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Role of Hydrodynamics Simulations for Laser-Plasma Interaction Predictive Capability[1]

NATHAN MEEZAN, Lawrence Livermore National Laboratory

Efforts to predict and control laser plasma interactions (LPI) in hohlraum targets for large laser facilities such as the National Ignition Facility (NIF) in the U.S. and the Laser Mega-Joule (LMJ) in France are based on plasma conditions provided by radiation hydrodynamic simulations. Recent experiments provide compelling evidence that codes such as HYDRA can accurately predict the bulk plasma conditions in laser heated targets. These targets include gasbag and gas-filled hohlraum platforms for studying LPI on the HELEN and OMEGA laser facilities. We find that initially puzzling experimental observations are often caused by bulk hydrodynamic phenomena rather than by speckle-scale LPI phenomena. For example, in 2ω gasbag experiments, shifts in the stimulated Raman backscatter (SRS) streak spectra can be reproduced from the simulated plasma density and temperature profiles. Transmitted light in hohlraum targets is shifted in wavelength due to the rapidly changing density in the interaction-beam channel. Simulations are in good agreement with spatially localized, time-dependent Thomson scattering measurements of the electron and ion temperatures. We use these calculated plasma conditions to explore a simple, linear-gain based phenomenological model of backscatter. Plotting the measured backscatter against the post-processed gain, we find that the backscatter increases monotonically with gain and that the onsets of the backscatter and filamentation instabilities occur near predicted thresholds. These results suggest a role for linear gain post-processing as a metric for assessing LPI risk.

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