The National Ignition Facility: An Experimental Platform for Studying Behavior of Matter Under Extreme Conditions

Edward Moses
Principal Associate Director
National Ignition Facility and Photon Science
Lawrence Livermore National Laboratory, Livermore

The National Ignition Facility (NIF), a 192-beam Nd-glass laser facility capable of producing 1.8 MJ and 500 TW of ultraviolet light is now operational at Lawrence Livermore National Laboratory (LLNL). As the world's largest and most powerful laser system, NIF serves as the national center for the U.S. Department of Energy (DOE) and National Nuclear Security Administration (NNSA) to achieve thermonuclear burn in the laboratory and to explore the behavior of matter at extreme temperatures and energy densities. By concentrating the energy from all of its 192 extremely powerful laser beams into a mm^3-sized target, NIF can reach the conditions required to initiate fusion reactions. NIF can also provide access to extreme environments for basic science: temperatures of 100 million K (kT ~10 keV), densities of 1,000 g/cm^3, and pressures of 100 billion atmospheres (100 Gbar). These conditions have never been created in a laboratory and exist naturally only in the interiors of stars and nuclear weapons.

Since August 2009, the NIF team has been conducting experiments in support of the National Ignition Campaign (NIC)—a partnership between LLNL, Los Alamos National Laboratory, General Atomics, University of Rochester, Sandia National Laboratories, and a number of university and international partners. The results from these initial experiments have been outstanding and show great promise for achievement of ignition. Capsule implosion experiments at energies up to 1.2 MJ have demonstrated laser energy absorption, radiation temperatures, and symmetry control that scale to ignition conditions. Of particular importance is the demonstration of peak hohlraum temperatures near 300 eV, with overall backscatter less than 10%. Cryogenic target capability and additional diagnostics are being installed in preparation for layered target deuterium-tritium implosions to be conducted later in 2010. NIF has also conducted important national security and science experiments. This talk will describe the unprecedented experimental capabilities of NIF and the results achieved so far on the path toward ignition, for stockpile stewardship, and on the beginning of frontier science experiments. The talk will also discuss our plans to transition to a national user facility, providing access to NIF for researchers from the DOE laboratories, as well as the national and international academic and fusion energy communities.

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