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Characterizing Hohlraum Plasma Conditions at the National Ignition Facility (NIF) Using X-ray Spectroscopy[1]

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Improved hohlraums will have a significant impact on increasing the likelihood of indirect drive ignition at the NIF. In indirect-drive Inertial Confinement Fusion (ICF), a high-Z hohlraum converts laser power into a tailored x-ray flux that drives the implosion of a spherical capsule filled with D-T fuel. The x-radiation drive to capsule coupling sets the velocity, adiabat, and symmetry of the implosion. Previous experiments[2] in gas-filled hohlraums determined that the laser-hohlraum energy coupling is 20-25% less than modeled, therefore identifying energy loss mechanisms that reduce the efficacy of the hohlraum drive is central to improving implosion performance. Characterizing the plasma conditions, particularly the plasma electron temperature (T_e), is critical to understanding mechanism that affect the energy coupling such as the laser plasma interactions (LPI), hohlraum x-ray conversion efficiency, and dynamic drive symmetry. The first T_e measurements inside a NIF hohlraum, presented here, were achieved using K-shell X-ray spectroscopy of an Mn-Co tracer dot. The dot is deposited on a thin-walled CH capsule, centered on the hohlraum symmetry axis below the laser entrance hole (LEH) of a bottom-truncated hohlraum. The hohlraum x-ray drive ablates the dot and causes it to flow upward, towards the LEH, entering the hot laser deposition region. An absolutely calibrated streaked spectrometer with a line of sight into the LEH records the temporal history of the Mn and Co X-ray emission. The measured (interstage) Ly_α/ He_α line ratios for Co and Mn and the Mn-He_α/Co-He_α isoelectronic line ratio are used to infer the local plasma T_e from the atomic physics code SCRAM.[3] Time resovled x-ray images perpendicular to the hohlraum axis record the dot expansion and trajectory into the LEH region. The temporal evolution of the measured T_e and dot trajectory are compared with simulations from radiation-hydrodynamic codes.

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[2]S.A. Maclaren, et al, Phys. Rev Lett. 112, 105003 (2014).

[3]S.B. Hansen, *et al.* High Energy Density Phys. 3, 109 (2007).