MEASUREMENTS OF THE CONDUCTION-ZONE LENGTH AND MASS ABLATION RATE IN CRYOGENIC DIRECT-DRIVE IMPLOSIONS ON OMEGA TO RESTRICT THERMAL-TRANSPORT MODELS

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In direct-drive inertial confinement fusion, electron thermal transport governs the energy flow through the conduction zone, which determines the length of the conduction zone, the mass ablation rate, and ultimately the kinetic energy coupled to the target through the rocket effect. Correctly modeling this transport is also essential to predict the growth of hydrodynamic instability. The conduction zone provides a buffer between the high-intensity modulations in the laser beam (speckles) and the ablation surface [where these modulations seed the Rayleigh–Taylor (RT) instability], while the mass ablation reduces the growth of this instability.

Imaging the soft x rays emitted by the coronal plasma of a directly driven imploding cryogenic target on the OMEGA Laser System is used to measure the ablation-front trajectory [1] and the averaged mass ablation rate of the deuterated plastic [2]. These measurements, coupled with the measurement of the scattered-light spectrum, make it possible to determine the length of the conduction zone [3]. These data, added to the measurement of the time-resolved laser absorption, constrain the electron thermal-transport. Hydrodynamic simulations that use nonlocal thermal-transport [4] and cross-beam energy transfer (CBET) models [5] reproduce these experimental observables. Hydrodynamic simulations that use a time-dependent flux-limited model reproduce the measured shell trajectory and the laser absorption but underestimate the mass ablation rate by ~10% and the length of the conduction zone by nearly a factor of 2. These results highlight the importance of developing multidimensional hydrodynamic codes that include CBET and nonlocal thermal-transport models to accurately determine the energy flow between the laser-absorption region and the ablation surface, particularly when studying effects that depend on the mass ablation rate.

This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0001944, the University of Rochester, and the New York State Energy Research and Development Authority. The support of DOE does not constitute an endorsement by DOE of the views expressed in this abstract.