Clinical trials have begun for a first-in-class medication that targets specific genetic mutations implicated in many types of cancer. In a collaboration among LLNL, BridgeBio Oncology Therapeutics, and the Frederick National Laboratory for Cancer Research, the drug discovery was powered by LLNL supercomputers Ruby (shown), Quartz and Lassen.

PARTNERSHIPS

Providing S&T expertise and capabilities to meet our nation's most important needs

LLNL engages in wide-ranging partnerships with other laboratories and research institutions, academia, and industry. Many collaborations integrate disparate expertise and capabilities with focus on innovations to meet challenging mission objectives. Others serve to transition science and technology (S&T) breakthroughs into new applications and products.

A FOCUS ON FUSION ENERGY

In December 2023, DOE awarded a four-year, $16 million project to a multi-institutional team led by LLNL to accelerate inertial fusion energy (IFE) research. This effort is being carried out by the IFE Science and Technology Accelerated Research for Fusion Innovation and Reactor Engineering (STARFIRE) Hub, which is supported by the DOE Office of Fusion Energy Sciences. IFE-STARFIRE is accelerating the demonstration of high-gain target designs, target manufacturing, and diode-pumped solid state laser technologies—all with an emphasis on integrated systems engineering. Presentations by Laboratory scientists and their collaborators were prominent at the IFE-STAR Conference, held in April 2025 and attended by more than 200 fusion experts from national laboratories, academia, and the private sector. The hub is both advancing critical technologies and serving to develop the future IFE workforce.

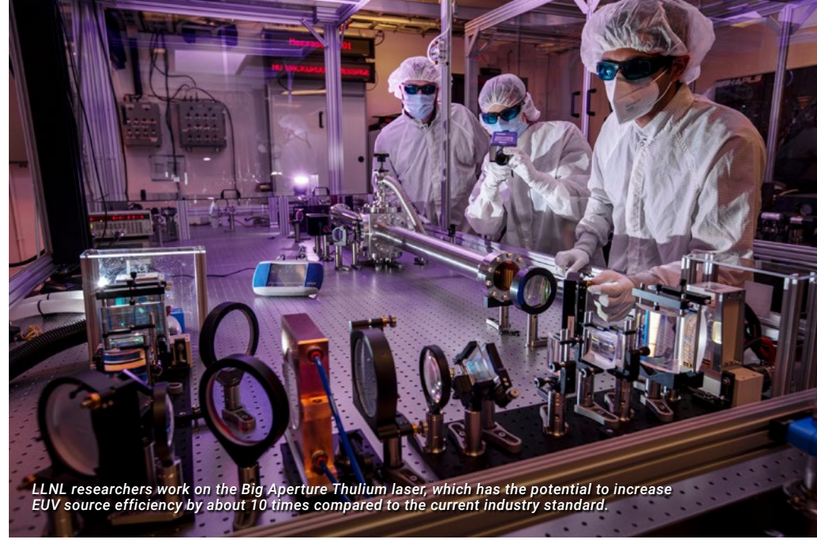
The hub and LLNL institutional investments in IFE synergistically complement NNSA's major investments in inertial fusion research and development. Building on ignition experiment successes, in August 2025, a ribbon-cutting ceremony opened the Livermore Institute for Fusion Technology (LIFT) on the Livermore Valley Open Campus as an expansion of an LLNL institutional initiative to accelerate the development of fusion energy through partnerships with industry and academia. LIFT is building partnerships in both IFE and magnetic fusion energy technologies. The institute is also launching several Cooperative Research and Development Agreements (CRADAs) and Strategic Partnership Programs with private fusion companies.

DEVELOPING EFFECTIVE CANCER TREATMENTS

LLNL researchers, in partnership with BridgeBio Oncology Therapeutics (BBOT), developed a new cancer drug candidate that can block tumor growth by disrupting a key interaction between two cancer-driving proteins—RAS (Rat Sarcoma) and PI3Kα (phosphoinositide 3-kinase)—without triggering high blood sugar. A structural biology team at the Frederick National Laboratory for Cancer Research helped define the initial protein–drug molecule site, and the Livermore Computer-Aided Drug Design (LCADD) platform iteratively refined molecules for potency, selectivity, and pharmacokinetics prior to laboratory testing and validation. LCADD combines AI and machine learning with detailed physics-based modeling to simulate and predict drug behavior. Called BBO-10203, the compound is one of three advanced small-molecule cancer drug candidates developed through the BBOT–Livermore collaboration and the second to reach patients through clinical trials. In addition to helping patients with aggressive, nontreatable cancers, the compound—combined with standard treatments—may also enhance the effectiveness of existing therapies used to treat breast, lung, and colorectal cancers.

LLNL TO LEAD EUV LITHOGRAPHY PROJECT

A new research partnership led by LLNL aims to lay the groundwork for the next evolution of extreme ultraviolet (EUV) lithography, centered around a Livermore-developed driver system dubbed the Big Aperture Thulium (BAT) laser. The $12-million four-year project in the DOE Office of Science's Extreme Lithography & Materials Innovation Center will test the BAT laser's ability to increase EUV source efficiency by about 10 times when compared with carbon dioxide lasers, the current industry standard. The laser technology could lead to a next-generation lithography system producing chips that are smaller, more powerful, and faster to manufacture while using less electricity. Researchers at the Jupiter Laser Facility (see p. 17) plan to use compact high-rep-rate BAT laser light bursts on targets to produce EUV light with nanosecond pulses as well as high-energy x-rays and particles using ultrashort sub-picosecond pulses. The Laboratory performed pioneering work on EUV lithography in the 1990s and continued to advance many key related technologies over the decades since.



LLNL researchers work on the Big Aperture Thulium laser, which has the potential to increase EUV source efficiency by about 10 times compared to the current industry standard.

ACCELERATING PANDEMIC PREPAREDNESS

Researchers from LLNL, in collaboration with other leading institutions, have successfully used an AI-driven platform to preemptively optimize an antibody to neutralize a broad diversity of SARS-CoV-2 variants. This pioneering approach, published in the journal *Science Advances*, represents a significant leap in the fight against rapidly evolving viruses such as SARS-CoV-2, improving future pandemic preparedness and antibody therapy resilience. The paper details the development of a next-generation antibody derived from a medicine from global biopharmaceutical company AstraZeneca. The research team employed the Generative Unconstrained Intelligent Drug Engineering (GUIDE) computational platform, developed for the Department of War's Joint Program Executive Office for Chemical, Biological, Radiological and Nuclear Defense. GUIDE researchers used the platform to analyze over 10 billion potential antibody modifications and predict which alterations would enhance binding to SARS-CoV-2 variants, including those not yet in circulation. The top candidates were then laboratory-tested to confirm their efficacy.

INNOVATIVE INDUSTRIAL AND ENERGY PARTNERSHIPS

LLNL is benefiting the U.S. economy with innovative technology and methods. Livermore recorded 88 new inventions, obtained 130 new U.S. patents, and received $7.4 million from CRADA partners in FY 2024. As can be seen throughout this *Annual Report*, Livermore is strengthening existing partnerships and engaging in new ones with other government agencies, industry, and academia. Among honors, LLNL earned four R&D 100 awards from *R&D World Magazine*. The In-air Drop Encapsulation Apparatus is a groundbreaking production tool that tailors microcapsules for applications like pharmaceutical delivery and sustainable manufacturing. Monolithic optics address a need for robust, high-performance telescopes in space (see p. 10). Metaoptics-enabled Large-scale 3D Nanolithography is a one-of-a-kind, high-precision additive manufacturing platform that enhances 3D nanofabrication rates by 1,000 times. Finally, FIDDLE is a cutting-edge x-ray imaging diagnostic used at the National Ignition Facility to study rapid phase changes in materials at extreme conditions. The Laboratory also secured $1.8 million in funding from DOE's Technology Commercialization Fund to revolutionize seismic monitoring and forecasting using real-time, advanced machine learning. The RECONNECT project is engaging partners in the West Texas–New Mexico area to mitigate potential seismicity risks from subsurface energy industry operations. Finally, DOE's High-Performance Computing for Energy Innovation announced funding for three new LLNL-collaborative projects with industry. The aim is to improve carbon capture, production of slab steel, and the design of exhaust filters for electric arc furnaces.

The FIDDLE x-ray imaging diagnostic won an R&D 100 award.