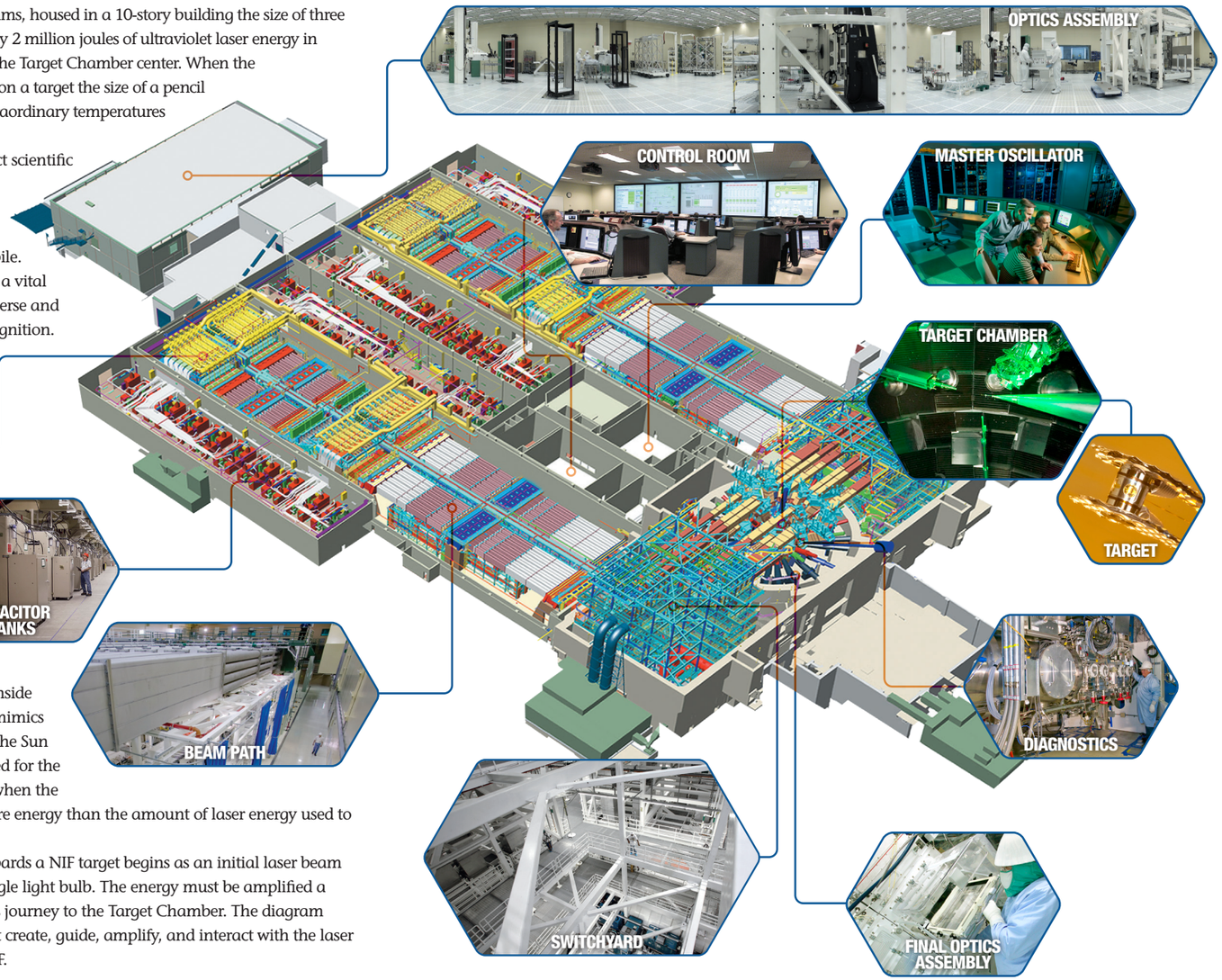
National Ignition Facility

NIF Is the World's Largest and Most Energetic Laser

Lawrence Livermore National Laboratory is home to the National Ignition Facility (NIF), which made history on Dec. 5, 2022, by demonstrating fusion ignition.

NIF's 192 powerful laser beams, housed in a 10-story building the size of three football fields, can deliver nearly 2 million joules of ultraviolet laser energy in billionth-of-a-second pulses to the Target Chamber center. When the beams focus all of their energy on a target the size of a pencil eraser, they briefly produce extraordinary temperatures and pressures inside the target.

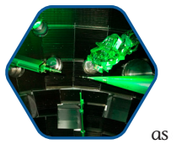
NIF's chief goal is to conduct scientific research to help further our nation's security, including ensuring the safety and reliability of the nuclear stockpile. But the laser facility also plays a vital role in understanding the universe and achieving nuclear fusion and ignition.



When fired, the laser energy creates pressures and temperatures so intense that hydrogen atoms inside the target fuse, a process that mimics what occurs constantly inside the Sun and stars. Ignition was achieved for the first time ever in a lab setting when the reaction released 1.5 times more energy than the amount of laser energy used to create the reaction.

The laser energy that bombards a NIF target begins as an initial laser beam that is too weak to power a single light bulb. The energy must be amplified a quadrillion times as the beams journey to the Target Chamber. The diagram illustrates the components that create, guide, amplify, and interact with the laser energy as it travels through NIF.

NIF Is a Unique Experimental Facility Addressing Compelling National Security, Science, and Energy Missions



National Security

Maintaining the U.S. nuclear weapons stockpile as a deterrent against foreign aggression has been a mainstay of national policy since the end of World War II. The long-term success of stockpile stewardship depends on improving the predictive capability of simulation codes used to assess nuclear weapons performance. The simulations use complex physics models that are being improved by LLNL's increasingly more sophisticated supercomputers and evolving machine learning and artificial intelligence capabilities. Experiments on NIF enable scientists to better understand the underlying physics, reduce weapons performance uncertainties, and improve codes. NIF's unique capabilities for studying materials under extreme conditions provide valuable data that support national security missions.

Energy Security

Because nuclear fusion has the potential to provide clean, safe, and virtually unlimited energy, the U.S. Department of Energy has made fusion a key element in the nation's long-term energy plans, leveraging the investments from the National Nuclear Security Administration's defense programs that support NIF. Ignition experiments on NIF are supplying data to scientists and policymakers for evaluating fusion as a potential commercial power source.

Discovery Science

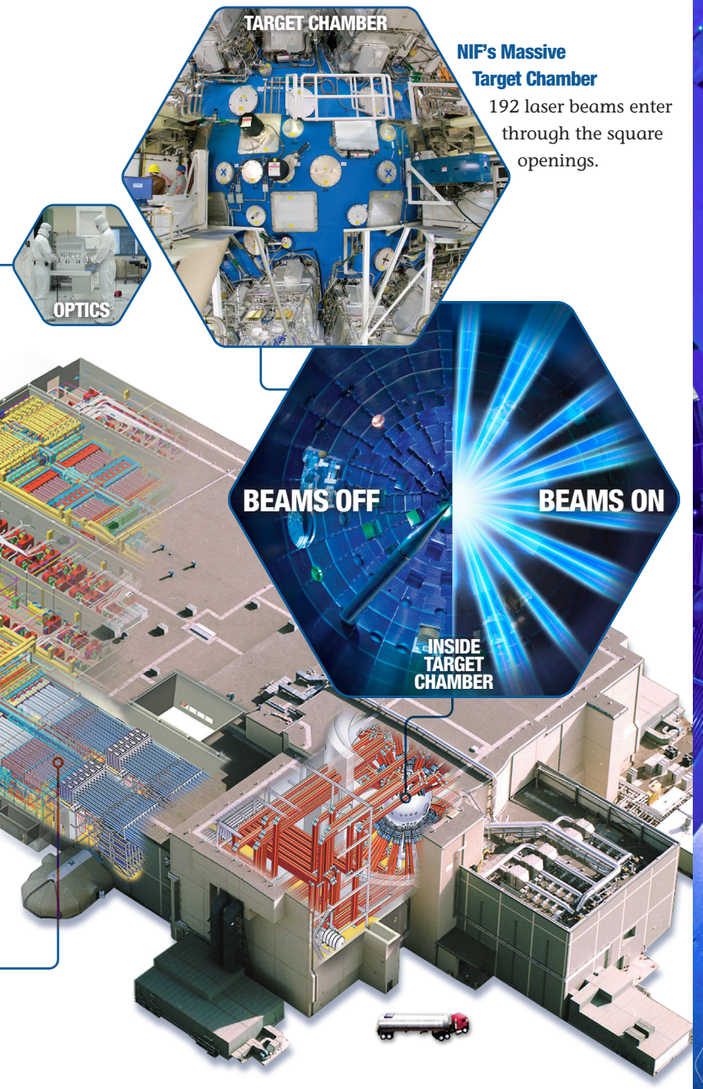
Since the dawn of history, humans have sought to understand how the universe began and how it works. By recreating conditions that exist naturally only in the interiors of stars, supernovae, and giant planets, NIF provides important insights into what happened in the first nanoseconds of creation and helps us understand how the fundamental particles of matter combined to become the stars, the planets, and the elements that make life possible. Scientists are using NIF to explore materials under extreme temperature, pressure, and density conditions that are not accessible at other experimental facilities, enabling research that is shedding light on many aspects of our universe and its formation.

Stewards of Tomorrow

NIF experiments help maintain the skills of nuclear weapons scientists and train the next generation of experts to maintain the stockpile.

From tours for our highly competitive summer student program to collaborations with universities and our postdoctoral scholar appointments, NIF is teaching future science stars.

Learn more at
lasers.llnl.gov



NIF's Massive Target Chamber

192 laser beams enter through the square openings.

For NIF news and information, go to:

lasers.llnl.gov

NIF&PS

LLNL-BR-845308

The Threshold of the Future

Thank You for Visiting NIF

The National Ignition Facility (NIF) is the world's largest and highest-energy laser system. By providing the capabilities to achieve fusion ignition and burn in a laboratory setting, NIF is a critical experimental facility for the National Nuclear Security Administration's Stockpile Stewardship Program and is a key international scientific resource. NIF is used to understand issues about high energy density science and to explore aspects of astrophysics, material science, plasma physics, and many other areas of Discovery Science.

Additional information is available on the NIF & Photon Science website at **lasers.llnl.gov**.

Please enjoy,

Jeff Wisoff
Principal Associate Director
NIF & Photon Science

Lawrence Livermore National Laboratory

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