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Quantifying the Growth of Cross-Beam Energy Transfer in Polar-Direct-Drive Implosions at the Omega Laser and National Ignition Facilities

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Direct-drive inertial confinement fusion requires multiple overlapping laser beams that can drive the cross-beam energy transfer (CBET) instability. This instability is of primary concern because it can reduce the laser energy coupling and can affect the symmetry in a polar-direct-drive (PDD) configuration. An experiment was designed to determine the CBET growth by measuring the angularly resolved mass ablation rate and ablation-front trajectory in a PDD configuration. Adding a thin layer of Si over a CH shell generates two peaks in x-ray self-emission images that are measured with a time-resolved pinhole imager. The inner peak is related to the position of the ablation front and the outer peak corresponds to the position of the interface of the two layers in the plasma. The emergence of the second peak is used to measure the time for the laser to burn through the outer layer, giving the average mass ablation rate of the material. The mass ablation rate was measured by varying the thickness of the outer silicon layer. The shell trajectory and mass ablation rate measured in PDD on the pole, where CBET has little effect, were compared with simulations to validate the electron thermal-transport model. Excellent agreement was obtained when using a 2-D nonlocal transport model, and these observables could not be reproduced with flux-limited models. A similar comparison was performed on the equator where the CBET growth is large. Without the CBET model, the shell velocity and mass ablation rate were significantly overestimated by the simulation. Adding the CBET model reduced the drive on the equator and reproduced the experimental results. This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0001944. In collaboration with, D. Cao, D. T. Michel, M. Hohenberger, R. Epstein, V. N. Goncharov, S. X. Hu, I. V. Igumenshchev, J. A. Marozas, D. D. Meyerhofer, P. B. Radha, S. P. Regan, T. C. Sangster, and D. H. Froula (Laboratory for Laser Energetics, U. of Rochester); M. Lafon (CEA).