COMPRESSION OF MATTER TO PETAPASCAL PRESSURES

B. Bachmann[1], J. Nilsen[1], A. L. Kritcher[1], D. Swift[1], J. Caggiano[1], G. W. Collins[1], R. W. Falcone[2,3], S. H. Glenzer[4], R. Hatarik[1], J. Hawreliak[5], S. Khan[1], D. Kraus[2], O. L. Landen[1], N. Masters[1], S. Nagel[1], T. Pardini[1], G. B. Zimmerman[1] and T. Döppner[1]
[1]Lawrence Livermore National Laboratory, Livermore, USA
[2]University of California, Berkeley, USA
[3]Lawrence Berkeley National Laboratory, Berkeley, USA
[4]SLAC National Accelerator Laboratory, Menlo Park, USA
[5]Washington State University, Pullman, USA
bachmann2@llnl.gov

We have developed an experimental platform for compressing and probing targets up to several petapascal (tens of Gbar) pressures on the National Ignition Facility (NIF) within the Fundamental Science Program.[1] These pressures occur in inertial confinement fusion (ICF) plasmas and the center of stars. We use an indirect hohlraum drive to launch a spherical shock wave into a solid CD_2 sphere. During shock transition through the sphere, we use streaked radiography to measure the density change at the shock front and absolutely measure the equation-of-state along the Hugoniot curve of CD_2 [1]. At shock stagnation in the center of the sphere, we observe short and bright x-ray self-emission from high density (~50 g/cc) plasma at several keV temperature and DD neutron yields in the range of $1\text{x}10^{10}$.

Here, we present results of an approach to experimentally determine the hotspot conditions such as temperature, density and pressure. By measuring the hotspot size using penumbral imaging [2], hotspot temperature using two-color spectroscopy [3], the neutron yield from DD nuclear reactions, and the time history of the burn from x-ray emission, we infer hotspot pressures of several petapascal, exceeding previously reported pressures in carbon by three orders of magnitude [4]. Our findings agree very well with independently performed 1D radiation-hydrodynamics simulations, confirming a near symmetrical implosion performance.

[1] A. L. Kritcher *et al.*, Probing matter at Gbar pressures at the NIF, High Energy Density Phys. 10, 27 (2014)
[2] B. Bachmann *et al.*, Using penumbral imaging to measure micrometer size plasma hot spots in Gbar equation of state experiments, Rev. Sci. Instrum. 85, 11D606 (2014)
[3] B. Bachmann *et al.*, High-speed three-dimensional plasma temperature determination of axially symmetric free-burning arcs, J. Phys. D: Appl. Phys. 46, 125203 (2013)
[4] R. F. Smith et al., Ramp compression of diamond to five terapascals, Nature 511, 330-333 (2014)

[1] This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344 and supported by Laboratory Directed Research and Development Grant No. 13-ERD-073