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Laser-Energy Coupling, Mass Ablation Rate, and Shock-Heating in Direct-Drive ICF

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Direct-drive laser-energy coupling, mass ablation rate, and shock-heating are experimentally studied on the OMEGA Laser System to validate hydrodynamics simulations. High-gain, direct-drive inertial confinement fusion (ICF) target implosions require accurate predictions of the shell adiabat α (entropy), defined as the pressure in the main fuel layer to the Fermi-degenerate pressure. Since the minimum energy for ignition scales as $E_{min} \sim \alpha^{1.9}$ and the Rayleigh–Taylor ablative stabilization term is proportional to the ablation velocity $V_a \sim \alpha^{3/5}$; a balance must be struck. The temporal pulse shape of the laser irradiation determines the adiabat. A series of experiments in spherical and planar geometries with CH targets have measured the laser absorption, mass ablation rate, and the amount of shock heating in the target. Time-resolved measurements of laser absorption in the corona are performed on spherical implosion experiments. The mass ablation rate is inferred from time-resolved Ti K-shell spectroscopic measurements of nonaccelerating, solid CH spherical targets with a buried tracer layer of Ti. The amount of shock heating is diagnosed in planar-CH-foil targets using two techniques: time-resolved x-ray absorption spectroscopy and noncollective spectrally resolved x-ray scattering. The predicted shell conditions are close to the experimental results. A detailed comparison of the experimental results and the simulations will be presented. This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement No. DE-FC52-92SF19460. Contributors: H. Sawada, D. Li, V. N. Goncharov, R. Epstein, J. A. Delettrez, J. P. Knauer, J. A. Marozas, F. J. Marshall, R. L. McCrory, P. W. McKenty, D. D. Meyerhofer, P. B. Radha, W. Seka, T. C. Sangster, S. Skupsky, V. A. Smalyuk, LLE/UR, R. Mancini, University of Nevada, S.H. Glenzer, O. Landen *LLNL,* G. Gregori, *RAL*