



Space Science & Security Program

Innovating space-defense capabilities and developing new space science missions

The Laboratory's Satellite, Telescope, Aerial drone, and Remote sensing Mission Operations Center (STARMOC), a dedicated facility for space domain awareness research teams

Meeting Tomorrow's Challenges with Innovative Capabilities

In 2010, Lawrence Livermore National Laboratory (LLNL) stood up a national security space program to support the full lifecycle of new space security missions needed to respond to space domain threats posed by U.S. adversaries. LLNL provides support to the U.S. government that integrates intelligence analysis and modeling, high-fidelity multi-physics simulation, unique experimental tests, data science and machine learning applications, optical payloads for space flight, and space operations. LLNL's design, analysis, and instrumentation capabilities have advanced our fundamental understanding of the universe and enabled use of the space domain for groundbreaking scientific pursuits.

LLNL has proven leadership in the two key space-security mission areas: space domain awareness and space protection and defense. LLNL provides unique mission analysis and mission assurance by integrating our capabilities to meet emerging threats and needs. The space program works also with the LLNL Strategic Deterrence Directorate's flight performance integration team to evaluate new national security missions related to space and missile defense. LLNL scientists provide expertise on modeling nuclear threats in space along with partners at the NNSA design laboratories, including effects from high-altitude nuclear explosions.

A Proven and Trusted Track Record

LLNL has been a trusted leader in developing and delivering instrumentation for space science missions for nearly six decades. The Laboratory's work on space security began during the Strategic Defense Initiative in the 1980s, primarily supporting the Brilliant Pebbles program. Many of LLNL's accomplishments in space science have supported NASA and the National Science Foundation, helping to design and field world-class optical facilities like the Vera Rubin Observatory and the Gemini Planet Imager, x-ray missions like NuSTAR and XRISM, planetary missions like MESSENGER and Psyche, and heliophysics missions such as the Solar Dynamics Observatory and GOES network.

LLNL's forensic science and cosmochemistry capabilities also have contributed to planetary science through sample return analysis from the Apollo program and missions such as Hayabusa2 and OSIRIS-REx.

Scientific Underpinnings

LLNL applies its depth and breadth of technical expertise and capabilities to advance technology and applied research to space science, including:

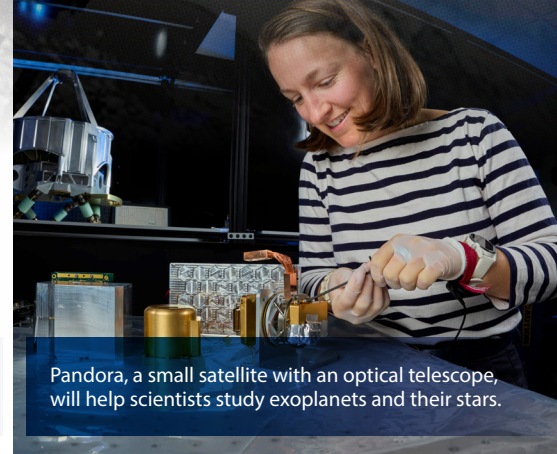
- Astronomy and astrophysics
- Planetary science and cosmochemistry
- Earth and atmospheric science
- High-energy-density science and atomic physics
- Materials science and advanced manufacturing
- Artificial intelligence
- High-performance computing, data analysis, and automation
- Physics-based modeling and simulation
- Advanced photonics and lasers
- Optical sensing payloads
- Detector systems
- Radio frequency mission analysis and testing
- Power and energy systems for space nuclear power
- Radiation testing for extreme environments
- Kinetic testing and space debris analysis
- Environmental monitoring and emergency response
- Intelligence



Electrical engineers use long-range targets to focus a tri-optic payload module that will demonstrate rapid characterization of on-orbit threats.



NASA's Pandora observatory deploys into space off of a Falcon-9 upper stage.



Pandora, a small satellite with an optical telescope, will help scientists study exoplanets and their stars.

Space Flight Programs

LLNL's space security missions have focused on using optical telescopes to demonstrate new space domain awareness capabilities as well as pathfinders for intelligence, surveillance, and reconnaissance and missile warning.

LLNL is a leader in responsive space missions for the national security and space science communities. The Laboratory also serves as the program manager for NASA's Pandora Small Satellite mission to study stars and exoplanets, providing an entire science observatory for NASA Astrophysics, which launched in January 2026.

LLNL also has delivered payloads and operational support for the nation's leading responsive missions for the U.S. Department of War, including tactically responsive launch-2 (TacRL-2), Defense Innovation Unit's Sinequonon, and Victus Haze. LLNL's Argus tri-optic payload system will operate on six upcoming responsive space missions, including one to lunar orbit.

LLNL is known for aggressively reducing payload sizes, shortening time-to-mission, and partnering with major commercial small-satellite providers.

State-of-the-Art Facilities

- Specialized space payload integration facilities that enable rapid development of integrated optical telescopes for in-space sensing missions
- High-performance computing systems for space security, to include SCI computing, with more overall classified computing capacity at LLNL than any facility in the United States.
- Classified test facilities that enable researchers to demonstrate and evaluate technologies in realistic operational environments, including material effects laboratories, laser systems, radio-frequency evaluation, and gas guns for space velocity testing
- Multilayer coating design and fabrication capabilities for visible, extreme ultraviolet, x-ray, and gamma-ray optics
- An adaptive optics laboratory, which hosts a high-contrast imaging testbed and access to University of California observatories for on-sky demonstrations
- Unique assets for cosmochemical sample analysis, including high-precision isotope analysis and radiometric dating capabilities
- Electron Beam Ion Trap (EBIT) facility for x-ray laboratory astrophysics, enabling high-resolution x-ray spectroscopic investigations
- A Space, Telescope, Aerial drone, and Remote sensing Mission Operations Center (STARMOC) with unclassified and classified mission operations capabilities for check-out, anomaly resolution, and hardware and software in-the-loop testing

Partnerships

LLNL's key sponsors and stakeholders include:

- U.S. Space Force
- Air Force Research Laboratory
- The U.S. intelligence community
- U.S. Space Command
- NASA's Science Mission Directorate and Small Satellite Technology Program
- DOE NNSA

LLNL partners with universities, industry, and government agencies to facilitate joint research and development in space security, science, and policy. Collaborators include the University of California Berkeley, NASA Ames Research Center, NASA Goddard Space Flight Center, the Japan Aerospace Exploration Agency, and our DOE NNSA laboratory partners.

LLNL also has a range of unique partnerships with commercial space companies to advance space sensing in new environments utilizing innovative business models, including collaborative research and development agreements with a number of non-traditional space companies.

LLNL-BR-2017199. This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.