

GLOBAL SECURITY



A rendering of Firefly's Elytra Dawn vehicle shows it using LLNL's 25-centimeter diameter monolithic telescope to perform space domain awareness operations. (Graphic courtesy of Firefly Aerospace.)

Reducing the threat from terrorism and weapons of mass destruction, providing cyber and space security, and enhancing global strategic stability

BUILDING THE PATHFINDER TELESCOPE

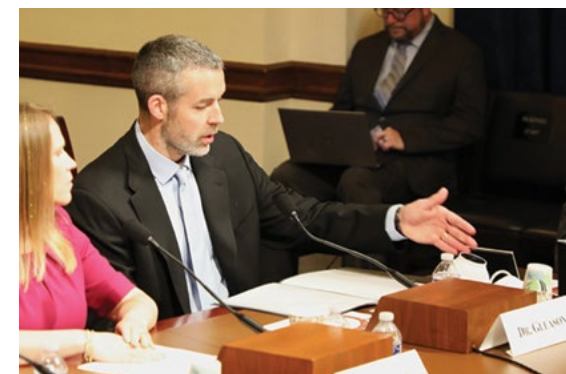
In FY 2025, the Laboratory was selected by the U.S. Department of War's (DOW's) Defense Innovation Unit (DIU) to provide a new monolithic telescope for a responsive space mission launching as early as 2027. Firefly Aerospace will host and operate the payload on its Elytra orbital vehicle in low Earth orbit (LEO). The payload includes two optical telescopes and an electronics module with a NVIDIA processor. LLNL will also support imaging operations throughout the mission. Building on the Laboratory's expertise in monolithic telescopes, which are designed to be robust and highly adaptable for a range of optical payload configurations, LLNL will design, build, and deliver the flight ready payload in only 13 months. The Pathfinder 10-inch (25 centimeter) diameter monolithic telescope will deliver advanced, high resolution optical space domain awareness. The mission will demonstrate rapid, highly maneuverable, responsive in-space imaging capabilities for the DOW in a variety of orbits, with future applications extending to deep space and the lunar regime. This will be LLNL's third mission to develop rapid space payloads for the DOW.

As Firefly scales up production of its Elytra vehicle line, the partnership will support responsive on-orbit services across LEO, medium Earth orbit, geosynchronous orbit, lunar orbit and beyond. Together, Elytra and LLNL's telescopes will enable on demand

imaging, space domain awareness, and other responsive services for national security, science, and commercial users. The mission supports the DIU's Sinequone project that aims to deliver cost-effective, responsive access to space beyond geosynchronous orbits, referred to as xGEO. xGEO orbits are deep in space, a little more than 22,000 miles above the Earth, and are used for a variety of strategic and commercial missions.

CYBER AND INFRASTRUCTURE RESILIENCE

In his testimony on July 22, 2025, before the U.S. House Committee on Homeland Security's Cybersecurity and Infrastructure Protection Subcommittee, Nate Gleason, leader of LLNL's Cyber and Infrastructure Resilience



Testifying before a U.S. House Subcommittee in July 2025, program leader Nate Gleason described LLNL's efforts to strengthen U.S. cyber and infrastructure resilience.

Program, outlined LLNL's support to the Cybersecurity and Infrastructure Security Agency (CISA), DOE, DOW, and critical infrastructure operators. He highlighted the Laboratory's central role in CISA's CyberSentry program, which partners with private-sector organizations to monitor operational technology networks for malicious activity. Since 2020, Livermore has developed and deployed advanced analytics and machine learning (ML) models that use real-time operational data, high-performance computing, and intelligence information to detect sophisticated attacks. As a notable example, Gleason described LLNL's 2022 discovery of high-risk Chinese surveillance cameras embedded in U.S. critical infrastructure networks. Using an advanced beacon detection technique, LLNL built an ML model to automatically identify these devices, finding in some cases hundreds of cameras on a single network.

REDUCING NUCLEAR DANGERS

Supported by NNSA and other sponsors, Livermore executed a broad range of nuclear security and forensics activities, many in partnership with or for the International Atomic Energy Agency (IAEA). These efforts included technical exchanges, workshops, and scenario-based training with stakeholders from countries across Africa, Asia, Europe, and the Middle East. Activities ranged from advancing computer security and nuclear forensics to supporting equipment transfers, legal discussions, and the safe transition of radiological technologies. Many engagements were person-to-person, building relationships and technical capacity from Estonia to Egypt, Libya to Taiwan, Spain to Türkiye, and beyond. LLNL subject matter experts also provide support to the IAEA through guidance on document development; national, regional, and bilateral training events; and technical meetings, consultancy meetings, and bilateral assessments. In addition, in its efforts to secure, account for, and interdict the illicit movement of nuclear weapons, weapons-useable nuclear materials, and radiological materials, Livermore continued to use both in-person and virtual engagements covering security upgrades at nuclear and radiological facilities in Europe, the Middle East, North Africa, and Sub-Saharan Africa.



Research teams use capabilities in LLNL's Satellite, Telescope, Aerial drone, and Remote sensing Mission Operations Center (STARMOC) to track mission progress and collect and analyze data. STARMOC provides much needed operational space for smaller and lower-budget missions working in space domain awareness.

ADVANCING SPACE SECURITY

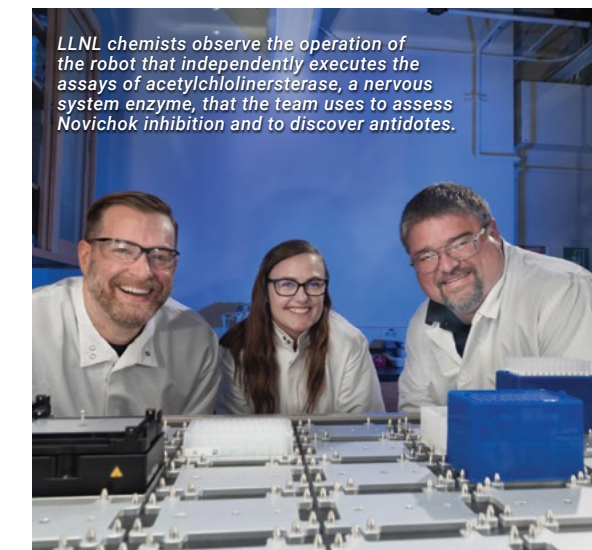
In addition to developing new small satellites and optical payloads, Livermore supports national space domain awareness by tracking and characterizing satellites, debris, and natural objects. Thousands of satellites, including 2,664 launched in one year alone, now crowd Earth's orbits, raising collision risks and threatening critical services that underpin national infrastructure and financial systems. LLNL collects data from ground and space sensors, develops computational tools, and partners with the U.S. Space Force and others to address emerging threats, including those posed by potential adversaries. Livermore also works with the U.S. Space Force's SDA TAP Lab to rigorously benchmark multisensor fusion tools that help "close kill chains" assessments, for example, whether a rocket launch threatens satellites. Laboratory researchers have also created tools that use ML and statistics to overcome sparse, expensive training data. One of these tools, MuyGPs, provides fast, accurate predictions of a satellite's motion with robust uncertainty estimates, focusing on variations around likely trajectories rather than single point estimates. Another uses high-performance computing to perform fast, high-fidelity orbit propagation and orbital state inference, accurately handling chaotic, real-world orbits and complex forces like drag and gravitational perturbations.

ACCELERATING CHEMICAL AGENT COUNTERMEASURE DISCOVERY

LLNL's Forensic Science Center (FSC), working with Purdue University, developed an automated, high-throughput mass spectrometry platform for rapid discovery of medical countermeasures against chemical warfare agents,

including the Russian-developed Novichok compounds. FSC researchers conducted the first quantitative in vitro potency study of authentic Novichok agents, confirming their strong inhibition of a crucial nervous system enzyme in humans, with similar potency to sarin and VX. The research identified a promising countermeasure, challenging previous views that it would be ineffective against Novichok agents.

The developed platform enables thousands of safe, rapid biochemical assays in a matter of hours, a major advance over traditional methods, and uniquely allows direct testing with real chemical agents under strict safety protocols. This new capability strengthens LLNL's rapid response capability for chemical threats, and supports national security. It also demonstrates LLNL's leadership in safe, high-throughput research with toxic agents and upholds its role as an Organisation for the Prohibition of Chemical Weapons-designated laboratory.



LLNL chemists observe the operation of the robot that independently executes the assays of acetylcholinesterase, a nervous system enzyme, that the team uses to assess Novichok inhibition and to discover antidotes.