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Demonstration of 55 ± 7-Gbar Hot-Spot Pressure in Direct-Drive Layered DT Cryogenic Implosions on OMEGA

S.P. REGAN, Laboratory for Laser Energetics, U. of Rochester

Direct-drive ignition target designs for the National Ignition Facility (NIF) require hot-spot pressures in excess of 100 Gbar. Only one-third of the required pressure was inferred in earlier experimental campaigns conducted on the 60-beam, 30-kJ, 351-nm OMEGA laser with direct-drive implosions of layered DT cryogenic targets.[1] Laser and target improvements were implemented on OMEGA to increase the stagnation pressure, including a set of phase plates to increase the laser irradiation uniformity on target and a purified fuel with isotope composition reaching a 50:50 DT ratio. Diagnostic improvements were made for a neutron burnwidth measurement with a 40-ps impulse response and a 16-channel Kirkpatrick–Baez microscope to measure gated (30-ps) x-ray images of the core near peak compression with 6-μm resolution. The inferred volume-averaged, peak pressure in the current campaign almost doubled to 55 ± 7 Gbar with a neutron yield approaching 5×10^{13}. Further target performance improvements to reach hydrodynamic equivalence to ignition on OMEGA require mitigation of cross-beam energy transfer (CBET), which reduces the laser coupling. A proposed technique to reduce CBET by driving the spherical target with overlapping laser beams having individual focal spots smaller than the outside diameter of the target was investigated. The diameter of the target was discretely varied from 800 to 1000 μm, while the laser focal spot size was kept constant at 820 μm. The larger targets driven with up to 30 kJ of laser energy used dynamic bandwidth reduction, where the smoothing by spectral dispersion (SSD) is only applied to the pickets. The smaller targets driven with 26 kJ of laser energy had SSD on the entire pulse. This talk will summarize the results of this CBET mitigation campaign and describe a path forward to achieve ignition hydro-equivalence on OMEGA. 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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[1]V. N. Goncharov *et al.*, Phys. Plasmas **21**, 056315 (2014).