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NIF Target Designs and OMEGA Experiments for Shock-Ignition Inertial Confinement Fusion

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Shock ignition (SI)[1] is being pursued as a viable option to achieve ignition on the National Ignition Facility (NIF). Shock-ignition target designs require the addition of a high-intensity ($\sim$5 $\times$ 10^{15} W/cm^2) laser spike at the end of a low-adiabat assembly pulse to launch a spherically convergent strong shock to ignite the imploding capsule. Achieving ignition with SI requires the laser spike to generate an ignitor shock with a launching pressure typically in excess of $\sim$300 Mbar. At the high laser intensities required during the spike pulse, stimulated Raman (SRS) and Brillouin scattering (SBS) could reflect a significant fraction of the incident light. In addition, SRS and the two-plasmon-decay instability can accelerate hot electrons into the shell and preheat the fuel. Since the high-power spike occurs at the end of the pulse when the areal density of the shell is several tens of mg/cm^2, shock-ignition fuel layers are shielded against hot electrons with energies below 150 keV. This paper will present data for a set of OMEGA experiments that were designed to study laser–plasma interactions during the spike pulse. In addition, these experiments were used to demonstrate that high-pressure shocks can be produced in long-scale-length plasmas with SI-relevant intensities. Within the constraints imposed by the hydrodynamics of strong shock generation and the laser–plasma instabilities, target designs for SI experiments on the NIF will be presented. Two-dimensional radiation–hydrodynamic simulations of SI target designs for the NIF predict ignition in the polar-drive beam configuration at sub-MJ laser energies. Design robustness to various 1-D effects and 2-D nonuniformities has been characterized. This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement No. DE-FC52-08NA28302.

[1]R. Betti *et al.*, Phys. Rev. Lett. **98**, 155001 (2007).