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X-ray Thomson scattering measurements of temperature and density from multi-shocked CH capsules[1]

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To achieve the high level of compression, at low entropy, needed for inertial confinement fusion currently requires the use of multiple and precisely timed shock waves [1]. While x-ray Thomson scattering has previously been applied to isochorically heated matter in many planar shocked systems [2], we have performed proof-of-principle measurements of the electron densities, temperatures, and ionization states of spherically compressed multi-shocked CH capsules through the use of spectrally resolved x-ray Thomson scattering. A total of 13.5 kJ incident on a CH shell (45 beams at the Omega laser system), are used to compress a 70 micron thick CH shell above solid-mass density using three coalescing shocks. Separately, a laser-produced Zinc He alpha x-ray source at 9 keV delayed 200 ps - 800 ps in time after maximum compression is used to probe the plasma under a non-collective scattering geometry. The data show high compression of less than 8 g/cc consistent with radiation-hydrodynamic simulations that use adequate coalescence of the three shocks. These results are compared with independent experiments in CH that use counter-propagating shocks or highly compressed implosions. We show that x-ray Thomson scattering allows probing extreme states of Warm Dense Matter and enables a complete description of the time-dependent hydrodynamic evolution of shock-compressed CH.

[1] S. W. Haan et al., Nucl. Fusion 44, S171 (2004).
[2] S. H. Glenzer et al., Rev. Mod. Phys. 81, 1625 (2009).

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