# National Ignition Facility & Photon Science

## Maintaining the Nuclear Weapons Stockpile

**National Ignition Facility**

The National Ignition Facility will provide researchers with unprecedented experimental access to the physics of thermonuclear burn.

As the largest, highest-energy laser ever built, the National Ignition Facility (NIF) can create conditions in the laboratory—temperatures of 100 million degrees and pressures 100 billion times that of the Earth's atmosphere—similar to those in stars and nuclear weapons. NIF is the only facility that can perform controlled, experimental studies of thermonuclear burn, the phenomenon that gives rise to the immense energy of modern nuclear weapons.

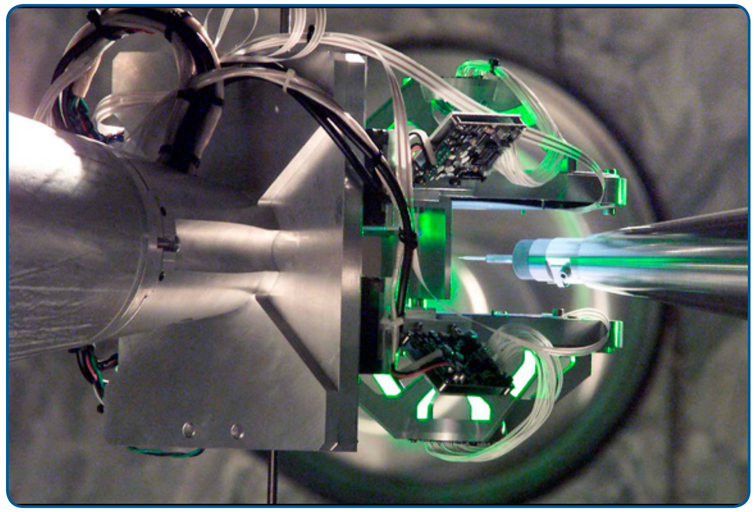
In the 1990s, after the United States ceased underground nuclear testing at the Nevada Test Site, the U.S. National Nuclear Security Administration created the Stockpile Stewardship Program (SSP) to ensure the reliability and safety of the U.S. nuclear deterrent without the need for full-scale testing. Ongoing cycles of surveillance, assessment, refurbishment, and reassessment comprise the SSP. The oldest nuclear weapon in the stockpile was added in 1970. Not many people own a 40-year-old car or refrigerator, and those machines are far less complex than a nuclear weapon. Changes to weapons systems for safety and security can have unintended consequences if those changes cannot be fully validated. Full validation is achieved through the combination of experiments using facilities such as NIF and advanced computational modeling.

The goal of SSP is to bring advanced experimental and computational tools to bear on the evaluation and assessment of the weapons in the nuclear stockpile. NIF experiments are an essential component of the nation's stockpile assessment and certification strategy. NIF provides the experimental platform for scientists to gain access to and examine thermonuclear burn. These experiments will also help the nation attract and retain the skills needed for DOE missions, which are crucial in order to assess the age-related changes that could compromise weapon reliability.

NIF provides unprecedented experimental access to the physics of nuclear weapons. Data from NIF experiments complement testing at other Livermore experimental facilities and elsewhere. This experimental data helps to inform and validate sophisticated, three-dimensional weapons simulation computer codes and bring about a fuller understanding of important weapon physics.

In effect, NIF allows scientists to separate the pieces of the physics of a nuclear weapon and examine each piece in isolation. Even before all of NIF's 192 laser beams became fully operational, experiments were already investigating physics matters of importance for the SSP.

SECURITY



Not only will NIF create controlled thermonuclear burn in a laboratory setting, but NIF beams can also be used to create conditions of extremely high energy density (HED) in materials. One example is using various arrangements of beams to shock materials and demonstrate how they behave at high temperatures and pressures. HED physics plays a critical role in nuclear weapons. Understanding how the many different kinds of materials used in nuclear weapons behave—especially as they age beyond their intended lifetimes—under the extreme environments produced in a thermonuclear reaction is a key part of the SSP mission. NIF also will be used to help address planned and proposed stockpile life-extension programs, which are regularly planned refurbishments of weapon systems to ensure their long-term safety and reliability.

### NIF Experiments

The target positioner and target alignment system precisely locate a target. The target is located with an accuracy of less than the thickness of a human hair. Data from NIF experiments validate computer codes that simulate weapons processes.

### Terascale Simulation Facility

LLNL's Terascale Simulation Facility houses the Department of Energy Advanced Scientific Computing Program's supercomputers. These machines enable 3D simulations with high-fidelity physics models of the performance of a full nuclear weapon system.

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