Expanding shock waves from 100 Gbar implosions on the National Ignition Facility

Siegfried Glenzer[1], Andrea Kritcher[1], Art Pak[1], Tammy Ma[1], Steven Ross[1], Steve Glenn[1], David Bradley[1], Tilo Dppner[1], Joseph Ralph[1], Riccardo Tommasini[1], Andrew MacPhee[1], Nobuhiko Izumi[1], Eduard Dewald[1], John Moody[1], Sebastian LePape[1], Andrew Mackinnon[1], Steven Weber[1], Pierre Michel[1], Laurent Divol[1], David Farley[1], John Klein[2], and George Kyrala[2]

[1]Lawrence Livermore National Laboratory
[2]Los Alamos National Laboratory

March 22, 2012

Abstract

Inertial confinement fusion implosion experiments on the National Ignition Facility show a supernova-like emission ring after peak capsule compression. These experiments use thermonuclear fuel fielded as a cryogenic layer on the inside of a spherical plastic capsule in the center of a cylindrical gold hohlraum. Heating the hohlraum with 192 laser beams with a total laser energy of 1.6 mega joules compresses the initially 2.2-mm diameter capsule by a factor of 30 to a spherical dense fuel shell that surrounds a central 3 keV hot-spot plasma of 50 μm diameter. X-ray and neutron imaging of the compressed core and fuel indicate high fuel areal densities of 1 g cm^{-2} with fuel densities approaching 600 g cm^{-3}. This achievement is the result of the first hohlraum and capsule tuning experiments where the stagnation pressures that have been systematically increased by more than a factor of

10 by fielding low-entropy implosions through the control of radiation symmetry, small hot electron production, and proper shock timing. The implosions reach stagnation pressures above 100 Gbar driving a spherical shock that is expanding into the ambient plasma with velocities of 300 km/s. The comparison with radiation-hydrodynamic simulations indicates that the shocks provide a signature of the implosion energy.

*This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.