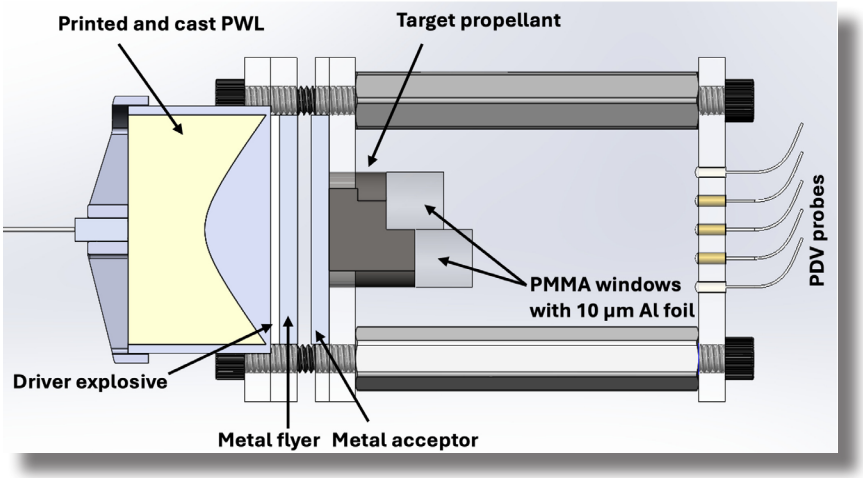
QUARTERLY HIGHLIGHTS

FY26 Q3

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 Q3

Los Alamos NATIONAL LABORATORY



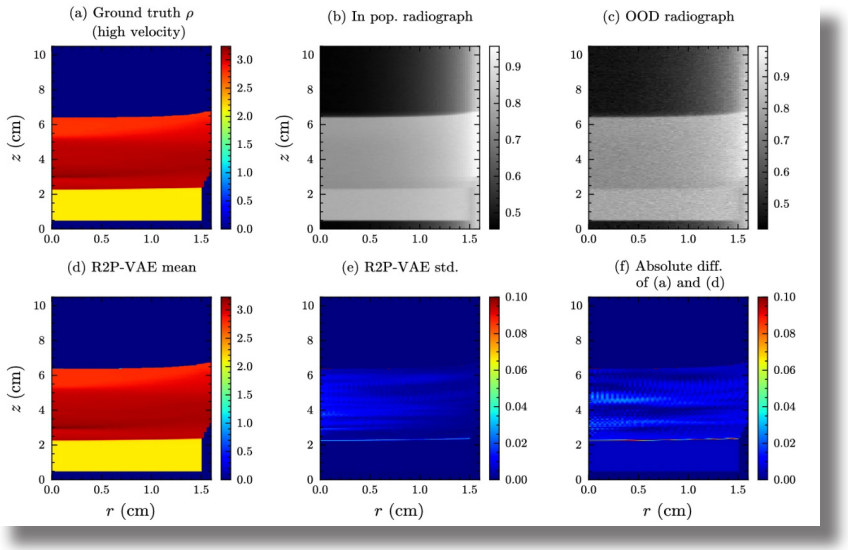
The SPIFFY 2.0 experimental assembly, with cut-back array test sample. Eight photonic doppler velocimetry (PDV) probes are utilized, with four centered on polymethylmethacrylate windoes with 10 μm Al foil layers, and four aligned around the cutback structure to measure shock input timing and symmetry. (Image credit: LANL)

The LANL SPIFFY test for evaluation of shock behavior of explosives and propellants

In a recent article published in the International Journal of Energetic Materials and Chemical Propulsion, Los Alamos researchers explain how the Laboratory-developed SPIFFY test is used to evaluate how new propellants and explosives behave under shock before moving on to more complex experiments. It uses 3D printed components to create a very flat shock wave that launches a small metal plate, allowing researchers to measure how the material responds and how easily it transitions to a reaction. Read more..

- **Mission Agility, Technical Vitality**

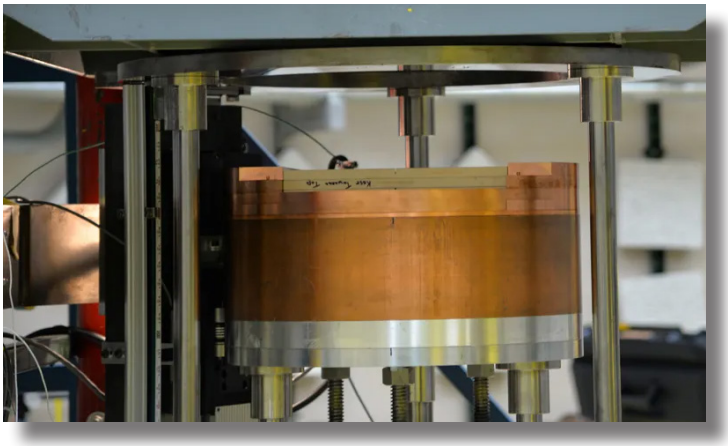
Learning robust parameter inference and density reconstruction in flyer plate impact experiments



Demonstration of radiographs-to-parameters variational autoencoder (R2P-VAE) density reconstruction pipeline for out of distribution radiographic noise, using 1000 posterior samples. (Image credit: LANL)

Researchers at Los Alamos are using advanced machine learning techniques to improve how scientists estimate material properties from radiographic images collected during shock physics experiments. By combining low- and high-velocity impact data with generative AI models, the team developed a new approach for inferring equation-of-state and porosity parameters directly from radiographs, even in the presence of noise or previously unseen physics. The work could significantly enhance the ability to characterize materials and predict their behavior under extreme conditions. Read more...

- **Mission Agility, Technical Vitality, Workforce Development**



Based on AI selections, scientists ran experiments at the National Criticality Experiments Research Center in Nevada. Nuclear reaction data taken at Los Alamos Neutron Science Center (LANSCE) is already being analyzed. (Image credit: LANL)

Finding the best experiment combinations to refine nuclear data

New theoretical tools are being developed by researchers at Los Alamos to better understand how small-scale projectile impact experiments relate to real-world, full-scale events. By applying advanced mathematical techniques to penetration physics, the team is exploring when results from laboratory tests can reliably predict larger-scale behavior. The work provides a stronger scientific foundation for designing and interpreting impact experiments and could improve the accuracy of future penetration models. Read more...

- **Mission Agility, Technical Vitality, Workforce Development**

Lawrence Livermore National Laboratory

A modern approach to high explosives manufacturing

LLNL and collaborators at Colorado School of Mines outside the Edgar Mine where explosives research and testing occurs. (Image credit: LLNL)

New LDRD investments ensure that ongoing high explosives (HE) science research and technology remain a critical component to keeping the nation safe and secure. This LDRD project has contributed new capabilities design to modernize the way to approach the development of explosives. Plastic-bonded explosives (PBX) are made with a >90% amount of HE powder with the remainder being a polymer binder. The mixing, or formulation, of crystals and binders forms a composite material commonly referred to as "prill," which then becomes a feedstock for pressing. The physical attributes and distribution of the constituents within prill all play an important– and complicated– role in achieving the careful balance of properties such as performance, safety, mechanical properties, aging and scaling to production. Read more...

› **Mission Agility, Technical Vitality**

LLNL LDRD Project DarkStar established foundational research for the potential of artificial intelligence and machine learning to support a wide range of national security missions. (Image credit: LLNL)

Investigating artificial intelligence and machine learning applications to scientific problems of complex hydrodynamics, shockwave physics, and energetic materials

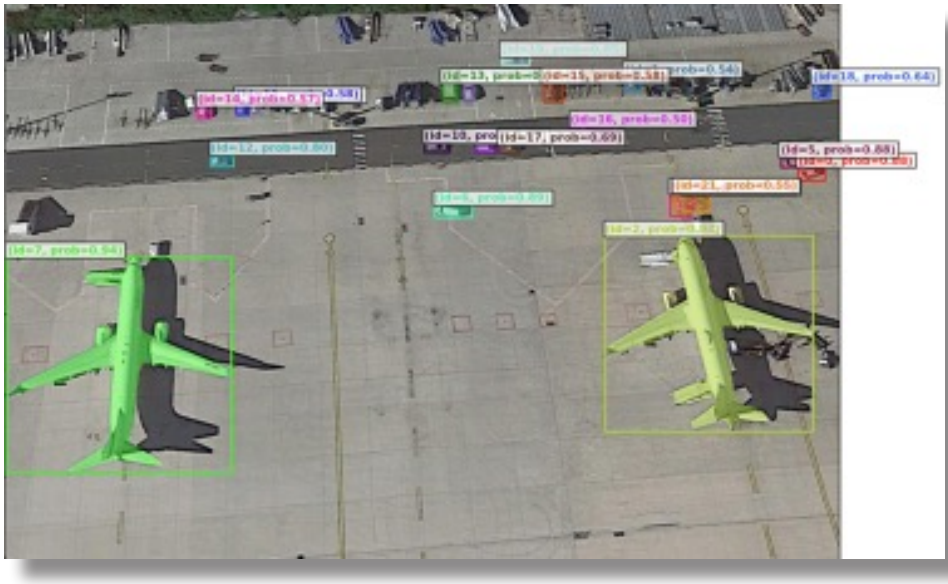
LLNL's LDRD-funded Strategic Initiative Project DarkStar made advancements in controlling material deformation by investigating the scientific problems of complex hydrodynamics, shockwave physics and energetic materials. The purpose of this project was to take the quantum leap from understanding dynamic material response to controlling it. The scientific and technological achievements attained will enable a completely new paradigm for weapons physics and design and advance the U.S. national security posture. Today, foundational methods in surrogate modeling, multimodal anomaly, detection, and explainable reasoning are reusable across mission spaces. Advancements in predicting and controlling instability formation were demonstrated on both high explosive experiments and inertial confinement fusion studies. Read more...

› **Mission Agility, Technical Vitality**

NEVADA NATIONAL NNSS SECURITY SITES

SDRD embraces AI and ML to advance the NNSS mission

Of Site Directed Research and Development's (SDRD) artificial intelligence (AI) and machine learning (ML) portfolio, one of the most exciting projects currently underway is "Background Subtraction and Noise Reduction via Machine Learning," which is led by principal investigator (PI) Cliff Watkins. Watkin's aim with this project is to explore methods for interpreting data coming into SDRD using ML. Read more...

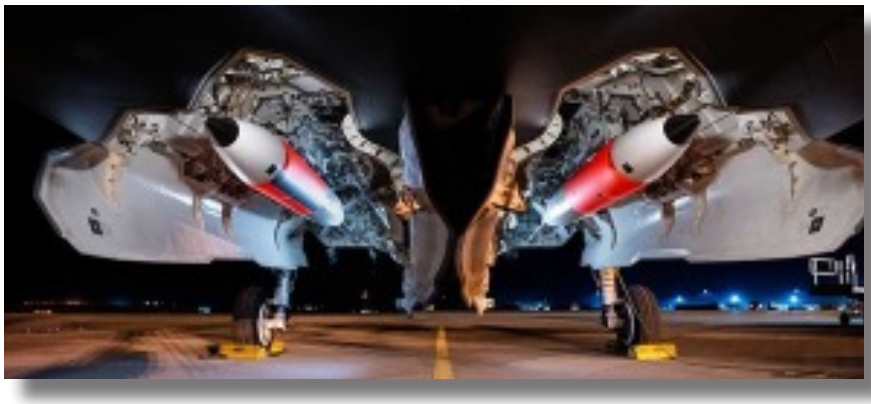


Object detection work completed by Michael Mortenson for Cliff Watkins' SDRD project in FY26 using Meta's open-source foundation model SAM3. (Image credit: NNSS)

› **Mission Agility, Technical Vitality, Workforce Development**

Sandia National Laboratories

Developing new and improved safety technology for nuclear weapons



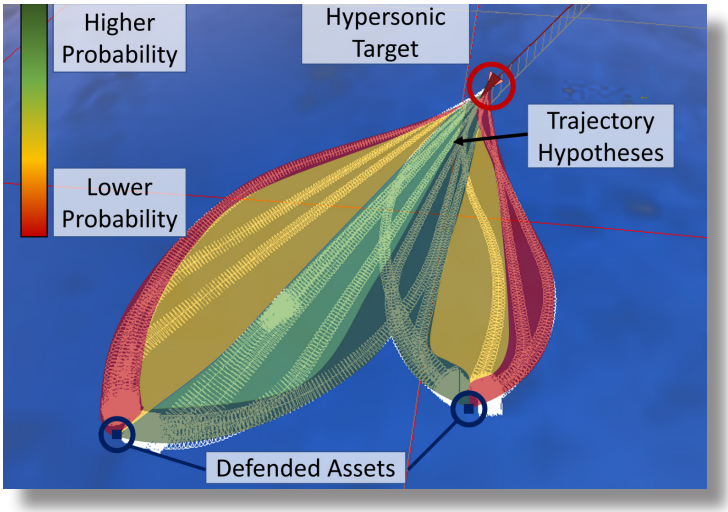
Two B61-12 joint test assemblies loaded on an F-35 aricraft for a flight test on Aug.19, 2025. (Photo by Craig Fritz)

Improving safety systems for new nuclear weapons and making them more cost-effective and faster to develop. That's the focus of the Time-Resolved Elastodynamic Discrimination (TRUE-D) LDRD project. This project led to the creation of new materials and design insights that help control signals and power transmission for weapon operation and offer a reliable alternative to traditional, more complex mechanical safety systems. The TRUE-D flight hardware was tested on the SkyFox flight demonstrator, showing promising results that could shape the future of nuclear programs. Read more...

› **Mission Agility, Technical Vitality**

Sandia National Laboratories

Fortifying fire control algorithms for cooperative hypersonic target prediction and interception



Side-by-side comparison of aimpoint selection methods including traditional, literature-based, and Sandia's multi-hypothesis approach for defending an asset from a hypersonic threat. (Image credit: Sandia)

Hypersonic weapons pose a challenge to missile defense systems due to their extreme speed, unpredictable maneuvers, and aimpoint ambiguity. To meet this threat, Sandia LDRD researchers developed a fire control algorithm that forecasts multiple possible flight paths, selects probabilistic intercept points during launch, and continuously updates guidance commands for multiple simultaneous interceptors in flight.

The findings provide valuable insights into hypersonic trajectories and maneuvers, identifying which are most challenging to counter. This strategically positions Sandia in supporting national priorities, including Golden Dome and space-based interceptors. Read more...

› **Mission Agility, Technical Vitality**

PanTEX

Optimizing warehouse storage

It's a warehouse — a place where stuff is stored. What possible research and development could be done in this area? How could asset storage be optimized? It was exactly that last question that started the Plant Directed Research and Development (PDRD) Warehouse Optimization Project at the Pantex Plant (Pantex). Was there a way to optimize storage efficiency, improve space constraints, control inventory and placement, or track the location of assets?

A group of Pantex principal investigators set out to research ways to optimize and modernize the plant's storage facilities. Read more...

› **Mission Agility, Technical Vitality**

Automated Storage and Retrieval Systems (AS/RS): an ongoing research effort into warehouse optimization. (Image credit: Pantex)

Process Development Summits will strengthen collaboration across NNSA laboratories, sites, and programs to drive mission success and enterprise-wide impact. (Graphic created using ChatGPT)

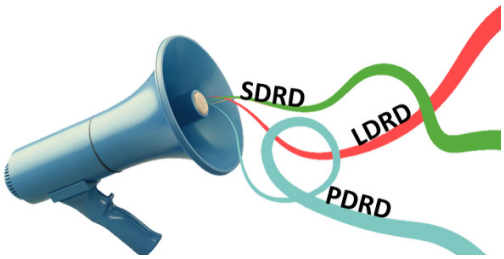
Process Development Summits strengthen communication between design and production agencies

To enhance formal communication between design and production agencies across the National Nuclear Security Administration (NNSA) enterprise, Research, Development, Test, and Evaluation (RDT&E) is launching a new series of Process Development Summits. Hosted at PDRD sites, these summits will provide laboratories with a direct venue to brief plant partners on emerging design considerations and the technologies and production processes that may be required in the future.

The summits, scheduled to take place in June and July of this year, will provide clear, collaborative pathways between labs and plants. Insights and opportunity areas identified during each summit will be incorporated into future strategic planning, helping ensure that R&D efforts are aligned with upcoming mission and production needs.

Why this matters: Strengthening early, consistent communication between design and production reduces uncertainty, shortens development cycles, and ensures that emerging technologies transition more smoothly into manufacturable capabilities. This alignment keeps the NNSA enterprise agile, efficient, and ready to meet evolving mission demands.

AMAZING LDRD HIGHLIGHTS



IMPROVING IMPACT EXPERIMENT DESIGN AT LANL: Using theoretical tools to understand full-scale events > Mission Agility, Technical Vitality

SILICON BEHAVIOR IN EXTREME RADIATION ENVIRONMENTS: LANL studies radiation changes to silicon at the microscopic level > Mission Agility, Technical Vitality

LLNL TACKLES STRUCTURAL DESIGN OF ELECTRODES: 3D-Printed interlocking electrodes demonstrate optimization potential for energy storage> Mission Agility, Technical Vitality

LLNL'S NEXT GENERATION AVLIS ADVANCES URANIUM ENRICHMENT: Revitalized laser technology captures commercialization grant > Mission Agility, Technical Vitality

EXTREME ENVIRONMENTS- SANDIA IS READY: Accelerating real-time AI with advanced analog in-memory computing> Mission Agility, Technical Vitality, Workforce Development

SANDIA IS FACING RADIATION CHALLENGES HEAD ON: Evolving semiconductor technology for national security applications> Mission Agility, Workforce Development, 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. LA-UR-26-25250

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

Pantex PDRD
Caleb Heltenberg
caleb.heltenberg@pantex.doe.gov