Lawrence Livermore National Laboratory

The National Ignition Facility

Scientists have been working for more than 50 years to achieve self-sustaining nuclear fusion with energy gain in the laboratory. The National Ignition Facility (NIF), located at Lawrence Livermore National Laboratory (LLNL), brings that long-sought goal closer to realization.

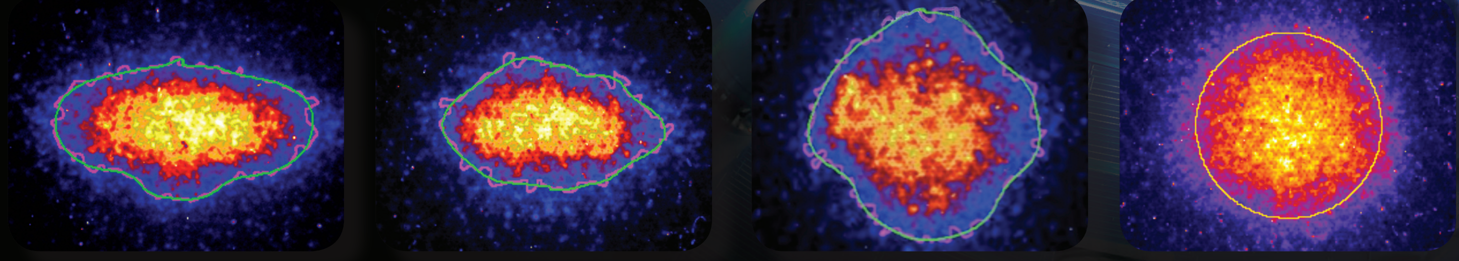
Achieving nuclear fusion in the laboratory lies at the heart of NIF's three complementary missions: helping maintain the safety, security and reliability of the nation's nuclear weapons stockpile, laying the groundwork for clean, safe and abundant fusion energy, and achieving breakthroughs in a wide variety of scientific disciplines from planetary science to astrophysics.

As the world's largest and highest energy laser system, NIF can create temperatures of 100 million degrees and pressures 100 billion times that of Earth's atmosphere — conditions that exist only in stars, giant planets and thermonuclear explosions. NIF's 192 laser beams, housed in a 10-story building the size of three football fields, deliver nearly 100 times more energy than any previous laser system. By focusing nearly two million joules of ultraviolet laser energy on a peppercorn-sized target in the center of its 10-meter-diameter target chamber, NIF can force the nuclei of deuterium and tritium (isotopes of hydrogen) to fuse, ultimately releasing many times more energy than the laser energy required to initiate the process.

NIF is a precision machine, meeting or exceeding all design specifications, and is one of the largest scientific construction projects successfully completed by the Department of Energy. NIF was named "International Project of the Year" by the Project Management Institute in 2010.

While construction of NIF was a marvel of engineering, the facility also is a tour de force of science and technology development. Working closely with industry partners, Laboratory scientists, engineers and technicians devised solutions for NIF's optics in rapid-growth crystals, continuous-pour glass, optical coatings and new finishing techniques that can withstand extremely high energies. Other cutting-edge technologies pioneered by NIF include a unique optical switch, advanced preamplifiers, deformable mirrors, precision target fabrication techniques and an extraordinarily innovative and sophisticated computer control system.

Since it was commissioned three years ago, NIF has completed more than 1,200 high-power, high-intensity laser experiments, making significant contributions to national security, helping the nation maintain leadership in science and technology and exploring the groundwork of practical fusion energy.



NIF has successfully demonstrated the use of wavelength tuning to adjust the shape of the target capsule implosion from asymmetric to spherical, a key requirement for achieving ignition in a laboratory setting.

National Ignition Facility and Photon Science

Technicians install a static X-ray imager in the 10-meter-diameter target chamber. One of the more than 30 diagnostic instruments installed at NIF, this device helps scientists determine the positioning of NIF beamlines within the hohlraum.

National Security

NIF is an essential component of the nation's Stockpile Stewardship Program. It provides the only means by which scientists can experimentally access and examine the physics of nuclear fusion and thermonuclear burn without underground nuclear testing. Understanding how the many different kinds of materials used in nuclear weapons behave, especially as they age beyond their intended lifetimes, under the extreme conditions produced in a thermonuclear reaction, also is a key element of the Stockpile Stewardship Program.

Data from NIF and other experimental facilities at Livermore and elsewhere help to inform and validate sophisticated, three-dimensional weapon simulation computer codes and build a fuller understanding of important weapon physics. NIF also is used to study materials under high-energy-density conditions and to help address planned and proposed stockpile life-extension programs. In addition, NIF's unique capabilities are applied in experiments of interest to agencies in the Department of Defense to further basic science relevant to national security.

Energy for the Future

NIF is designed to be the first inertial confinement fusion facility that can demonstrate ignition and a self-sustaining fusion burn. In the process, NIF's fusion targets will release 10 to 100 times more energy than the amount of laser energy required to initiate the fusion reaction. NIF will not be used to produce electricity, but NIF experiments will bring fusion energy a major step closer to being a viable source of virtually limitless energy.

By demonstrating the ability to attain fusion ignition in the laboratory, NIF will lay the groundwork for future decisions about the long-term potential of inertial confinement fusion (ICF) as a safe, carbon-free energy source. The timing is fortuitous. Estimates are that over the next 75 years, the demand for energy will be more than three times what it is today.

Understanding the Universe

For the first time, experiments at NIF enable researchers to study the effects on matter of extreme temperatures, pressures and densities that exist naturally only in stars and deep inside planets. Results from this relatively new field of research, known as high-energy density (HED) science, mark the dawn of a new era of experimental science. By recreating conditions that exist naturally only in the interiors of stars, supernovae and giant planets, NIF provides exciting new insights into what happened in the first nanoseconds after the Big Bang as well as the formation of planets and the lifecycle of stars. Research into plasma physics and laser-plasma instabilities improves understanding of black holes and supernovas. Other NIF programs promise breakthroughs in the use of lasers in medicine, hazardous waste treatment, particle physics and X-ray and neutron science.

For more information, contact the LLNL Public Affairs Office, P.O. Box 808, Mail Stop L-3, Livermore, California 94551 (925-422-4599) or visit our website at www.llnl.gov.

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