

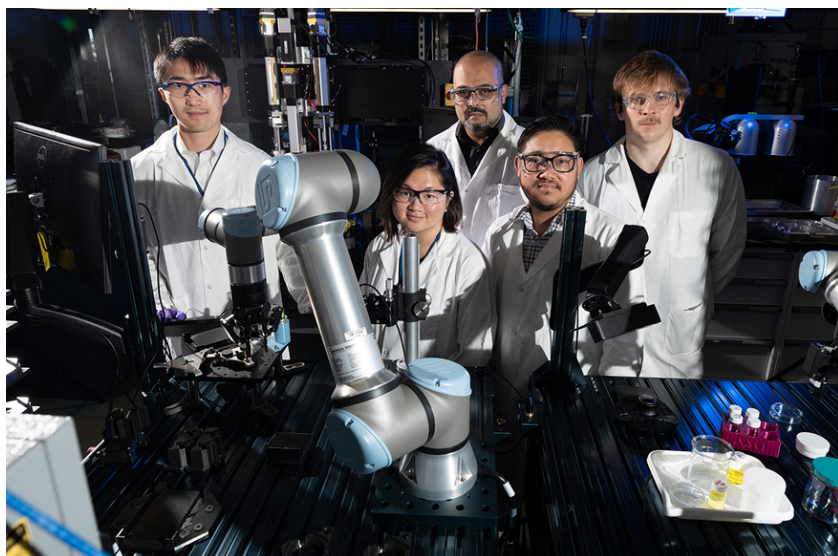
QUARTERLY HIGHLIGHTS

FY26 Q4

The Laboratory Directed Research and Development (LDRD) program drives innovative research and develops capabilities that enable agile responses to national security challenges. These highlights showcase recent LDRD-related technical advances, mission-impacts, and collaborative successes across the National Nuclear Security Administration's (NNSA) Nuclear Security Enterprise.



FEATURED HIGHLIGHTS FOR Q4



How LLNL is using AI, robotics and automation to accelerate advance manufacturing

Lawrence Livermore National Laboratory (LLNL) scientists and engineers, in conjunction with the Department of Energy (DOE) and National Nuclear Security Administration (NNSA), are increasingly looking to AI, robotics and automation to help accelerate advanced manufacturing, materials discovery and experimental science. The work is part of a broader push to move faster from concept to deployment in mission-relevant technologies .

[Read more...](#)

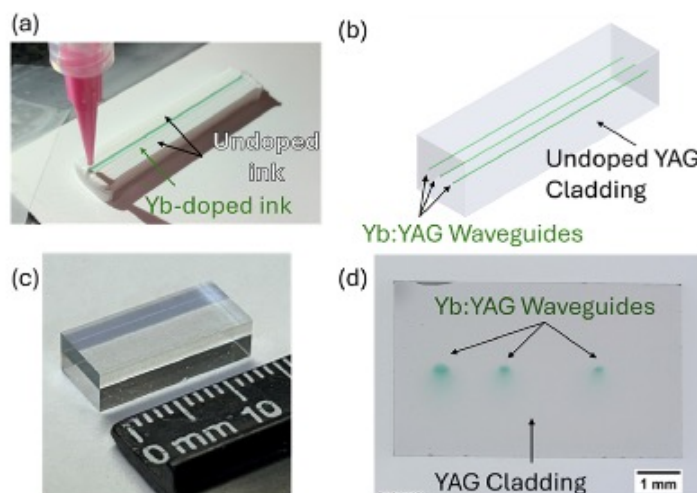
► Mission Agility, Technical Vitality

Lawrence Livermore National Laboratory is increasingly looking to AI, robotics and automation to help speed the process of advanced manufacturing. Pictured are (from left) Robotics and Automation scientists and engineers Tony Qin, Karly Knox, Abhik Sarkar, Aldair Gongora and Michael Troksa. (Image credit: Blaise Douros/LLNL)

3D-printed ceramic waveguide lasers could surpass the power of glass fiber lasers by 10 times

Waveguiding optics are among the most important advances in photonics since the invention of the laser. They are fundamental to the structure of glass fiber lasers, which are used for high-power national security applications like counter-drone laser systems and missile defense.

Now, researchers at Lawrence Livermore National Laboratory (LLNL) have fabricated a first-of-a-kind all-ceramic waveguide with 3D printing. The work was published in [Optics Letters](#). “With further development, this crystalline architecture could enable more than a tenfold increase in output power over glass fibers while retaining a compact footprint,” said LLNL scientist and author Ross Osborne. [Read more...](#)



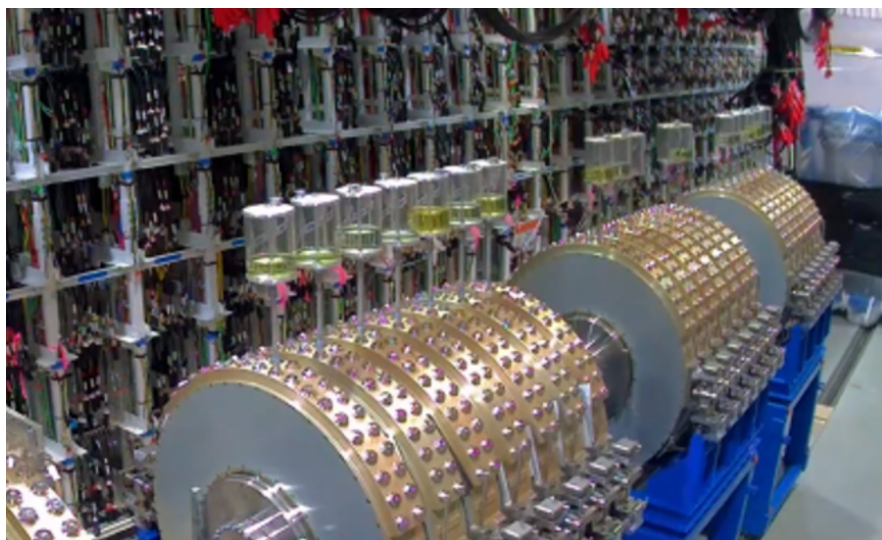
LLNL researchers 3D-printed a transparent ceramic waveguide based on ytterbium-doped yttrium aluminum garnet, or Yb:YAG. This approach could be used to greatly increase the power of fiber laser systems. (Image credit: Osborne et al.)

➤ Mission Agility, Technical Vitality,



NNSS Partners with UNR to Prepare a Mission-Ready Workforce

To prepare for future Scorpion operations and strengthen the specialized technical capabilities needed for current and future NNSA missions, the NNSS has partnered with the University of Nevada, Reno (UNR) in an enhanced collaboration effort *Scorpion Accelerator Modules at the NNSS Integrated Test Stand (ITS)*. The effort is designed to develop critical skills within the existing NNSS workforce, create hands-on, mission-relevant research opportunities for students and faculty, and establish a long-term pipeline of scientists and engineers familiar with the NNSA mission.



Scorpion Accelerator Modules at the NNSS Integrated Test Stand (ITS). (Image credit: NNSS)

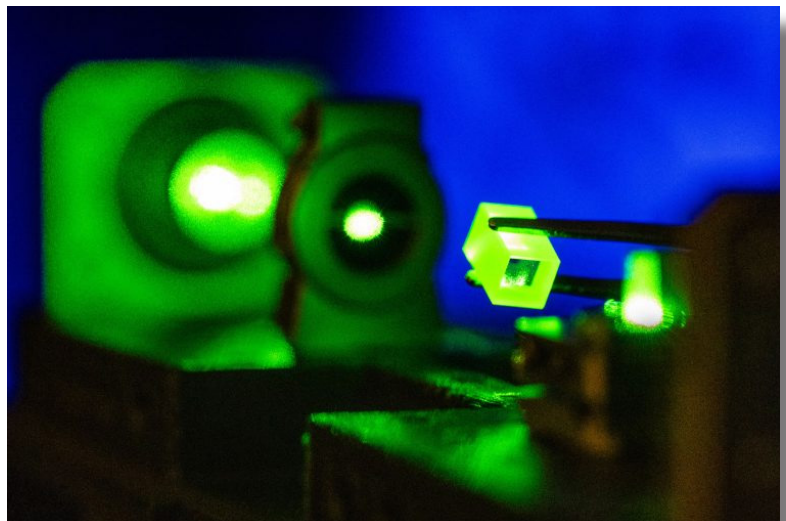
➤ Mission Agility, Technical Vitality, Workforce Development



**Sandia
National
Laboratories**

Crystal power: Magnetic field sensors for fusion research, pulsed power

Intense magnetic fields in some of the harshest experimental environments in science are being measured by Sandia to benefit fusion research, pulsed-power experiments, and high-energy physics. The sensor that the LDRD research team developed uses a rare earth crystal and laser light that could help collect precise measurements in places where conventional sensors can struggle with radiation, electrical interference, or plasma conditions. [Read more...](#)



A rare earth garnet used by Sandia researchers to measure intense magnetic fields, such as those needed for fusion research and high-energy physics experiments. Here, the crystal is being illuminated by a green laser. (Image credit: Craig Fritz)

➤ Mission Agility, Technical Vitality



Sandia AI researcher Georgios Fragkos said locating a threat is key to shutting down a potential cyber-physical attack to the electric grid. (Image credit: Craig Fritz)

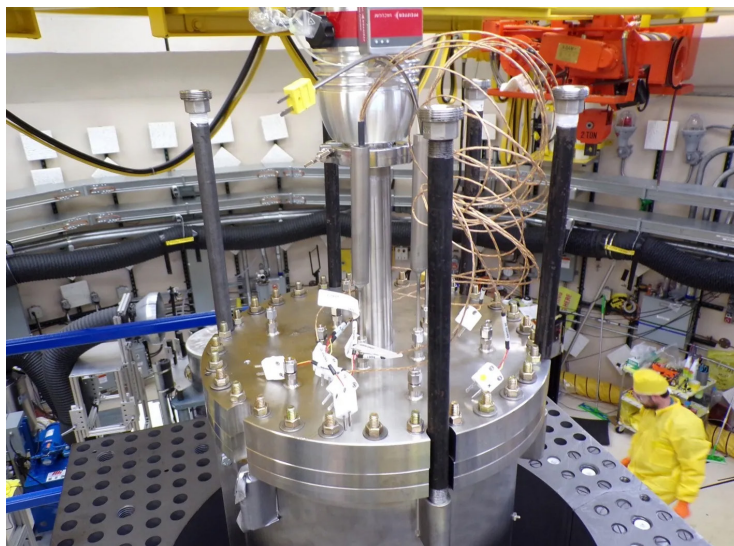
Fighting AI with AI to protect the electrical grid

Cyberattacks on the electrical grid could plunge cities into darkness, crippling everything from hospitals and emergency services to food supply chains and transportation. To counter this danger, LDRD researchers are leveraging Sandia's deep capabilities in threat detection, risk assessment and the development of new generative AI tools to create a system that can both detect and locate cyber-physical threats targeting the electrical grid. Data engineering was the key to the solution. [Read more...](#)

➤ Mission Agility, Technical Vitality

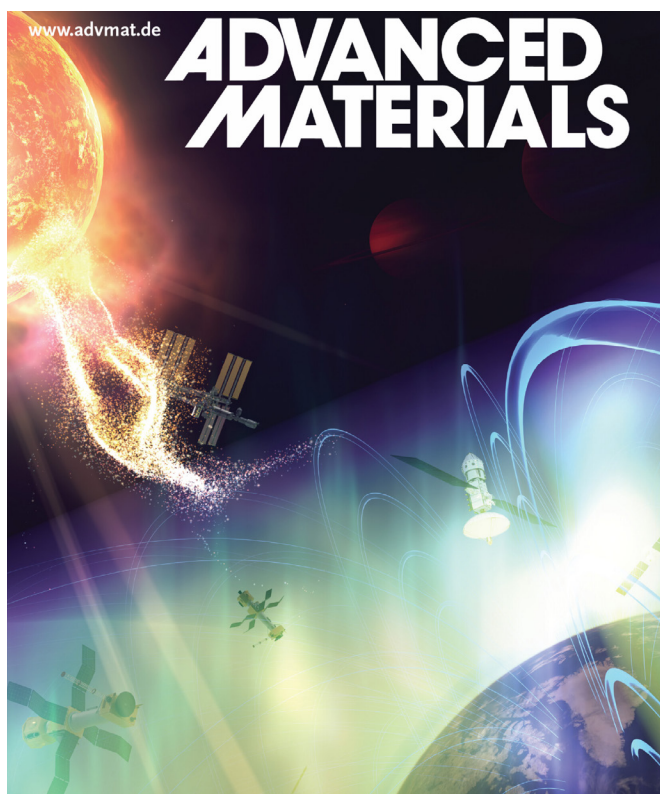
ZiaCore microreactor successfully achieves criticality

The emerging technology of advanced nuclear microreactors offer solutions to many modern energy challenges. The ZiaCore design, a low-enriched uranium dioxide-fueled microreactor developed by Los Alamos National Laboratory, now joins several developing concepts for fission-based nuclear power microreactors achieving initial criticality. The ZiaCore design reached this milestone with the execution of a proof-of-principle experiment with a high-temperature, zero-power criticality demonstration at the National Criticality Experiments Research Center in Nevada. The ZiaCore LDRD project was first initiated in 2021 and is an excellent demonstration of LANL's ability to rapidly develop advanced capabilities through LDRD support. [Read more...](#)



*The top flange of the ZiaCore microreactor experiment.
(Image credit: LANL.)*

➤ Mission Agility, Technical Vitality, Workforce Development



New Radiation-Resistant Aluminum Alloy for Space Missions in the Extreme Environment of the Solar System

In this recently published article that was featured on the cover of Advanced Materials, researchers introduce a newly developed ultrafine-grained crossover alloy for long-duration deep space missions. The alloy shows exceptional resistance to extreme irradiation, with no notable hardening or embrittlement, making it a promising lightweight material for future spacecraft and extraterrestrial exploration. [Read more...](#)

➤ Mission Agility, Technical Vitality

Image Credit- Willenshofer, P.D., Tunes, M.A., Vo, H.T., Stemper, L., Alfreider, M., Renk, O., Greaves, G., Kiener, D., Uggowitzer, P.J. and Pogatscher, S. (2026), Radiation-Resistant Aluminum Alloy for Space Missions in the Extreme Environment of the Solar System (Adv. Mater. 20/2026). Adv. Mater., 38: e72925. <https://doi.org/10.1002/adma.72925>. First published: Advanced Materials, 2025, DOI: 10.1002/adma.202513450. Licensed under [CC-BY-4.0](#)

LDRD investments lead to award-winning innovation

Los Alamos National Laboratory-developed technologies recently earned seven 2026 R&D 100 Awards. Five of the award winners have roots in LDRD-funded research. Often called the “Oscars of Innovation,” the R&D 100 Awards recognize the year’s most significant technology products and innovations from industry, academia, and government-sponsored research organizations.

The LDRD-connected winners are ICONS: Integrated Composite Optical Neutron Sensor, which also received Gold Special Recognition as a Market Disruptor; AIMSS: Autonomous Ion Mass Spectrometer Sentry; Deimos: Advanced Reactor Testbed; and UltraSep: Ultrasonic Acoustic Separation Platform. Another LDRD-related project, ArtIMis: Artificial Intelligence for Mission, was named a finalist in the 2026 competition. These awards demonstrate how early investment in bold ideas can help advance groundbreaking technologies with real-world impact. [Read more...](#)



Five of the seven R&D 100 Awards that LANL received in 2026 are rooted in LDRD. (Image: AI-generated with ChatGPT and user-provided source images.)



*On the Cover:
LLNL Staff Robotics Engineer Mason Sage (left) and Staff Engineer Aldair Gongora are principal investigators for APEX and ARMOR, respectively. They are pictured examining the APEX platform. (Image credit: Blaise Douros/LLNL)*

AMAZING LDRD HIGHLIGHTS



LLNL RESEARCHERS EXAMINE COMPLEX BATTERY MATERIALS FOR BETTER ENERGY STORAGE AND NATIONAL ENERGY RESILIENCE: [With machine learning, LLNL researchers embrace the atomic-scale complexity of batteries](#) > Mission Agility, Technical Vitality

LLNL ENGINEERS APPLY NOVEL METALLIC-PARTICLE MANUFACTURING CAPABILITY TOWARD PRODUCING ROBUST NUCLEAR FUEL: [LLNL partners with industry to advance next-generation reactor fuel](#) > Mission Agility, Technical Vitality

LLNL TEAM RANKS TO DEVELOP DRONE TO CARRY PAYLOAD FOUR TIMES ITS BODYWEIGHT: [LLNL CHAMPS team selected to develop a heavy-lift drone for DARPA competition](#) > Mission Agility, Technical Vitality

MINING BATTERIES, IN A MICROWAVE: [Sandia's microwave-based method leads to a new process for upcycling old lithium-ion cathodes](#) > Mission Agility, Technical Vitality, Workforce Development

FIXING FLOPS: [Sandia counters catastrophic cancellation caused by round-off errors](#) > Mission Agility, Technical Vitality

TRANSFORMING HOW SCIENCE GETS DONE: [LANL's URSA brings AI-powered assistance to scientific research](#) > Mission Agility, Workforce Development, Technical Vitality

A NEW TARGET FOR NUCLEAR SCIENCE: [LANL researchers explore a new way to measure reactions involving rare isotopes](#) > Mission Agility, Technical Vitality

This newsletter, published quarterly, features LDRD, SDRD, and PDRD work done by Lawrence Livermore, Los Alamos, Nevada National Security Sites, Sandia, and NNSA PDRD programs. 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. LLNL-MI-2025220

For more information:

NNSA LDRD

Anthony Lewis

anthony.lewis@nnsa.doe.gov

LANL LDRD

Kirsten McCabe

kjmccab@lanl.gov

LLNL LDRD

Elizabeth Wheeler

wheeler16@llnl.gov

SANDIA LDRD

John Feddema

jtfedde@sandia.gov

NNSS SDRD

Michael Reed

reedms@nv.doe.gov