ELECTRON TEMPERATURE MEASUREMENT OF NIF HOHLRAUM PLASMAS USING DOT SPECTROSCOPY

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Indirect-drive Inertial Confinement Fusion (ICF) experiments at the National Ignition Facility (NIF) use a high-Z hohlraum to convert laser power into a temporally tailored x-ray drive that implodes the fuel capsule and initiates alpha-burn. The laser-hohlraum coupling mechanisms and efficiency determine the velocity, adiabat and symmetry of the implosion. It is important to understand these hohlraum-specific effects in order to improve hohlraums so as to increase the likelihood of ignition. Empirically characterizing the temporal history of the hohlraum plasma conditions, such as the electron density (n_e) and electron temperature (T_e), at various locations within the hohlraum, will provide insight into the hohlraum x-ray conversion efficiency, dynamic x-ray drive symmetry, temporal development and saturation behavior of cross-beam energy transfer (CBET), and laser-plasma interactions (LPI) with associated hot electron pre-heat. Providing benchmark data will additionally improve predictive radiation-hydrodynamic (RH) hohlraum models.

The first T_e measurements inside a NIF hohlraum, near the laser entrance hole (LEH) region, using temporally resolved K-shell X-ray spectroscopy of a Mn-Co tracer are presented in this talk. Targets used a thin (0.16-0.32 μm) Mn-Co (1:1) dot deposited on top of a thin-walled CH capsule, with the dot co-axial with the symmetry axis of a bottom-truncated hohlraum. In the experiment the hohlraum x-ray drive causes the dot to ablate and expand toward the LEH, constrained by the capsule and hohlraum gas plasmas. As the dot material is heated and ionized, it reaches thermal equilibrium with the surrounding local hohlraum plasma. The recorded x-ray spectra of the Mn-Co dot is used to infer the local T_e in the hohlraum plasma, by using both isoelectronic line ratios [1,2] and Ly_α/He_α line ratios [2]. Measured line ratios are compared to detailed atomic physics simulations using SCRAM[3] for Mn and Co to determine the plasma T_e. Time resovled and time-integrated x-ray images perpendicular to the hohlraum axis and 19° from the dot normal record the dot expansion into the LEH region. Comparison of measured results with RH simulations using HYDRA [4], show that current simulations underpredict T_e in the hohlraum near the LEH. Implications of these results will be discussed.

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