DPP14-2014-000598
Abstract for an Invited Paper
for the DPP14 Meeting of
the American Physical Society

Polar-Drive Experiments at the National Ignition Facility

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To support direct-drive inertial confinement fusion (ICF) experiments at the National Ignition Facility (NIF)[1] in its indirect-drive beam configuration, the polar-drive (PD) concept[2] has been proposed. It requires direct-drive–specific beam smoothing, phase plates, and repointing the NIF beams toward the equator to ensure symmetric target irradiation. First experiments testing the performance of ignition-relevant PD implosions at the NIF have been performed. The goal of these early experiments was to develop a stable, warm implosion platform to investigate laser deposition and laser–plasma instabilities at ignition-relevant plasma conditions, and to develop and validate ignition-relevant models of laser deposition and heat conduction. These experiments utilize the NIF in its current configuration, including beam geometry, phase plates, and beam smoothing. Warm, 2.2-mm-diam plastic shells were imploded with total drive energies ranging from $\sim$ 350 to 750 kJ with peak powers of 60 to 180 TW and peak on-target intensities from 4×10^{14} to 1.2×10^{15} W/cm^2. Results from these initial experiments are presented, including the level of hot-electron preheat, and implosion symmetry and shell trajectory inferred via self-emission imaging and backlighting. Experiments are simulated with the 2-D hydrodynamics code *DRACO* including a full 3-D ray trace to model oblique beams, and a model for cross-beam energy transfer (CBET). These simulations indicate that CBET affects the shell symmetry and leads to a loss of energy imparted onto the shell, consistent with the experimental data. This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0001944.

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