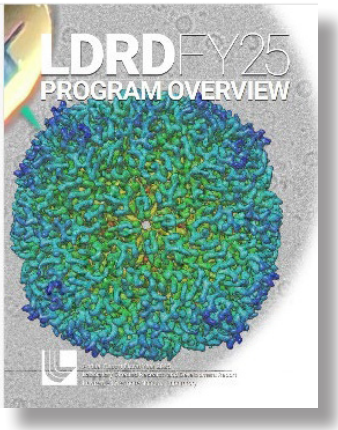
Quarterly Highlights

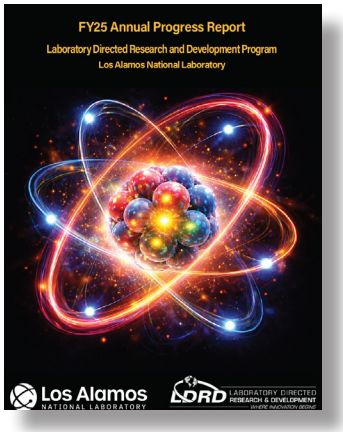
FY26 Q2

FY25 LDRD Annual Reports

SANDIA



LLNL



LANL

NNSS

FEATURED HIGHLIGHTS FOR Q2

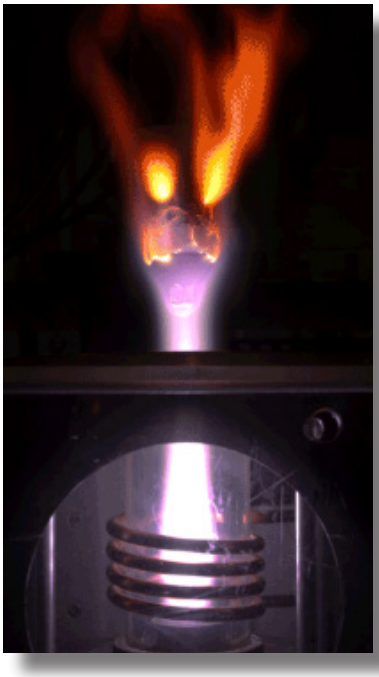
Sandia National Laboratories

It is rocket science: New heat shields, faster

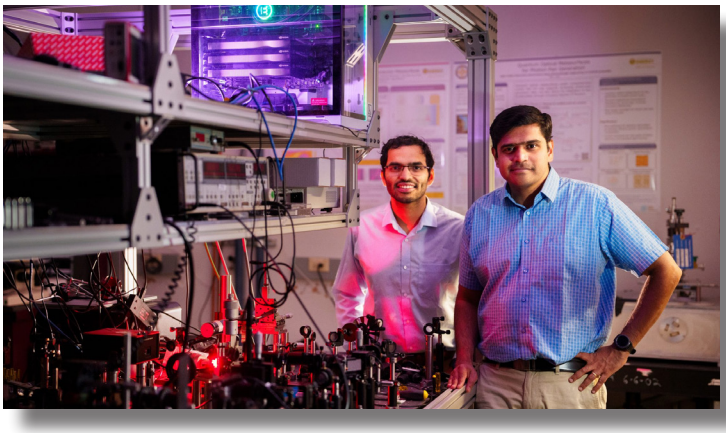
Heat shields are critical for protecting vehicles from the intense heat and friction of atmospheric reentry or traveling at many times the speed of sound.

Now, a team of Sandia engineers have developed ways to rapidly evaluate new thermal protection materials for hypersonic vehicles. Their three-year LDRD project combined computer modeling, laboratory experiments and flight testing to better understand how heat shields behave under extreme temperatures and pressures, and to predict their performance much faster than before. Read more...

Mission Agility, Technical Vitality



Sandia engineers test a thermal protection system material in an inductively coupled plasma torch. Material such as this protect hypersonic vehicles from the intense heat of traveling at more than 3,800 miles per hour. (Photo by Craig Fritz)



Sandia scientists Saaketh Desai, left, and Prasad Iyer, modernized an optics lab with a team of artificial intelligences that learn data, design and run experiments, and interpret results. (Photo by Craig Fritz)

Physicists employ AI labmates to supercharge LED light control

In 2023, a team of physicists from Sandia announced a major discovery: a way to steer LED light. If refined, it could mean someday replacing lasers with cheaper, smaller, more energy-efficient LEDs in countless technologies. The team assumed it would take years of meticulous experimentation to refine their technique.

Now, the same researchers have reported that a trio of AI labmates has improved their best results fourfold. It took about five hours. Read more....

Technical Vitality

Lawrence Livermore National Laboratory

LLNL, Meta co-develop groundbreaking polymer-chemistry dataset for training AI models

Polymers are fundamental to our daily lives, serving as the core components for a wide array of goods, including clothing, packaging, transportation infrastructure, construction materials and electronics. Advances in polymer science open pathways for recycling and upcycling waste materials into more valuable chemical feedstocks. They also can have an outsized environmental impact: many widely used polymers are Per- and Polyfluoroalkyl Substances (PFAS), widely recognized as "forever chemicals." Read more....

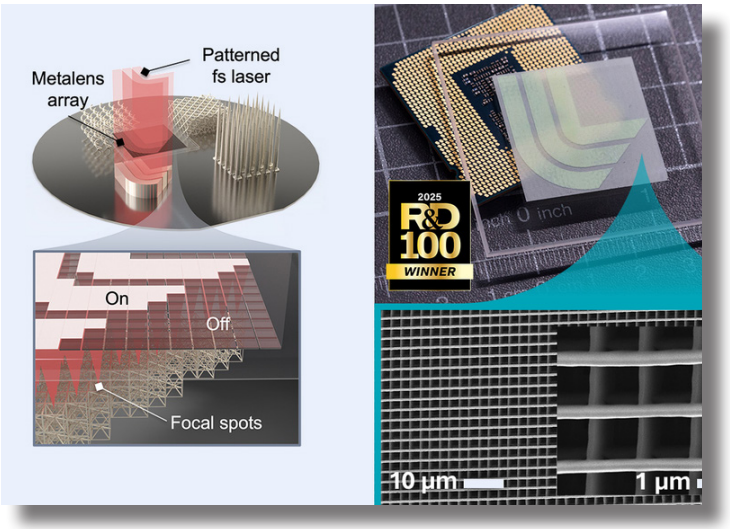
Mission Agility, Technical Vitality

In a pioneering partnership to accelerate materials discovery with AI, researchers from Lawrence Livermore National Laboratory and Meta have created the world's largest open dataset of atomistic polymer chemistry — a trove of millions of quantum-accurate simulations designed to help AI model the complex behavior of plastics, films, batteries and countless everyday materials. (Graphic: Dan Herchek/LLNL; background image: Evan Antoniuk/LLNL)

LLNL researchers break speed and scale barriers in 3D nanofabrication with new meta-optics platform

Lawrence Livermore National Laboratory (LLNL) engineers and scientists, in collaboration with Stanford University, have demonstrated a breakthrough 3D nanofabrication approach that transforms two-photon lithography (TPL) from a slow, lab-scale technique into a wafer-scale manufacturing tool without sacrificing submicron precision.

Published in Nature, the team's TPL platform uses large arrays of metalenses — engineered, ultrathin optical elements — to split a femtosecond laser into more than 120,000 coordinated focal spots that write simultaneously across centimeter-scale areas. The metalens-based method produces intricate 3D architectures with minimum feature sizes of 113 nanometers and achieves throughput more than a thousand times faster than commercial systems. Read more....



A breakthrough two-photon lithography platform from a team of Lawrence Livermore National Laboratory and Stanford University researchers uses large arrays of metalenses to split a femtosecond laser into more than 120,000 coordinated focal spots that write simultaneously across centimeter-scale areas. The method produces intricate 3D architectures with minimum feature sizes of 113 nanometers and achieves throughput more than a thousand times faster than commercial systems. (Images: Songyun Gu)

Technical Vitality

Los Alamos NATIONAL LABORATORY

LANL researchers Saryu Fensin and Janith Wanni are integrating autonomous robots with a brand-new AI model designed to transform materials discovery. (Image Credit: LANL)

From decades to days: How artificial intelligence (AI) is transforming materials science

Materials discovery has traditionally been a slow, incremental and labor-intensive endeavor. "The problem that scientists face when they're developing new materials is time and resources," said Saryu Fensin, a materials scientist at LANL. "It would take me 10 to 20 years to get all the testing done and validate the material before it can be brought to market. But AI is speeding this process up." Fensin and her team are pushing this frontier by integrating autonomous robots with a brand-new AI model designed to transform materials discovery. The robots are trained to perform a sequence of precise tasks: material pickup, weight measurement, compressive and tensile load testing, and failure characterization. Every data point they collect feeds into a growing database that trains and refines the emerging AI model. Watch the video....

Mission Agility, Technical Vitality, Workforce Development

Nuclear reactors are among the most efficient power sources globally, and their numbers continue to grow. This increases the need for robust monitoring methods to ensure compliance. (Image Credit: Cooling Towers by Petr Kratochivil - PublicDomainPictures.net)

LANL researchers are analyzing nuclear materials like a detective to enhance power plant security

Nuclear power provides approximately 10% of the world's power, and more power plants are slated for future production. Scientists at Los Alamos National Laboratory are creating novel methods to remotely monitor nuclear reactor operational status through a better understanding of nuclear material signatures.

Why this matters: To prevent unsanctioned use of reactors, authorities must be able to monitor how reactors are used and their compliance to treaties. The methods used in this team's research provide new techniques to remotely monitor conditions near nuclear reactors to provide insights into operational status as well as material and heat releases. Read more....

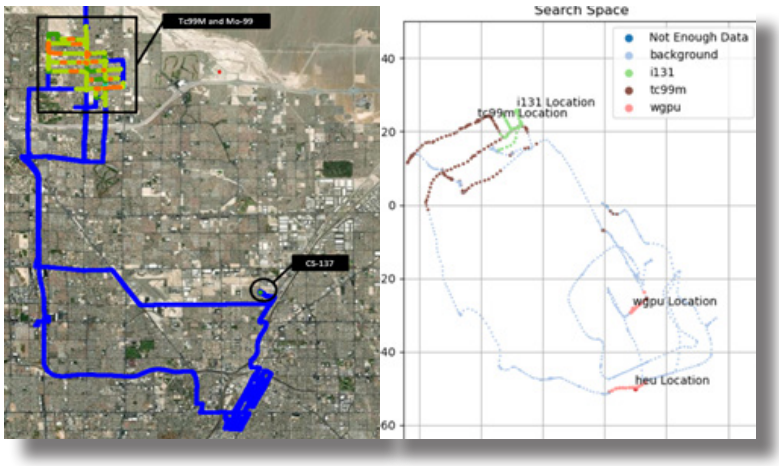
Mission Agility, Technical Vitality, Workforce Development

NEVADA NATIONAL NNSS SECURITY SITES

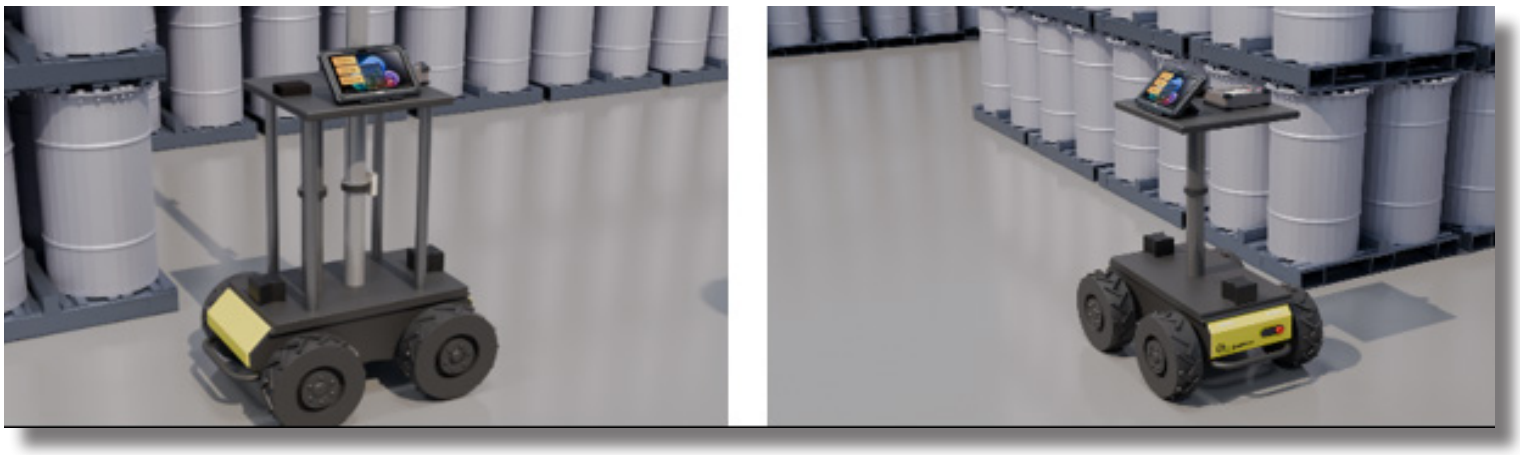
Carson Schuetze revitalizes nuclear search with machine learning

As artificial intelligence has become more common within scientific research, Site-Directed Research and Development (SDRD) PI Carson Schuetze recognized an opportunity to improve the efficiency of the nuclear search mission at the Nevada National Security Sites (NNSS). The mission needs include increased threat detection probability without increasing the false alarm rate, increased analyst sensor throughput, anomaly prioritization, and optimized sensor time on-target. Carson realized that these could all be addressed with the use of machine learning (ML), an idea she began exploring in her fiscal year (FY) 2025 SDRD project. Read more...

Mission Agility, Technical Vitality



Convolutional Neural Network (CNN) results over simulated (left) and real data (right). (Image Credit: NNSS)



The DEER roves the path to a smarter and safer future. (Image Credit: SRS)

Meet the DEER: Autonomous robot transforming radiation monitoring

Imagine a robot intelligently navigating on its own, tirelessly working to protect humans from unseen dangers while ensuring critical tasks are uninterrupted – meet the DEER, the future of radiation monitoring. Savannah River Nuclear Solutions (SRNS) Engineering is pioneering this game-changing innovation: an autonomous guided vehicle (AGV) equipped with radiation monitoring systems that's set to transform how nuclear material storage areas are monitored. By collecting accurate radiation data while reducing risk to personnel, the DEER, or Dose Exposure Estimation Robot, is not just a machine – it's a beacon of safety, efficiency, and technological progress; and the countdown to its groundbreaking debut has already begun.

Progress on the DEER has been steady, with multiple facets of the project already nearing completion. Engineers have crafted and beta programmed the robot's advanced navigation system, enabling seamless autonomous movement. Meanwhile, the design and fabrication of a mounting pedestal – crucial for securing the radiation monitoring equipment – are finalized, ensuring a stable platform for reliable data collection. Additionally, key hardware acquisitions are underway, and the security plan has been submitted for final approval, ensuring that all operational safety considerations are wrapped up before the DEER rolls onto the field.

When fully operational, the DEER will shift how radiation monitoring is handled in nuclear facilities. The traditional reliance on personnel to conduct manual scans, often in high-risk environments, will become a thing of the past. With the DEER on the job, the tasks of collecting and analyzing radiation levels will not only be more accurate but also significantly safer. This means Radiation Protection teams can redirect their talents to address priority challenges without compromising on monitoring quality.

SRNS' commitment to innovation is setting a new benchmark in solving real-world challenges. The DEER exemplifies their forward-thinking vision, offering a solution that pushes the boundaries of autonomous technology while prioritizing human well-being. As its development rolls toward completion, the DEER symbolizes a momentous step forward – one where advancements in science and technology align perfectly with the pressing demands of today's nuclear operations. Get ready to welcome a safer and smarter future, one path at a time.

Mission Agility, Technical Vitality, Workforce Development

AMAZING LDRD HIGHLIGHTS

MAKING WIRELESS DEVICES SMALLER AND MORE EFFICIENT: New laser developed through Sandia LDRD collaboration uses sound instead of light > Technical Vitality, Workforce Development

UNDER PRESSURE: From fleeting to stable: LLNL scientists uncover recipe for new carbon dioxide-based energetic materials > Mission Agility, Technical Vitality

LLNL STUDIES CRYSTAL DEFECTS: Allowing atoms to come and go opens the door to better materials modeling > Mission Agility, Technical Vitality

LLNL TACKLES CLEANING UP WASTEWATER: Turning wastewater into valuable fertilizer > Mission Agility, Technical Vitality

LANL SCIENTISTS ASSESS UNDERGROUND HYDROGEN STORAGE: Evaluating hydrogen recoverability using core feasibility metrics > Mission Agility, Technical Vitality, Workforce Development

LANL SCIENTISTS SHAPE THE FUTURE OF NEUTRON RADIOGRAPY: Capturing neutron imaging data with higher resolution and greater fidelity > Mission Agility, Workforce Development, Technical Vitality

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This newsletter, published quarterly, features LDRD, SDRD, and PDRD work done by Lawrence Livermore, Los Alamos, Nevada National Security Sites, Sandia, and Y-12 National Security Complex. To see a PDF with all articles referenced in this newsletter or review past issues, visit https://lanl.gov/engage/orgnaizations/nnsa-directed-r-and-d/ and click on the Quarterly Highlights tab. SAND 2026-19683O

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