DPP16-2016-000797

Abstract for an Invited Paper
for the DPP16 Meeting of
the American Physical Society

Three-Dimensional Hydrodynamic Simulations of OMEGA Implosions

I.V. IGUMENSHCHEV, Laboratory for Laser Energetics, U. of Rochester

The effects of large-scale (with Legendre modes less than ~ 30) asymmetries in OMEGA direct-drive implosions caused by laser illumination nonuniformities (beam-power imbalance and beam mispointing and mistiming) and target offset, mount, and layers nonuniformities were investigated using three-dimensional (3-D) hydrodynamic simulations. Simulations indicate that the performance degradation in cryogenic implosions is caused mainly by the target offsets ($\sim 10\,\mathrm{to}\,20\,\mu\mathrm{m}$), beam-power imbalance ($\sigma_{\mathrm{rms}} \sim 10\%$), and initial target asymmetry ($\sim 5\%\,\rho R\,\mathrm{variation}$), which distort implosion cores, resulting in a reduced hot-spot confinement and an increased residual kinetic energy of the stagnated target. The ion temperature inferred from the width of simulated neutron spectra are influenced by bulk fuel motion in the distorted hot spot and can result in up to $\sim$ 2-keV apparent temperature increase. Similar temperature variations along different lines of sight are observed. Simulated x-ray images of implosion cores in the 4- to 8-keV energy range show good agreement with experiments. Demonstrating hydrodynamic equivalence to ignition designs on OMEGA requires reducing large-scale target and laser-imposed nonuniformities, minimizing target offset, and employing high-efficient mid-adiabat ($\alpha = 4$) implosion designs that mitigate cross-beam energy transfer (CBET) and suppress short-wavelength Rayleigh–Taylor growth. These simulations use a new low-noise 3-D Eulerian hydrodynamic code *ASTER*. Existing 3-D hydrodynamic codes for direct-drive implosions currently miss CBET and noise-free ray-trace laser deposition algorithms. *ASTER* overcomes these limitations using a simplified 3-D laser-deposition model, which includes CBET and is capable of simulating the effects of beam-power imbalance, beam mispointing, mistiming, and target offset. This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0001944.