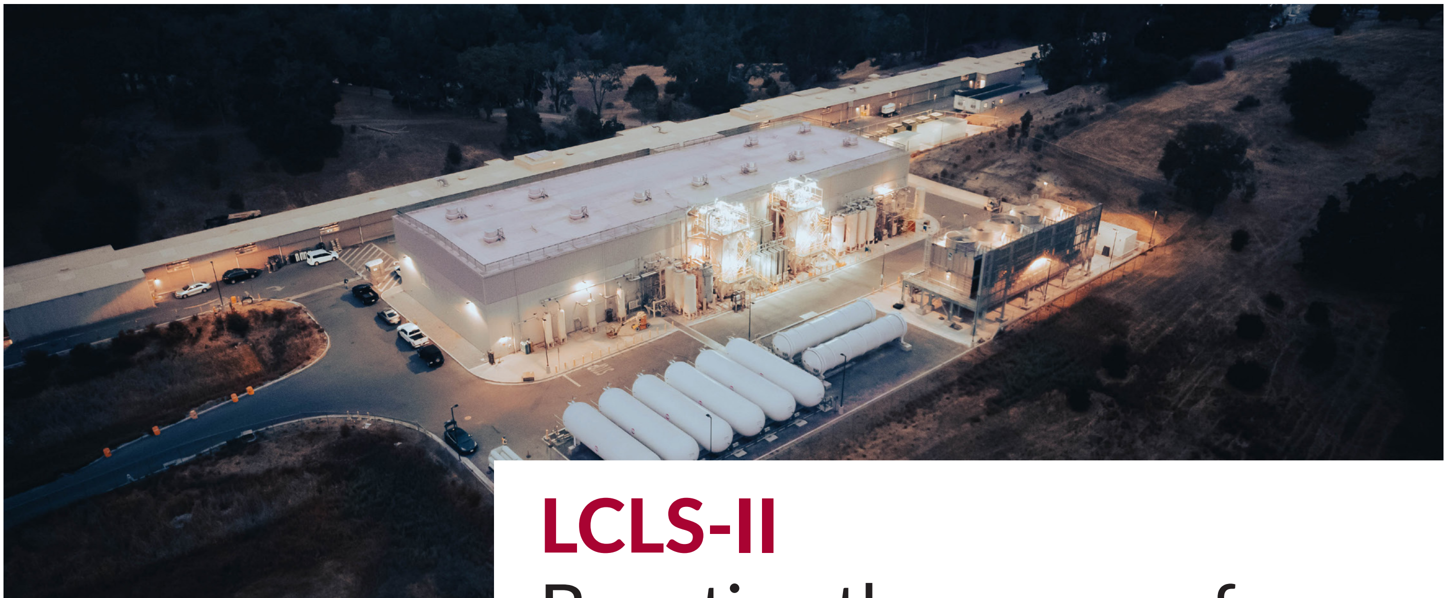

LCLS | Linac Coherent Light Source

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LCLS-II

Boosting the power of SLAC's premier X-ray laser

A major upgrade to SLAC's renowned Linac Coherent Light Source significantly boosts its power and capacity, allowing it to deliver X-ray laser beams that are 10,000 times brighter with pulses that arrive up to a million times per second. LCLS-II will transform our view of how nature works at the atomic scale and help advance technologies of the future, including novel electronics, life-saving drugs and innovative energy solutions.

Facts

- X-ray laser beams 10,000 times brighter
- Up to one million pulses per second
- Unprecedented views of the atomic world

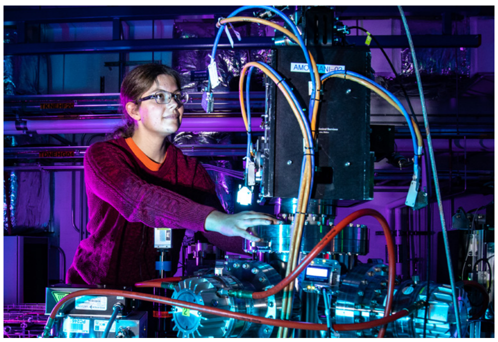
A superior X-ray microscope

Hundreds of scientists use LCLS each year to catch a glimpse of nature's fundamental processes. The unique X-ray microscope uses the brightest X-ray pulses ever made to provide unprecedented details of the atomic world.

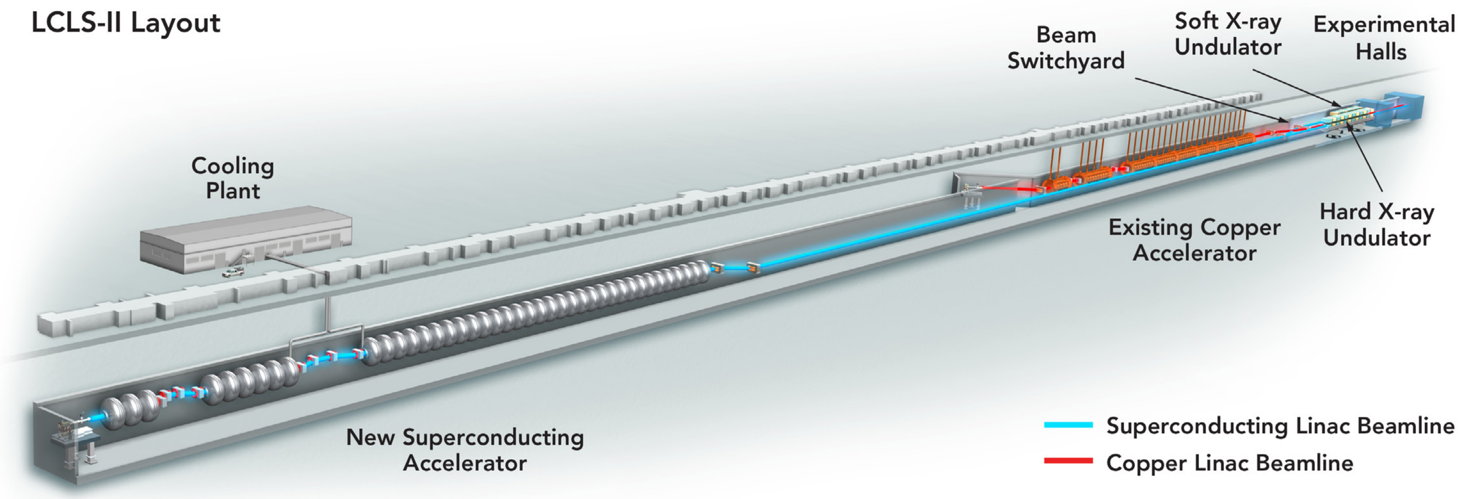
LCLS's ultrafast pulses allow scientists to create:

- Molecular movies that reveal how chemical bonds form and break, which can lead to novel energy production and storage technologies;
- Snapshots that capture the rapid rearrangement of electric charges in materials, which can inform the designs of advanced electronics and materials with revolutionary new properties; and
- Precise 3D dynamics of disease-related proteins with atomic level details that could hold the key for discovering cures.

LCLS-II will allow researchers to capture the full history of chemical processes that underpin sustainability, study real-world materials for clean energy technologies, reveal precise details of how quantum phenomena can be harnessed for next generation microelectronics and gather immense data that will change the nature of how X-ray science is performed.



At the Time-resolved Atomic, Molecular and Optical Science (TMO) instrument, scientists produce ultrashort X-ray pulses that last for just several hundred attoseconds (or billionths of a billionth of a second). This allows scientists to investigate how electrons zipping around molecules jumpstart key processes in biology, chemistry, materials science and more. Top image: a cryoplant built for LCLS-II cools helium gas to just a few degrees above absolute zero, providing coolant for the superconducting accelerator.



LCLS uses the last third of SLAC's 2-mile-long linear accelerator – a hollow copper structure that operates at room temperature. As part of LCLS-II, the first third of the copper accelerator was replaced with a superconducting one. The new superconducting accelerator (gray/blue) is shown alongside the existing copper one (red). At the beam switchyard, electron beams from each linac will be directed to one of two new undulators to produce hard or soft X-ray laser pulses. The pulses then travel to experimental halls where scientists conduct research.

Superconducting technology

The new X-ray laser will work in parallel with the existing one. Both LCLS and LCLS-II will use electrons accelerated to nearly the speed of light to generate beams of extremely bright X-ray laser light. The electrons fly through a series of magnets, called an undulator, which forces them to travel a zigzag path and give off energy in the form of X-rays. But the way those electrons are accelerated will be quite different and give LCLS-II much different capabilities. With LCLS, electrons are accelerated down a copper pipe that operates at room temperature and allows the generation of 120 X-ray laser pulses per second.

LCLS-II adds a superconducting accelerator, occupying one-third of SLAC's original 2-mile-long linear accelerator tunnel, which will generate a continuous stream of X-ray laser pulses, up to 1 million per second. In addition to the new accelerator, LCLS-II requires a number of other cutting-edge components, including a new electron source, two powerful cryoplants that produce refrigerant for the accelerator, and two new undulators to generate X-rays.

About LCLS

When LCLS opened in 2009 as a Department of Energy Office of Science User Facility, it was the world's first light source of its kind, a free-electron laser producing "hard," or very high-energy X-rays. Since then, more than 3,000 scientists from 37 U.S. states and around the world have conducted experiments at LCLS, and over 30% of experimenters each year are first-time users.

Strong Partnerships in X-ray science

SLAC is proud to partner with experts at four other national labs – Argonne National Laboratory, Lawrence Berkeley National Laboratory, Fermilab National Accelerator Laboratory and Thomas Jefferson National Accelerator Facility– and Cornell University on planning, design and construction for LCLS-II. The DOE's Office of Science program for Basic Energy Sciences is investing in this groundbreaking light source.

Cooled to minus 456 degrees Fahrenheit, these niobium cavities allow radiofrequency fields to boost electron energies without electrical resistance. Cryomodules—consisting of eight niobium cavities each—are a key component of LCLS-II's superconducting linear accelerator. (R. Hahn/Fermilab)

The Linac Coherent Light Source at SLAC National Accelerator Laboratory is an Office of Science User Facility operated for the Department of Energy by Stanford University.

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