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Polar Direct Drive—Simulations and Results from OMEGA and the National Ignition Facility

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Polar direct drive (PDD) is a valuable platform to study implosion dynamics at the National Ignition Facility (NIF). While hydrodynamic behavior is expected to scale between OMEGA and the NIF, coronal laser–plasma interactions that influence drive and shell preheat are expected to be different because of the larger coronal density scale lengths characteristic of the NIF. The goal of NIF experiments is to validate physics models (e.g., thermal transport and laser–plasma interactions relevant to energy coupling) at these longer scale lengths to gain confidence in hydrodynamic simulations of direct-drive implosions. Models in the hydrodynamic code *DRACO*, validated using OMEGA implosions, are used to design and interpret NIF experiments. The physics in these models, including cross-beam energy transfer and nonlocal transport, is discussed. Comparisons with observations including shell and ablation surface trajectory, temporally resolved scattered light and spectra, bang time, shell shape, time-resolved x-ray emission, and areal density are presented from OMEGA and NIF experiments. Excellent agreement is obtained on the backlit shell trajectories and scattered light, providing confidence in the modeling of the laser drive at the longer scale. Possible reasons for the discrepancy in the predicted trajectory of the ablation surface are discussed and planned experiments to address issues such as imprint and shock timing are presented. As will be shown, high-convergence implosions should be possible with custom phase plates relevant to PDD, improved single-beam smoothing, and laser pulse shaping. Such implosions are a necessary step toward a future direct-drive−ignition campaign. A path forward for direct drive on the NIF is presented. This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0001944.