

Hayes works on neutrino-nucleus physics in her spare time.

Anna Hayes credits her confidence in a male-dominated field to growing up in a large family with one sister and three brothers. "I got used to dealing with a dinner table dominated by brothers," she says. "You have to believe in yourself and stick to your point, if you're confident that you are right. But don't be afraid to be wrong."

Hayes came to the Laboratory 30 years ago as a Director's Postdoctoral Fellow in T-2, a group in the Laboratory's Theoretical Division. Now, she is the T-2 group leader. "I really enjoy the very exciting and intense research atmosphere" at Los Alamos, she says.

In addition to leading the group, Hayes interprets archived weapons data. "These data tell us so much about how a weapon really works," she says. "We often see very unexpected results." In those cases, the team has to determine an explanation for those results. "It's very challenging," she says, "but very fun."

During the coronavirus pandemic, Hayes doesn't work on site too often, which means that she hasn't had regular access to one of her most valuable tools—her chalkboard. "I don't have one at home," she says, "so my waste basket is always full of pages of my scratched physics notes."

◇◆ Greenfield aligns equipment for an experiment in high explosives.

MARGO GREENFIELD

HIGH EXPLOSIVES SCIENCE AND TECHNOLOGY

GROUP LEADER AND SCIENTIST

When Margo Greenfield faces a classroom full of seen-it-all military explosive-ordnance-disposal (EOD) technicians in the Laboratory's Advanced Homemade Explosives Course, they listen up. These warfighters detect, identify, and dispose of improvised explosive devices and other types of bombs in hostile environments around the globe. They know that Greenfield has information that could save their lives.

Greenfield, alongside colleagues including Virginia Manner (p. 53), trains EOD techs to handle homemade explosives and understand the physics and chemistry behind them. By giving EOD techs information and critical-thinking skills they can apply on the battlefield, "we help make their jobs safer and easier," she says.

Greenfield didn't know she was interested in explosives until she came to Los Alamos as a post-baccalaureate student in 2001 and worked on experiments with conventional explosives. "I was hooked from day one," she says.

Now, as a group leader, Greenfield leads high-explosives molecular research and development. "We make new materials," she explains, "and we spearhead understanding their safety response. In some cases, we utilize new manufacturing technologies to put them into application."

She also incorporates her findings into her teaching curriculum. "Information is passed along to the students," she says. "It feels good to go home at night knowing we have helped increase the safety of our military personnel."

KAREN HAYNES

PRODUCTION AGENCY QUALITY

DIVISION LEADER

For Karen Haynes, working at Los Alamos is a family affair. "The Lab has provided us with great opportunities," she says. "My husband, Don, works here; my daughter and son worked for the Lab through a student program while they were at Los Alamos High School, and my son is currently working in the Weapons program."

Haynes is the division leader for Production Agency Quality, which falls under the Lab's Weapons Production directorate. This directorate manufactures plutonium pits, detonators, heat sources, and many other weapons components. "After these components are produced, they need to be 'sold' to NNSA," Haynes explains. "Our division is full of quality analysts, engineers, and inspectors with a lot of expertise. We provide the proof that products meet the exacting quality requirements necessary, such as ensuring there aren't any defects in a product and that it will function the way it's meant to."

Haynes firmly believes in the Laboratory's national security mission: ensuring the viability of America's nuclear deterrent. "Los Alamos is an exciting place to work—for the science, the mission, and the range of opportunities available," she says, noting that the location is pretty great, too. "Northern New Mexico is a wonderful place to live. The move to Los Alamos was a fantastic one for our family."


◇◆ Don and Karen Haynes in Venice, Italy.

TAMRA HEBERLING

THEORETICAL DESIGN SAFETY AND SURETY

MATHEMATICIAN


◇◆ Heberling visits Buckingham Palace in London.

Tamra Heberling first learned about Los Alamos at a career fair during graduate school at Montana State University. New Mexico seemed like a good place to spend a few months, so she headed south for a summer, returned as a postdoc, and then stayed as a staff scientist.

Heberling's team assesses the safety and surety of nuclear weapons; in other words, it works to mitigate worst-case scenarios, such as a weapon accidentally detonating. As part of this team, Heberling creates large 3D computer simulations on the Lab's high-performance computers, then, through data analysis, machine learning, experimental design, and data fusion, she works to answer important questions related to the nuclear stockpile and global security.

"However you feel about nuclear weapons, they are our single greatest deterrent, which means that they are not going away," she says. "Therefore, making sure that our stockpile is safe, secure, and effective is extremely important."

"I get to work on many different projects and learn things every day," she continues. "I've also been fortunate to be able to work closely with some really wonderful people." Her advice to other women? "Don't be afraid to take up space—you're there for a reason."

◇◆ Hockaday with her first grandchild, Athena.

MARY HOCKADAY

NUCLEAR ENGINEERING AND NONPROLIFERATION

DIVISION LEADER

Growing up in Hawaii left Mary Hockaday without many options for becoming a technical scientist close to home. So, after the encouragement of her undergraduate advisor, she applied for jobs at Lawrence Livermore National Laboratory and to Los Alamos National Laboratory. "I took the high road," she says, "and went with Los Alamos." Hockaday spent her early career using state-of-the-art pulse power, radiography, and laser experiments to address key weapons questions; she also worked on underground nuclear testing.

Hockaday remembers being a woman in a male-dominated field was "very noticeable early in my career. I could easily go into a 100-person meeting and be the only woman in the room." Her advice for women in similar situations is, she says, "to be yourself. You are there for your ideas, your expertise, and your perspective."

Now the leader of the Nuclear Engineering and Nonproliferation Division, Hockaday gets to "help solve problems" that include detecting and preventing the development or use of nuclear weapons. "There is something about making the world a safe place," Hockaday says, "that gets me out of bed every morning with a spring in my step."

> "THERE IS SOMETHING ABOUT MAKING THE WORLD A SAFE PLACE THAT GETS ME OUT OF BED EVERY MORNING WITH A SPRING IN MY STEP."

DENIECE KORZEKWA

◇◆ Korzekwa tours the Lofoton Islands in Norway.

SIGMA DIVISION OFFICE

ENGINEER

When Deniece Korzekwa retired in November 2019, she was the deputy division leader of Sigma Division, where she worked on solidification and fluid flow modeling of uranium and plutonium casting processes.

Now a guest scientist at the Lab, Korzekwa is a world-renowned expert in her field and was named Laboratory Senior Fellow in 2020. Much of her work has implications for weapons manufacturing. She has focused on “understanding the relationship between processing, properties, and performance, with the aim to improve the efficiency and understanding of manufacturing processes for plutonium and uranium,” she says.

When her husband got a job at the Lab in 1983, Korzekwa moved to Los Alamos as what she calls “a trailing spouse.” In 1986, she began work at the Lab part-time while her young children were still at home. Once her children were in middle school, she began full-time work, a plan that, she says, “allowed me to both have a career and be a mother.” Her career of 30-plus years has aided the Lab’s integral work of weapons production—work that, she says, “is vital” to the United States. “I believe we need to understand the science of manufacturing,” she says. “It allows us to be more efficient with U.S. resources and to utilize new technologies.”

KIM KATKO

◇◆ Katko mountain biking in the Valles Caldera National Preserve.

SPACE AND REMOTE SENSING

ELECTRICAL ENGINEER

Twenty-seven years ago, Kim Katko moved from Minnesota to New Mexico to work as a summer student at Los Alamos. She immediately loved the small mountain town and her work on satellites. After she was hired full time, the Lab paid for her to earn a master’s degree, which she says paid dividends she didn’t understand until much later. “The more education you have, the more you set your own path and make a good life for yourself,” she explains.

“You get to do things that you truly enjoy. You get respected for it, and you get paid for it—it’s just so good.”

Katko has taken advantage of professional development opportunities over the years and attended a transformative leadership training course in 2012. “At that point in my career, I was sometimes hesitant to speak up in meetings,” she remembers. “I learned that what I have to say and contribute is really important.”

Katko, now a team lead, spends much of her time developing new technology that is tested on small (think loaf-of-bread-sized) satellites before being used on larger satellites. The work supports the Lab’s nonproliferation mission, but for Katko it’s even more than that. “It’s satellites and space,” she says. “It’s just really fun.”

◇◆ Hollis at the Valles Caldera National Preserve, just west of the Laboratory.

REBECCA HOLLIS

HAZARDOUS WASTE MANAGEMENT

GROUP LEADER AND MANUFACTURING MANAGER

While enrolled at the University of Alabama, Rebecca Hollis actually spent most of her graduate school years living in Los Alamos and taking courses by correspondence. "I feel like I really got my Ph.D. in chemistry from the 'University of Los Alamos' as much as the University of Alabama," she jokes. "After so many years of doctoral research at Los Alamos, I was a devotee to New Mexico and the Lab in particular."

Today, Hollis is a group leader who works with low-level and transuranic waste at the Plutonium Facility. (Low-level waste includes items that have become contaminated with radioactive material or have become radioactive through exposure to neutron radiation; "transuranic" (TRU) describes the elements that come after uranium on the periodic table—radioactive elements that aren't naturally occurring, such as plutonium. Use of these elements results in TRU waste, which has to be disposed of in very careful and specific ways.)

As a leader, Hollis strives to be dedicated, fair, honest, and compassionate. "Although many of the discrimination issues I encountered 30 years ago aren't as common, subtle messages to women that their presence is an afterthought still exist," she says. "I challenge everyone to think about the biases that make women feel like they don't belong."

> "I CHALLENGE EVERYONE TO THINK ABOUT THE BIASES THAT MAKE WOMEN FEEL LIKE THEY DON'T BELONG."

◇◆ LeDoux at the 2019 Walk for ALS (amyotrophic lateral sclerosis) in Albuquerque.

REINA LEDOUX

PROTOTYPE FABRICATION ENGINEERING

GROUP LEADER AND MANUFACTURING MANAGER

A 19-year veteran of the Lab, Reina LeDoux is the group leader for Prototype Fabrication Engineering in the Weapons Production directorate. In this role, she supports precision machining and inspection of non-nuclear weapons components. “I work here because it’s such a unique manufacturing environment, and it allows me to support a mission that continually presents new challenges,” she says. “Not to mention, my family has lived in Northern New Mexico for many generations; I grew up here.”

Because of the sensitive nature of her group’s work, LeDoux doesn’t always have full context for components her employees are working on—but that doesn’t prevent her from being invested in the mission. “Recently, we delivered on a multi-organizational manufacturing, inspection, and assembly mission,” she remembers. “All the customer could tell us afterward was, ‘you’re helping make the world a safer place.’ That’s what makes the work important to me.”

LeDoux’s advice to other women in science, technology, engineering, or math (STEM) fields is to “find your voice and contribute to the solution of the problem,” she says. “And as a woman in STEM, take the time to support, guide, and encourage other women.”

◇◆ Lopez-Barlow with her husband and daughters.

◇◆ Virginia Manner (left) and coworkers Nicholas Lease, Maria Campbell, and Nathan Burnside fire detonators in a control room.

VIRGINIA MANNER

HIGH EXPLOSIVES SCIENCE AND TECHNOLOGY

SCIENTIST

Los Alamos County's Olympic-sized indoor pool was closed for part of the coronavirus pandemic. But for Virginia Manner, not swimming wasn't an option. So, she regularly hiked nearly two miles for an early morning swim in the area's only large body of water—a murky reservoir at the bottom of a steep canyon.

"Swimming there probably summarizes the challenges of maintaining some sanity during this time," she says. But although times have been trying, they've also been strangely productive. Some days, Manner designs, sets up, or writes about explosives experiments. Other days, as the Energetic Materials Synthesis team leader, she ensures that her team members—other scientists, technicians, and technologists—have what they need to interpret experimental results. "Most of the work I do is very challenging and engaging, and it allows for creativity and collaborative problem solving," she says. "I really enjoy being able to solve problems that contribute to the safety of other people."

Manner, who has been at Los Alamos since 2009, is quick to give her colleagues credit for fostering a productive and accepting work environment. "I am lucky to be in an environment where I feel I am judged by my accomplishments," she says. "Everything significant I've done here has been due to the incredible group of people who support me and work hard to turn our ideas into reality."

ACQUELYN LOPEZ-BARLOW

NUCLEAR SECURITY PRODUCTION INTEGRATION

PROGRAM MANAGER

From a young age, Jacquelyn Lopez-Barlow has been fascinated by the unknown. So, it's no surprise that she's found a job that allows her to look for past and present signs of life on Mars. Lopez-Barlow leads a team that designs and manufactures radioisotope heat sources—small blocks of plutonium that provide electricity in deep space—for NASA. "When we launched the Mars Perseverance rover in July 2020, it was emotional, and I was so proud to say that I was a part of it," Lopez-Barlow remembers.

Lopez-Barlow has worked at the Lab since 2003, when she secured an internship while studying chemical engineering at the University of New Mexico. Staying on at the Lab after she graduated was an easy decision, she says, because she was excited to further her skills at the Lab's Plutonium Facility (PF-4). Working at PF-4 opened other doors, such as the opportunity to work on heat sources destined for Mars.

"To solve our nation's challenges, we need to have a diverse workforce that can bring forward innovative ideas and make them realities," she says. "It's our job to find solutions, and the more talented women we have, the better because women bring a unique approach to solving problems at the Lab."

◇◆ Martinez enjoys the view in Denver, Colorado.

ANALISA MARTINEZ

MATERIALS RECOVERY AND RECYCLE SCIENTIST

Analisa Martinez's uncle has worked at Los Alamos since 1997. "My uncle showed me that the Laboratory is a place to learn and grow with mission-driven, like-minded people," she says. "I love that we are the only place in the nation that's capable of doing what we do."

At the Lab's Plutonium Facility, Martinez is responsible for hazardous waste that is a byproduct of the Lab's current and previous weapons production work. The waste is stored in high-security vaults until it can be moved, recycled, or safely disposed of. "I plan what we'll remove from the vault and what we'll do with it," Martinez explains. "Some items need to be repackaged in new containers, others discarded or consolidated."

Throughout her eight years at the Laboratory, Martinez has always felt encouraged by her colleagues, and she believes Los Alamos is a great place for women to succeed. "I've had the opportunity to work with some of our nation's greatest minds, both men and women," she says. "That's not to say that I haven't been in meetings where I'm the only woman in the room. My advice for those women is to always speak your mind, and speak it with confidence."

STACY McLAUGHLIN

◇◆ McLaughlin with her children in Quebec, Canada.

ACTINIDE MATERIAL PROCESSING AND POWER DIVISION LEADER

A mom of four, Stacy McLaughlin often uses her parenting skills at work: She communicates clearly, doesn't back down, and strives to be compassionate and understanding. "Women inherently bring a different perspective to an environment, and that variety of perspectives is extremely important for innovation," she says. "Women should never be afraid to speak up."

McLaughlin, who started at the Laboratory as a student in 1994, leads a team of technical staff across three groups in the Actinide Materials Processing and Power Division. The division is responsible for meeting the production goals of several different missions, including NASA's space exploration programs, various defense programs, the Advanced Recovery and Integrated Extraction System (ARIES) for nuclear non-proliferation, and the Material Recovery and Recycle program to enable the future of the Laboratory's Plutonium Facility by processing and disposing of legacy waste residue.

Most of McLaughlin's employees have worked on site during the pandemic due to the essential, hands-on nature of their work. "The products that AMPP produces are one-of-a-kind; no one across the Department of Energy complex can produce what we produce," she says. "I love coming in to work every day and knowing I'm making a difference in our nation's security."

◇◆ Mares and her sons at the Albuquerque International Balloon Fiesta.

DANIELLE MARES

DYNAMIC STRUCTURE DESIGN AND ENGINEERING ENGINEER

Los Alamos native Danielle Mares began working at the Lab 21 years ago as a high school intern. The experience solidified her decision to study engineering in college. But in her classes, she was often the only woman. "That these fields are male dominated became very apparent to me early on," she says. "I learned to be persistent, to be assertive, and to come out of my shell to prove myself," Mares says. "My advice to women is: Follow your dream, and don't let anyone define your potential."

Mares is now an R&D engineer for the Lab's hydro program. During a hydrotest, scientists detonate a mock nuclear device inside a six-foot spherical, two-layer confinement vessel. "This work enables the Laboratory to ensure the operability of the weapons needed for our stockpile," Mares says.

As a vessel engineer, Mares focuses on preparing these behemoth containers for experiments. The cylindrical outer vessel provides mechanical support to the spherical inner vessel, which is made from 6.25-centimeter-thick steel. The inner vessel, which contains overlapping aluminum shielding plates around the device to protect the vessel from shrapnel damage, can handle up to 18 kilograms of explosives and can be cleaned up and reused for other hydrotests.

"MY ADVICE TO WOMEN IS: FOLLOW YOUR DREAM, AND DON'T LET ANYONE DEFINE YOUR POTENTIAL."

Mosby and her son run to the finish of the NORAD (North American Aerospace Defense Command) Trail Race in Colorado.

MICHELLE MOSBY

THEORETICAL DESIGN SAFETY AND SURETY

SCIENTIST

"BY CHANGING ATTITUDES AT AN EARLY AGE, WE CAN HOPE TO INSPIRE MORE GIRLS TO ENTER AND STAY IN STEM FIELDS."

"Nuclear deterrence should be important to everyone," says Michelle Mosby, a scientist in the Lab's X Theoretical Design Division. "The existence of nuclear weapons has global implications, and as a country in possession of that technology, it is important to steward it to the best of our ability."

Mosby uses multi-physics simulations to better understand how a nuclear weapon will perform. "The work I do underpins our nuclear deterrent," she explains, noting that this mission-focused work is what first attracted her to Los Alamos. "I learned during graduate school that I wanted to see a direct purpose for my work, rather than simply researching to better understand the field," she says. "At the Lab, that connection is easy to see, and I know that my contributions make a difference to national security."

Her contributions also affect future scientists. "A few years ago, I had the opportunity to be the designer on an integral experiment in which all of the leads were women," she remembers. "I hope that as a new generation of scientists is growing up, seeing women in STEM leadership roles is a more common sight. By changing attitudes at an early age, we can hope to inspire more girls to enter and stay in STEM fields."


◇◆ Mohr atop a cliff in Abiquiu, New Mexico.

HANNAH MOHR

SPACE ELECTRONICS AND SIGNAL PROCESSING

ENGINEER

Like cell phones and personal computers, high-tech satellites are becoming smaller and smaller. CubeSats, inexpensive satellites often the size a grapefruit, allow anyone—from researchers at national laboratories to middle-school students—the opportunity to put satellites into orbit.

Research and design engineer Hannah Mohr, of the Lab's Agile Space team, writes the software that controls the orientation and automates the operations of these tiny satellites. "The Lab has a long history of developing space technology to help keep our nation safe," Mohr says. "Continuing to build on those capabilities is important as we adapt to the changes in the way we can use satellites."

Mohr was one of the first recipients of the Lab's Athena Engineering Scholarship, which supports young women in the engineering sciences and funded her graduate work. In 2017, she earned a staff position, and her work has been focused skyward ever since. "I've realized this was the kind of place where I could spend my entire career learning new things," Mohr says of developing cutting-edge technology that keeps our nation on the forefront of satellite science. "I'm contributing to a mission that truly matters."

REBECCA OERTEL

FOCUSED EXPERIMENTS

EXPLOSIVES TECHNICIAN

Before Rebecca Oertel became an explosives technician at the Lab last year, she was a machinist, a scientist for the U.S. Geological Survey, an ecologist at Bandelier National Monument, and a wildland helitack firefighter—one of the people dropped from helicopters into the woods to battle forest fires.

These days, Oertel makes sure everything runs smoothly and safely when the Lab needs to explode something. She assembles the explosive shots. She ensures all cameras and lasers are running properly, and that all personnel are safely in the bunker. Then she starts the countdown. "These experiments give the Laboratory crucial information to better understand the effects of extreme conditions on different materials, and how those materials can be applied to maintaining our nuclear weapon capabilities," Oertel says.

Her path to the Lab might have been a bit more circuitous (and adventurous) than most but Oertel has deep roots in Los Alamos. Her father came to the Lab in 1943 to work on the Manhattan Project. Her mother arrived in 1950 and worked as a secretary for Director Norris Bradbury. Her advice to anyone who wants to work at the Lab is not to worry about what others think. "Believe in yourself," she says, "stay humble, surround yourself with supportive, positive people, and always look forward to your next successes."


◇◆ Oertel and her Alaskan malamute, Sierra.

◇◆ Reeves behind the wheel of the "rock crawler."

"I URGE WOMEN TO REMEMBER THAT THEIR STRENGTH IS NOT IN WHAT IS EQUAL TO MEN, BUT THAT WHICH IS DIFFERENT FROM THEM."

ALYSSA REEVES

PROTOTYPE FABRICATION ENGINEERING

R&D ENGINEER

Alyssa Reeves met her husband in auto shop class at Los Alamos High School. The couple has been working on cars together ever since. Their current project is their "rock crawler"—a burly 1985 Toyota 4-Runner that can make its way over any terrain.

Nearly 13 years ago, Reeves' passion for tinkering landed her a job at the Lab. "I have had, and continue to have, opportunities to do a lot of different and interesting tasks as an engineer at the Lab," she says. "And the location provides my family with a safe place to live, while keeping us close to our favorite outdoor activities—skiing, camping, and four-wheeling."

Reeves is part of an inspection team in the Prototype Fabrication Division, which manufactures non-nuclear components for weapons systems. "Our team performs a critical role in quality assurance—making sure the products we manufacture meet all safety and security requirements and other specifications," she explains.

Reeves has continued to work on site during the pandemic and says her team is most effective when her team members "realize our differences make us strong. I urge women to remember that they won't find their strength and success by comparing themselves to men."

◇◆ Plesko participates in the 1997 Earthwatch Student Challenge Awards Program.

CATHY PLESKO

MATERIALS AND PHYSICAL DATA

SCIENTIST

In 1997, high-school student Cathy Plesko participated in the Earthwatch Student Challenge Awards Program, which allowed her to shadow a Los Alamos scientist for two weeks. "I got to work on an observational astronomy project," Plesko remembers.

That was more than two decades ago. "I kept coming back to Los Alamos," she says, "because the people I want to work with are here, working on questions that matter to the world." She adds that "the mountains and green chile are pretty great, too."

Plesko is the Program Manager for the Advanced Simulation and Computing, Verification and Validation Program. Her team uses supercomputers to model what happens if an asteroid or comet hits the Earth. She also uses supercomputers to help determine how humans might stop that from happening. "We use computer models to study ways of pushing near-Earth objects (NEOs) off course, such as smashing a spacecraft into them or detonating a nuclear device from several hundred yards away," Plesko says. "We feed the best estimates of an NEO's shape, composition, mass, and strength into our computer models and predict what would happen in each scenario."

Plesko says she feels lucky "to be able to do scientific research and apply it to questions of national security and planetary defense and to work with so many brilliant, generous people who are happy to share their own knowledge and insights."

BRANDY ROYER

DYNAMIC STRUCTURE DESIGN, ENGINEERING, AND VESSEL OPERATIONS

GROUP LEADER AND R&D MANAGER

Under normal circumstances Brandy Royer likes to think of her group leader job as "steering the ship and ensuring the group has what it needs." Her group is responsible for the six-foot spherical confinement vessels used in hydrodynamic experiments at the Lab's Dual-Axis Radiographic Hydrodynamic Test facility. In a DARHT experiment, scientists detonate a mock nuclear weapon inside a confinement vessel and take radiographs of the resulting implosion. The heat and pressure created by the implosion cause the weapon's non-nuclear core to melt and flow like water. This change from solid metal to liquid is why the experiment is considered "hydrodynamic" and often called a "hydrotest."

Royer's group, founded in February 2019, is relatively new to the Lab. Usually, the group members interact in person frequently, but that's changed during the pandemic. "In a group like ours that's growing and learning from each other, the lack of face-to-face interactions means that we must take extra steps to make sure we coordinate that time with each other."

So, like a lot of people, Royer and her group are constantly meeting via Webex. "Our mission and focus haven't changed," she says. "We've adapted because our work is critical for both the Laboratory and the nation."

KIM SCHULTZ

DARHT EXPERIMENTS AND DIAGNOSTICS

PHYSICIST

Kim Schultz came to Los Alamos in 2018 as a postdoctoral fellow, and she took a permanent position at the Lab's DARHT facility the following year. "DARHT—the world's most powerful x-ray machine—provides the opportunity to perform basic science experiments in addition to its primary purpose in the stockpile stewardship program," she says. "It is really a unique place to work."

Schultz develops, installs, and maintains current diagnostics (measurements) for experiments. Her specialty is optical diagnostics. "I use lasers and fiber optic equipment every day," she says.

Schultz also helps analyze data that is gathered from all the diagnostics. This data validates the computer codes used to help certify America's nuclear stockpile. "I'm proud that my work allows the Lab to affirm that our stockpile behaves as intended and continues to be safe and secure," she says.

But because of the pandemic, Schultz's work hasn't been quite so hands-on lately. "I am an experimentalist and conduct most of my work with a team, with some programming and analysis work," she says. "I have now shifted to learning more programming languages and developing diagnostics to use in the future."

◇◆ Schultz attends a Chicago Bears football game.

ROLANDA SALAZAR-MARTI

PIT TECHNOLOGIES—PLUTONIUM MACHINING

GROUP LEADER AND MANUFACTURING MANAGER

"Since the pandemic, my workload has tripled," says Rolanda Salazar-Martinez. "My husband is a healthcare provider who isn't able to work from home, so I've stayed home with our two boys."

In addition to keeping her elementary schoolers on track with their remote schooling, Salazar-Martinez also manages 67 employees—mostly highly detail-oriented machinists and engineers—who contribute to making plutonium pits (nuclear weapon triggers). Los Alamos demonstrated pit production in 2007 and has been tasked by the NNSA to produce at least 30 pits per year by 2026 to ensure the future of America's nuclear stockpile.

"Working these past 18 years at the Lab, I've come to understand and appreciate the work we do for the safety of our nation," Salazar-Martinez says. "The men and women in our military depend on what our team provides to protect our freedoms. I have family members in the military, and it's comforting to know they have all they need to keep our country safe."

Although women managers are not uncommon in the directorate where Salazar-Martinez works, they are certainly not the majority. "My advice to women in the field is to speak up," she says. "And find a mentor. My mentor challenged me to 'sit at the table'—to be a participant, not a spectator, and to trust my worth."

◇◆ Schake tours the Isle of Skye, Scotland.

ADVANCED RECOVERY AND INTEGRATED EXTRACTION SYSTEM

SCIENTIST

ANN SCHAKE

For more than 30 years, Ann Schake has always felt supported by her Los Alamos colleagues. "There are many opportunities for all people to find interesting work and to succeed at Los Alamos National Laboratory," she says, noting that a good mentor can help the process. "There are mentors in every field and at every level, both men and women, who are willing to guide you and help you succeed."

Schake's success has taken her from a postdoctoral position in inorganic chemistry to a staff member position in the Nuclear Materials Technology Division to a team leader position in the Nuclear and Radiochemistry group to her current role in the Advanced Recovery and Integrated Extraction System (ARIES) program.

ARIES helps the nation meet its nonproliferation commitments by preparing surplus weapons-grade plutonium for final disposition by converting it to less-hazardous plutonium oxide and moving it into long-term storage. As a senior scientist on the ARIES characterization team, Schake helps develop new spectroscopic tools that measure contaminants in ARIES' plutonium oxide.

"Maintaining the nuclear deterrent is extremely critical for national and global security," she says. "Hand in hand with that work comes securing materials that are removed from the stockpile that represent a proliferation risk."

NEZ

◇◆ Salazar-Martinez with her husband and sons at Disneyland in 2019.

"WORKING THESE PAST 18 YEARS AT THE LAB, I'VE COME TO UNDERSTAND AND APPRECIATE THE WORK WE DO FOR THE SAFETY OF OUR NATION."

KIMBERLY SCOTT

OFFICE OF EXPERIMENTAL SCIENCES

PROGRAM DIRECTOR AND ASTROPHYSICIST

When Kimberly Scott was considering a job at the Laboratory 21 years ago, she was interested in how the Laboratory encouraged work-life balance because she was about to start a family. She also says that “the scientific overlap between my research field of astrophysics and the Laboratory’s mission was a real attractor.” Astrophysics considers the nuclear processes in stars; at Los Alamos, Scott could consider the nuclear processes in weapons.

Scott directs the Lab’s Experimental Sciences Program, which develops science and technology to maintain the current stockpile, enable the stockpile of the future, and mitigate threats to the stockpile. “Our country’s nuclear deterrent has been effective at ensuring our defense and those of our allies for more than seven decades,” she says. “Los Alamos helps to ensure that will continue to be the case.”

Scott advises young women to “pursue work in fields that interest you. Be tenacious and you’ll achieve your goals. Don’t compare yourself to others. Lead from your own strengths. Don’t be afraid that you don’t have what it takes—you do.”

◇◆ Scott with her extended family at a Buffalo Sabres NHL game.

CHRISTINA SCOVEL

THEORETICAL DESIGN PRIMARY PHYSICS

SCIENTIST

Christina Scovel comes from a family that has taken its patriotic duty seriously for more than two centuries. "I am the 12th generation of my family in the United States, and at least one family member in each generation has served the nation, mostly through the armed services," Scovel says. "I did not join an armed service but instead choose to serve my nation through the Laboratory."

Scovel moved to New Mexico from Seattle and has worked at Los Alamos for 21 years. She's part of the Primary Physics and Design group, which designs nuclear weapon primaries (the first, or fission, stage of a weapon) and assesses their performance and reliability. "Maintaining the viability of our nuclear deterrent is the best way I can support our national security," she says.

Over the years, Scovel has "felt nothing but support and respect" from her colleagues, and she encourages young women going into STEM fields to "use your voice when you need to, and remember that your voice is just as important as anyone else's." Scovel notes that being vocal is especially important during the coronavirus pandemic.


◇◆ Scovel is a certified yoga instructor.

"Open and over-communication with both colleagues and family members is the only way to maintain any semblance of balance" during this difficult time.

JORDAN SHOEMAKER

DETONATOR PRODUCTION DIVISION OFFICE

ENGINEER

Detonators are small devices that ignite the high explosives surrounding the core of a nuclear weapon. The resulting explosion compresses the core, which creates nuclear yield. Many detonators are required per weapon, and many of those detonators are designed and produced at Los Alamos. Jordan Shoemaker is among the people responsible for their production. "This involves coordinating engineering, production, design, and support teams to ensure producibility of next-generation detonators," she explains. "I have a direct impact on nuclear deterrence for our current and future generations."

Weapons Production, the directorate in which Shoemaker works, is just 27 percent female. "I have been mistaken as an intern on projects where I was the subject matter expert," she recalls. "I have been told both that I sound like a cheerleader and that I am too bossy and direct." Shoemaker is quick to note that the majority of her experiences are much more positive. "Continue to exhibit excellence in your field. The quality of your work will start to speak for itself and combat the hidden bias that still pervades our work."


◇◆ Shoemaker and her husband hike in New Zealand.

GOWRI SRINIVASAN

◇◆ Srinivasan and her son at Disney World in 2019.

VERIFICATION AND ANALYSIS

GROUP LEADER AND R&D MANAGER

Before Gowri Srinivasan came to the Lab 16 years ago, she worked in Silicon Valley as a software engineer, an occupation that, especially at the time, felt sometimes uncomfortably dominated by men. "I don't know of any of my women friends in STEM who haven't experienced either subtle or overt acts of gender discrimination at some stage of their lives," she says.

Now as a group leader in the X Computational Physics Division, which is responsible for the computer codes and simulation tools used for stockpile stewardship, she's in a unique position to mentor and guide young women so that they don't face similar obstacles. "Group leaders are the first line of defense for the Lab's success, since we are directly in contact on a daily basis with the staff that enable us to accomplish our goals," Srinivasan says.

Some of her time is devoted to administrative work, ensuring the group has what it needs to succeed. But the more exciting part, she says, is helping people with their own career development. Srinivasan has had several influential mentors herself and recognizes how valuable these relationships can be. "If you have even one person who is your cheerleader and an inspirational influence, latch on to that because it makes a big difference," she says.

LAURA SMILOWITZ

PHYSICAL CHEMISTRY AND APPLIED SPECTROSCOPY

SCIENTIST

Many explosives Laura Smilowitz works with have been around for decades; she knows a lot about them. For example, the explosives used in some detonators provide such consistent results that their accuracy is measured down to 100 nanoseconds. (One nanosecond is a billionth of a second, so that's pretty accurate.)

But even then, Smilowitz says "gaps in our understanding" exist, and she's dedicated her 25-year career to closing them. The Lab Fellow and member of the Thermal Kinetics and Dynamics team specializes in addressing questions about what might happen in unintended circumstances, so that if an accident occurs, the Laboratory can provide guidance on how to respond. "Something like detonators may provide extremely precise timing," Smilowitz says. "However, the fundamental mechanisms of how detonators function is still not totally understood, so my work addresses questions involving explosives safety and surety."

At times, the world of explosives can sometimes feel like a boy's club. Early in her career, Smilowitz found that with her soft voice, she was often talked over in meetings. So like any good scientist, she experimented with how to get her point across. "One technique I've found is to stand up and draw things on the board to make sure I'm heard and understood."

◇◆ Sprinkle at the Angel Fire Bike Park in New Mexico.

BETHANY SPRINKLE

EXPERIMENTAL DEVICE ENGINEERING AND ASSEMBLY

ENGINEER

Bethany Sprinkle likes motorcycles. She rides dirt bikes and sport bikes, and she likes to take them apart to see how they work. So it was important that her job at the Lab was not only intellectually fulfilling but also gave her a chance to work with her hands.

Today, Sprinkle helps systems engineers and physicists take their thoughts (mostly on explosives—not motorcycles) from design to product. She's involved in nearly every step of the process: from design reviews of drawings to assembling experiments, which has fulfilled her need for tactile work. "The Lab has provided me the incredible opportunity to take part in a wide variety of tasks," she says.

As for advice, Sprinkle says, "I attribute my success largely to the fact that I have never thought of myself as a 'woman,' but rather as an engineer with a job to do. Whether you are a man or a woman, peers respect someone who speaks up with conciseness and confidence."

" I HAVE NEVER THOUGHT OF MYSELF AS A 'WOMAN,' BUT RATHER AS AN ENGINEER WITH A JOB TO DO."

ANNA MARIA VIGIL

DETONATOR PRODUCTION DIVISION OFFICE

ENGINEER

Anna Maria Vigil was born and raised in Northern New Mexico but left after college. Fourteen years later, she returned to be closer to family—and to pursue a career at Los Alamos National Laboratory.

Vigil is part of the Continuous Improvement Team within Detonator Production, the division that makes the tiny devices that jumpstart a nuclear weapon. “My focus is on driving operational efficiencies, standardization, and infrastructure project activities,” she explains. Her work is dynamic and varied; some days she’s creating computer-aided design layout options to maximize space or improve process flows; other days she’s managing infrastructure projects.

“My goal is to promote and apply continuous improvement methods to benefit production, quality, and safety within the organization, which is critical to national security,” she says. “Being a tiny, tiny part of something that makes such a difference on a larger scale—national security—is extremely fascinating, rewarding, and, of course, pretty cool.”

Vigil says her colleagues are all part of making that difference. “I work with great people who are willing to share their knowledge and expertise,” she says. “I have been impressed by their willingness to support thinking outside the box, their consideration of all ideas, and their encouragement of continuous learning and improvement.”

◇◆ Vigil hikes to Wheeler Peak, the highest point in New Mexico.

JENNIFER YOUNG

WEAPONS ENGINEERING PROGRAM OFFICE

WEAPONS ENGINEER

As the acting director of the Lab’s Weapons Engineering Program Office, Jennifer Young works with NNSA to report advancements and estimate costs for the Lab’s stockpile stewardship program. Since the pandemic, Young says, “With most of my work being unclassified, I spend a lot of time on the phone and on Webex.”

Young came to the Lab 22 years ago, when she was offered a Director’s Postdoctoral Fellowship to work with Gordon Jarvinen, a former director of the Lab’s Seaborg Institute, which integrates physics, chemical, metallurgical, and nuclear research on plutonium. When her fellowship ended, Young decided to stay at the Lab because she “found the work fascinating, the mission compelling, the possibilities unlimited, and living in this part of the country is a dream come true.”

Young says she’s been lucky to have exceptional bosses at the Lab who believe in her. But that wasn’t always the case. Before she came to Los Alamos, Young worked at a petrochemical plant in Houston and learned that succeeding in STEM as a woman meant she often had to be exceptional to be viewed as competent. “My advice to women is to develop a support network to help you through the trying times that we all encounter,” she says. “And remember to get back up, dust yourself off, and keep going.”

◇◆ Young cross-country skis with her dogs near Taos, New Mexico.

LAURA WORL

PIT PRODUCTION MISSION INTEGRATION

PROGRAM MANAGER

Laura Worl grew up in Indiana, went to school in Delaware and North Carolina, and eventually took a postdoctoral position at Los Alamos so that she could live in a small mountain town and explore the Southwest.

Thirty-one years later, she's still here. "I never imagined that my big move from Indiana for a short-term position would lead to a 30-plus-year career of diverse and fascinating opportunities at the Lab," she says. "I have also raised my three children in Los Alamos and have been able to enjoy beautiful New Mexico and our special community throughout my career. The balance of work and home life is embraced at Los Alamos and has allowed me to pursue both a scientific career and have flexibility with my family and personal interests."

Currently, Worl's work includes establishing safe long-term storage for plutonium materials and providing opportunities to minimize plutonium waste. "My work is tied directly to key capabilities for our plutonium pit production mission," she explains, noting that the mission considers not just national but also global perspectives. "I was honored to participate in a NATO leadership training session in early 2020, and the positive impact that our mission has on the NATO countries is tremendous."

◇◆ Worl rides her horse, Simon, who she has owned and trained since he was a foal.

CINDY ZOLDI

NUCLEAR THREAT ASSESSMENT

WEAPONS PHYSICIST

◇◆ Zoldi mountain bikes in Northern New Mexico.

Since arriving at the Laboratory in 1998, Cindy Zoldi's work has been in national security, with a focus on nuclear weapons. She worked in the B61 program for ten years before leading the Capabilities for Nuclear Intelligence program, which produces science and technology used by the intelligence community to determine the safety and capability of foreign nuclear weapons.

In 2019, Zoldi stepped down as CNI program manager and returned to technical work, where, she says, "I felt I could have more of an impact." Zoldi works in stockpile stewardship, using computer models to simulate the designs of nuclear weapons no longer in the stockpile to better understand possible relevant foreign designs. "My current work," she says, "extends my weapons design expertise to perform global security assessments of foreign capabilities to assess adversary threats and guide future stockpile needs."

Zoldi also supports the Intelligence and Emerging Threats Program, which assesses "foreign threats to our nuclear enterprise and identifies what future capabilities may be necessary to maintain deterrence."

"The world's nuclear landscape continues to evolve," she continues. "We must be ready to deter other nations and show the resiliency of our nuclear stockpile to adversary threats. My work at the Laboratory allows me to do my part to support the safety and security of the nation."

Los Alamos employees: Are you a woman in weapons? *National Security Science* wants to hear your story. Email magazine@lanl.gov. ★

◆ On July 16, 2020, Lisa Gordon-Hagerty visited the Laboratory to commemorate the 75th Anniversary of the Trinity test—the detonation of the world's first atomic device, which was created by Los Alamos scientists during the Manhattan Project. "Beyond the advances in nuclear physics and chemistry that made the first functional, atomic device possible, Trinity was arguably the greatest scientific experiment ever conducted," Gordon-Hagerty said.

"THE GREATEST OPPORTUNITY OF MY LIFETIME"

Lisa Gordon-Hagerty shares her experiences leading the National Nuclear Security Administration and working at a national laboratory (spoiler alert: it wasn't Los Alamos).

BY WHITNEY SPIVEY

Growing up in Michigan, Lisa Gordon-Hagerty's father, a World War II veteran, was a police officer for the city of Detroit. "Besides that, I didn't have much exposure to the military or to national security," she says. "But national security always interested me."

Fast forward more than 30 years, and you'll be hard-pressed to find someone who knows more about national security. From February 2018 to November 2020, Gordon-Hagerty served as administrator of the National Nuclear Security Administration (NNSA). Part of the Department of Energy, the NNSA is responsible for the safety, security, and effectiveness of the U.S. nuclear weapons stockpile. (One way it does this is by operating nuclear weapons laboratories, such as Los Alamos.) NNSA also works to reduce global danger from weapons of mass destruction and responds to nuclear and radiological emergencies in the United States and abroad.

Gordon-Hagerty's work in counterterrorism, nonproliferation, and nuclear security has earned her several pop-culture comparisons. In 1997, for example, when Gordon-Hagerty was the director of the Office of Emergency Response Defense Programs at the Department of Energy, *Peacemaker*, a fictional film starring Nicole Kidman and George Clooney, had just been released.

"The movie portrays nuclear emergency search teams springing into action to save New York from a terrorist nuclear weapon," explained Pennsylvania Congressman Curt Weldon during a hearing of the Military Research and Development Subcommittee of the House National Security Committee. "Today, if a terrorist event such as portrayed in *Peacemaker* were to actually occur, Ms. Gordon-Hagerty would be doing Nicole Kidman's job, coordinating our response to the terrorist threat."

Now, looking back, Gordon-Hagerty says she's "flattered by those comparisons" and that "some of them are pretty amusing." She's quick to note though, that any success she's had is the result of a lot of behind-the-scenes teamwork. "I have been surrounded by experts," she says. "It just happened that I was the leader, so I was the face of it."

The concept of teamwork—of supporting the 50,000 men and women of the national security enterprise—came up often in Gordon-Hagerty's December 2020 conversation with *National Security Science*. "Serving as NNSA administrator was my

▲ Lisa Gordon-Hagerty and New Mexico Congressman (now Senator) Ben Ray Lujan attend a media event at the Laboratory's historic V-Site in July 2020. In the 1940s, V-Site was the high-explosives facility where the Gadget was assembled prior to its detonation at the Trinity site.

pleasure, the greatest opportunity of my lifetime, because of these dedicated men and women who are executing incredibly important work for our nation," she says. "It was an honor to be able to lead them in this incredibly important and critical mission."

Read on for more on Gordon-Hagerty's legacy of service and contributions to the nuclear enterprise.

You started working at Lawrence Livermore National Laboratory in 1986. How did you decide to work there, and what were you doing?

I attended graduate school in health physics at the University of Michigan and conducted my master's thesis work at the Savannah River Plant in South Carolina. [Starting in the 1950s, the Savannah River Plant—renamed the Savannah River Site in 1989—produced materials used in nuclear weapons, such as tritium and plutonium-239.] That was my first entrée into national security and the nuclear security enterprise. Savannah River offered me a position after graduate school. There was also an opportunity at a place called Rocky Flats Plant—good on me for not going there!

On a more serious note, all five of my siblings and I are graduates of the University of Michigan, and four of the six of us, shortly after school, made our way out to California's East Bay. We have an incredibly close-knit family, so that's what made my decision to join Livermore that much easier—and besides that, I was actually going to be a health physicist. I was going to use my skillset at one of the most famous national laboratories in the world.

What were your first impressions of the national laboratories—not just Livermore but also Los Alamos?

In the three and a half years I was at Livermore, I was most intrigued by the breadth of work done there. It wasn't just about national security or the nuclear deterrent; there was so much science and engineering in just about every field imaginable. That being said, at that time, the United States was still conducting underground explosive testing, and Livermore had testing responsibilities. Learning about the importance of testing was quite insightful and later informed my thinking as administrator.

As a health physicist, I worked in Livermore's plutonium facility alongside great technicians, metallurgists, actinide chemists, and physicists. I believe I'm one of the few people who has worked in a plutonium facility and been a bureaucrat—I view that as a badge of honor.

During that time, I was also the x-ray safety person for Livermore, and I had an opportunity to come to New Mexico to visit with the x-ray safety team at Los Alamos. Even 30 years ago, what I saw there was a robust health and safety program. It was obvious that Los Alamos knew how to work safely with highly hazardous

▲ Lisa Gordon-Hagerty visits the Lab's Plutonium Facility during a visit to Los Alamos in July 2020.

materials—but materials that make a great contribution to our national security.

After Livermore, you moved to Washington, D.C., to work on the United States House Committee on Energy and Commerce. Why did you decide to make the transition into government?

When I was at Livermore, I met a professional staff member of the House Energy and Commerce Committee who needed a person with technical expertise. As a result, I found my way to Washington, D.C., on a one-year detail [short-term assignment] at the request of the ranking member of the committee.

I was able to, due to my technical expertise, help balance the playing field—to provide some modicum of sense to members of Congress who were conducting oversight to missions that involved plutonium or highly enriched uranium. Most people don't know about plutonium and uranium; they just hear about the bad things, never taking the time to study the invaluable missions that are executed with these materials. What I tried to do was provide some objectivity and to share how operations were being executed at the national labs, plants, and sites.

I had every intention that I would return to Livermore, but that one year turned into two years, which turned into 30 years, and here I am, still in Washington.

That short-term assignment was pivotal to your career in that it brought you to Washington, D.C. But how did it change your perception of the relationship between scientists and policy makers?

Those two years as a professional staff member are really important and a critical detail in my career. I recall working at Livermore and more than once thinking, "What are those bureaucrats in Washington thinking? Why do they need this now? Why are they making up these silly rules?"

When I came to Washington, I gained a new appreciation for why the federal staff was asking for an issue paper on plutonium or metallurgy or a particular weapons system. Having interactions with both headquarters and the field opens up the aperture for what is really going on and how requirements are developed for our programs. It's really a two-way street, and at the end of the day, most importantly, we're on the same team. It's also one of the reasons, during my tenure as administrator, I was so keen on the NNSA workforce taking advantage of one- and two-year details to other parts of the nuclear security enterprise.

You led the NNSA for nearly three years. What was the most rewarding part of that experience?

My goal has always been and continues to be to support our nation's nuclear security and our national security program. My intent, actually, was never to be the administrator, but I was honored and humbled to serve in that capacity. I don't regret a minute of it. Working with the fine men and women of NNSA has truly been the highlight of my career.

NNSA could have the best facilities and state-of-the-art supercomputers, but without the dedicated people of the enterprise, we're nothing. I used to joke that my job will be done when I'm able to shake the hand of every man and woman throughout the NNSA enterprise and thank them for their duty and commitment to our nation. Most Americans will never have any idea about the contributions only NNSA can make to our nuclear deterrent, but at least there would be someone to thank our workforce for its dedicated support to the mission.

Can you talk about your leadership style?

As administrator, my leadership style was to make fully informed decisions in a coordinated and integrated fashion. I allowed people to exercise their expertise by thinking about health, safety, and security from different perspectives. I asked the team to bring me their issues, to show me how we could execute our missions safely and "get me to yes."

Leading means something, and one person has to lead. I took charge of the organization, and it was an invaluable experience. Hopefully, I made a difference in our national security and represented the fine men and women as best I could. I believe that every single person in an organization matters. Every single person—whether you're a welder, a pipe fitter, administrative assistant, or a primary designer—every single person contributes to our nation's national security. No one is more important than anyone else, and everyone contributes.

What are your biggest contributions to the nuclear enterprise?

Reestablishing a plutonium production capability in the United States and ensuring that Congress and the executive branch understood the implications of that capability is perhaps my biggest contribution.

"I'm one of the few people who has worked in a plutonium facility and been a bureaucrat—I view that as a badge of honor."

Further, I wanted to ensure that NNSA had the budget to rebuild the necessary infrastructure and hire the workforce of the future. Our workforce currently executes missions that no one else can do in 50-plus-year-old facilities. Constructing new nuclear facilities is going to take 10–20 years, and we must concurrently maintain the existing infrastructure—both of which require adequate funding, and I believe we achieved that important step.

Additionally, 40 percent of the workforce is going to be retirement-eligible in the next five years. But to replace them with the best, brightest, and most qualified new hires, we need to have a consistent budget throughout the NNSA enterprise. The worst thing that could happen is to hire these brilliant people for a year or two and then have to lay them off. They will never return to the NNSA family.

How do we get people interested in the NNSA family in the first place? How do we encourage kids to pursue STEM (science, technology, engineering, and math) opportunities?

I certainly advocate for girls and young women to go into STEM, and making sure they have access to and are interested in STEM fields is critical. The significant efforts undertaken by the nuclear security enterprise have been successful, but there's more work to do. This is not a singular "male or a female" topic but a significant U.S. issue that we need to tackle together to keep our national security strong here in the United States. That being said, we should do everything we possibly can to get girls interested in national security, and I always jump at the chance to speak with girls and advocate their studying science and engineering—because it's fun! I may sound like a nerd, but it's truly fun.

As administrator, I always supported "Take your kid to work day." Our employees would bring their children, and I loved it. To me, those days gave children unique insight into what their parents' workplace is like, as well as an opportunity to see firsthand that there are others dedicated to serving national security missions. Perhaps they'll remember that in the future.

More broadly, NNSA supports STEM education and minority-serving programs by contributing more than $100 million a year across the nation's education system. That funding and support must continue; our nation will suffer otherwise.

At the end of the day, my main message I want to send to women and men, boys and girls, is to reach for the stars no matter what area you're interested in—administration, public affairs, science and engineering, anything. Believe in yourself. Take advantage of every opportunity that's presented to you. I hope I can continue to serve as a model of that philosophy.

What advice do you have for people interested in working at one of our national laboratories?

The national laboratories are incredible places to work. National laboratories offer opportunities unlike any private sector company or any other government organization because there are so many different mission areas being executed every day. Take NASA's Mission to Mars. Los Alamos made the heat source for the Perseverance rover in the plutonium facility where they work on materials for our nuclear deterrent. That's a perfect example of the strength and scope of the national laboratories.

As administrator, I tried to ensure that everyone outside of our enterprise understood what it takes to work at Los Alamos and our national labs, plants, and sites. You don't walk in off the street. Obtaining a security clearance, working in glovebox operations, and becoming a nuclear weapon designer all take several years of training—these are not things that can be handled in a day or that just anybody can do. I saw firsthand the grit and the dedication of every single person in the workforce, and I thank them from the bottom of my heart for the work they're doing for our great nation. ★

INSPIRING SCIENCE IN FUTURE GENERATIONS

Astrophysicist Nicole Lloyd-Ronning works with youth across Northern New Mexico.

BY OCTAVIO RAMOS

On a clear summer evening, Nicole Lloyd-Ronning of Los Alamos National Laboratory's Computational Physics and Methods group steps outside her house and looks at the stars in the sky. As an Army brat growing up at various locations in the United States and Germany, Lloyd-Ronning would often stand outside the military housing where her family lived and stare at the moon. She imagined herself one day venturing into outer space and exploring the moon and the planets beyond.

"I wasn't super-focused on 'sciencey' things growing up," Lloyd-Ronning notes. "I played a lot of sports, had a lot of interests. It wasn't until late high school—thanks to some amazing teachers—that I discovered I really liked physics and math. That was the route I wanted to pursue in the hopes of becoming an astronaut."

Now, Lloyd-Ronning is an astrophysicist studying gamma-ray bursts. Her career path was a bit different than she expected, she admits, and deep inside she still wishes for the chance to experience space as an astronaut. "I've not let go of the dream," she says, a twinkle in her eye.

LIFE INTERRUPTS CAREER

In 2004, a few years after she received her doctorate in physics from Stanford University, Lloyd-Ronning joined the Laboratory as a Director's Postdoctoral Fellow. Early on, she found that she had to make a decision about pursuing her career or taking care of her children.

"I couldn't seem to find balance as a postdoc with young children, and I had trouble finding childcare that worked for our family," Lloyd-Ronning explains. "It was a frustrating time, and I decided to take a career break, during which I stayed home with my three kids for the next 10 years."

Through the help of the M. Hildred Blewett Fellowship from the American Physical Society, Lloyd-Ronning came back to work nearly five years ago. As a subcontractor, she spends about half the week working at the Laboratory. She also is on the faculty of the University of New Mexico–Los Alamos, where she teaches courses in physics and modern astrophysics.

Nicole Lloyd-Ronning's fascination with outer space has never wavered. Here she is standing behind a telescope at the Los Alamos Nature Center Planetarium.

As a Scientist Ambassador, Nicole Lloyd-Ronning leads an activity for students from the Santa Fe Indian School.

INSPIRING FUTURE GENERATIONS

The Laboratory's Community Partnerships Office contacted Lloyd-Ronning after she had been back at work for a few years. The office wanted to know if she could assist Taos artist Agnes Chavez, who needed the expertise of an astrophysicist. This collaboration led to Lloyd-Ronning's involvement at the PASEO 2018: Indigenous Cosmology Meets Particle Physics Youth Workshop.

At this workshop, Lloyd-Ronning led a hands-on activity that reinforced that western science textbooks and indigenous cosmology are not in conflict—they are very much on the same page. Through this activity, she hoped that students deepened their understanding of the cosmos while merging Feynman diagrams (which visualize how particles interact with each other) and petroglyphs (which are Native American visual stories carved into rock).

"With outreach, it's all about creativity; I don't lecture the kids in any way," Lloyd-Ronning says.

Lloyd-Ronning's outreach also includes STEMarts Lab, the program Chavez founded to deliver sci-art installations and STEAM (science, technology, engineering, arts, and math) programming for schools, art and science organizations, festivals, and events.

She's also a Scientist Ambassador for the Laboratory's Bradbury Science Museum, where she promotes the public's understanding of science, technology, and engineering. "It's been gratifying to engage people who might otherwise not discuss science in their daily lives," she says. "And, maybe most importantly, it's made me a better communicator of the things I work on, and why these things might matter to everyone, scientist or not."

IMPRESSIVE YOUNG MINDS

As part of her outreach efforts, Lloyd-Ronning has developed programs and is regularly performing hands-on physics experiments with students throughout Northern New Mexico. She helps develop curriculum and mentorship programs for area schools and occasionally gives planetarium shows.

Lloyd-Ronning is often amazed by the impressive young minds she encounters during her efforts. "The students are brilliant and inquisitive, and they really work together to figure things out when we are doing an activity," she says. "I frequently get knocked off my feet by second-graders asking things that get at the core of fundamental physics." ★

THE DISTINGUISHED ACHIEVEMENTS OF LOS ALAMOS EMPLOYEES

The Los Alamos Public Safety Association presented Laboratory Medical Director Sara Pasqualoni with the Public Safety Dedication Award for her work in the fight against COVID-19, both at the Laboratory and in the Los Alamos community.

Six Laboratory physicists were elected Fellows of the American Physical Society (APS): Luis Chacon, Andrea Favalli, Ralph Menikoff, Andrea Palounek, Nikolai Sinitsyn, and Blas Uberuaga. The APS Fellowship Program recognizes APS members who made advances in physics through original research and publication or made significant innovative contributions in the application of physics to science and technology.

Evelyn Mullen, chief operating officer for Global Security, was named a Fellow of the American Nuclear Society for her leadership in nuclear national security and for ensuring the nation's experimental capability in nuclear criticality. Mullen was instrumental in developing plans for new diagnostic capabilities for subcritical plutonium-integrated experiments at the Nevada National Security Site. Read more about Mullen on p. 15.

Five Los Alamos scientists were named Fellows of the American Association for the Advancement of Science (AAAS): David Chavez (High Explosives Science and Technology), Patrick Fitch (Chemistry, Earth, and Life Sciences), Chris Fryer (Computational Physics and Methods), Marcelo Jaime (National High Magnetic Field Lab), and Robert Williams (Bioenergy and Biome Sciences). AAAS awards members this honor because of their scientifically or socially distinguished efforts to advance science or its applications.

Nathan Moody, Accelerators and Electrodynamics group leader, is a co-winner of the Institute of Electrical and Electronics Engineers Nuclear and Plasma Sciences Society 2021 Particle Accelerator Science and Technology Award.

Seven scientists and engineers were named 2020 Laboratory Fellows: Tanmoy Bhattacharya (Nuclear and Particle Physics, Astrophysics, and Cosmology), Christopher Fontes (Materials and Physical Data), Vania Jordanova (Space Science and Applications), Thomas Leitner (Theoretical Biology and Biophysics), John Lestone (Radiation Transport Applications), Joseph Martz (Materials Science and Technology), and Ralph Menikoff (Physics and Chemistry of Materials). "To be a Fellow is to be a leader at the Laboratory and within the scientific community at large," says Laboratory Director Thom Mason.

Piotr Zelenay, of the Materials Synthesis and Integrated Devices group, was recognized with a 2020 Department of Energy Hydrogen and Fuel Cells Program merit review award for his leadership in the Electrocatalysis Consortium (ElectroCat), a research group created in 2016 as part of the Energy Materials Network.

David Harvey was selected as a 2020 Fellow of the American Society for Nondestructive Testing. Harvey was cited for his professional distinction and continued significant contributions to the advancement of nondestructive testing and evaluation. Nondestructive testing is the process of inspecting, testing, or evaluating materials, components, or assemblies for discontinuities without destroying the serviceability of the part or system.

Adam Rondinone is the new co-director for the Center for Integrated Nanotechnologies. "CINT is a nanoscience center, but nanoscience isn't really about nanobots like we see in the popular press. It's about advanced materials, the interface of biology with materials science, new optical and electronic devices, and lately, quantum information sciences. It's also about developing new techniques to examine and understand the world around us," Rondinone says. "My goal is for CINT to be deeply integrated into the Los Alamos mission in addition to being a national resource."

Sumantra Sarkar, a scientist specializing in self-replicating materials, received the 2021 Irwin Oppenheim Award from the American Physical Society. "Self-replication is a biophysical process through which an object can create a near identical replica of itself," Sarkar says. "In the awarded work, I developed a theoretical model of self-replicators, which I used to provide guidelines for designing artificial self-replicators. That work is helping scientists design experiments to build artificial cells or to understand the origin of life."

BETTER SCIENCE = BETTER SECURITY

Hardworking people—the Laboratory's most important asset—enable Los Alamos to perform its national security mission.

IN MEMORIAM

Loren Gilmore Lundquist

U.S. Army Lieutenant Colonel Loren Gilmore Lundquist joined Los Alamos as a technical staff member in the primary design group in 1984. He worked on advanced primary designs that resulted in a number of successful hydrodynamic and nuclear tests.

Lundquist, 78, passed away on December 16 after a long illness. "He will be long remembered for his insights into primary design, his firm-but-kind mentoring style, and his unwavering dedication to our mission and our country," says Brian Lansrud-Lopez, leader of the X Theoretical Design Division. "His contributions will continue to protect our nation and its allies for years to come." ★

32 YEARS AGO

In 1964, biochemist Julia Hardin came to Los Alamos to study the effects of radiation on DNA. According to Los Alamos bioscientist Babetta Marrone, Hardin's research aided national security by helping "to inform the development of occupational health and safety practices for nuclear workers."

Like many women at that time, Hardin began her career as a research assistant, but it wasn't long before she wondered if research assistant was the correct job title. "I raised the question of whether my qualifications were appropriate for a staff member position," she told *The Atom* magazine in 1974. As a result, Hardin was promoted, as were several other women. "I don't claim I effected any change," she said. "But then, I think if you are constructive in your attitudes, instead of destructive, change will come. I believe that." Hardin, pictured here in 1989, worked at Los Alamos until her death in 1991. Read more about Hardin on p. 23. ★

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THEN + NOW

In 1945, Nancy Connely began working as a lab assistant at Project Y (the Los Alamos, New Mexico, branch of the Manhattan Project) for $175 per month. Her hiring letter was a stock letter sent so frequently to men that the salutation reads “Dear Sir,” with the “Sir” crossed out and replaced with “Madam.”

Connely, who married Manhattan Project engineer John Idenden, is pictured here at Bandelier National Monument in New Mexico on February 24, 1946. Bandelier became a national monument on February 11, 1916, and celebrates its 105th birthday in 2021. ★