# National Ignition Facility & Photon Science

## The National Ignition Facility at a Glance

The National Ignition Facility (NIF) is the world's largest laser system, housed in a 10-story building the size of three football fields at Lawrence Livermore National Laboratory, east of San Francisco.

NIF's 192 laser beams are currently capable of delivering up to 10 times more energy than any other laser system. NIF can focus more than 1.8 million joules of ultraviolet laser energy on a tiny target in the center of its 10-meter-diameter Target Chamber—creating conditions similar to those that exist only in the cores of stars and giant planets and inside nuclear weapons. Thermonuclear fusion experiments on NIF have a goal of achieving ignition when the fusion reactions release as much or more energy than the energy injected into the hohlraum by the laser.

Experiments conducted on NIF make significant contributions to national and global security, could help pave the way to practical fusion energy, and further the nation's leadership in basic science and technology and economic competitiveness.

Building NIF and performing fusion, high energy density, and Discovery Science experiments has been enabled by an international collaboration among government, industry, academia, and industrial partners.


**NIF Control Room**
NIF's complex operation, alignment, and diagnostic functions are controlled and orchestrated by the Integrated Computer Control System. It consists of 300 front-end processors, containing 13.5 million lines of computer code attached to nearly 60,000 control points, including mirrors, lenses, motors, sensors, cameras, amplifiers, capacitors, and diagnostic instruments. The shot director oversees all NIF subsystems when preparing for a shot.

## NIF's Missions

- Support the U.S. National Nuclear Security Administration's Stockpile Stewardship Program, which ensures a safe, secure, and reliable nuclear stockpile, by conducting experiments to enhance understanding of the physics of nuclear weapons
- If ignition is achieved, lay the foundation for the natural next steps to explore fusion's potential as a clean, safe energy source
- Empower academic collaborators to explore new Discovery Science frontiers in astrophysics, materials science, nuclear science, and many other scientific disciplines
- Further U.S. scientific and economic competitiveness by transferring technology to the private sector and training future generations of scientists

NIF AT A GLANCE

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## NIF Timeline

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| **January 1993** | DOE key decision D signed by Energy Secretary James Watkins affirming NIF's mission need |
| **May 1994** | NIF's conceptual design study approved |
| **May 1997** | NIF groundbreaking ceremony |
| **June 1999** | Target Chamber installed |
| **October 2001** | First laser light created |
| **December 2002** | First tests of four laser beams generate 43 kilojoules (kJ) of infrared light in a pulse lasting five billionths of a second |
| **May 2003** | NIF produces 10.4 kJ of ultraviolet light in a single laser beam, setting a world record for laser performance |
| **December 2008** | All 192 Target Chamber final optics installed |
| **January 2009** | All line replaceable units installed; all project performance completion criteria met |
| **March 2009** | 1.1 megajoules (MJ) of ultraviolet energy fired to Target Chamber center |
| **March 2009** | Formal certification of NIF Project completion by the National Nuclear Security Administration |
| **May 2009** | NIF dedicated |
| **Summer 2009** | 192-beam experimental shots to Target Chamber center begin |
| **September 2010** | First integrated ignition experiment performed |
| **July 2012** | More than 1.8 MJ of ultraviolet energy and 500 trillion watts of peak power delivered to Target Chamber center |
| **September 2013** | NIF implosion yields more energy than the energy absorbed by the fuel, a key step on the path to igniton |
| **January 2014** | NIF experiment produces 27 kJ of fusion energy; more than half of the yield is attributed to alpha heating |
| **August 2017** | An experiment produces 54 kJ of energy, the highest yield to date |
| **May 2018** | The NIF lasers set a new energy record, firing 2.15 MJ of energy into the Target Chamber |

## NIF by the Numbers

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| **Total laser energy** | 4.2 MJ (infrared) |
| **Energy on target** | More than 1.8 MJ (ultraviolet) |
| **Equivalent peak power** | 500 trillion watts |
| **Large (meter-scale) optics** | 7,500 |
| **Small optics** | More than 26,000 |
| **Lines of computer code** | 13.5 million |
| **Computer control points** | 60,000 |
| **Target Chamber diameter** | 10 meters |
| **Target Chamber weight** | 130 metric tons |
| **Capsule diameter** | About 2 millimeters |
| **Target temperature at ignition** | More than 50 million degrees Centigrade |
| **Target pressure at ignition** | More than 350 billion atmospheres |
| **Neutrons released during ignition** | About 6 quintillion ($6 \times 10^{17}$) |