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Integrated Diagnostic Analysis of ICF Capsule Performance

CHARLES CERJAN, Lawrence Livermore National Laboratory

An understanding of the dynamics of imploding Inertial Confinement Fusion (ICF) capsules is crucial to achieve high convergence and gain. The relative roles of laser irradiation, hohlraum drive, and capsule response are intertwined and will be difficult to disentangle unless appropriate diagnostic probes are fielded and their results correlated. In the case of capsule implosions, several currently deployed diagnostics provide important information about the size and shape of the developing hot spot through x-ray self-emission, neutron production and average ion temperature by neutron time-of-flight signals, shell material mix into the hot spot by high-resolution x-ray spectra, and remaining mass during convergent ablation by x-ray backlighting. Obtaining a physically consistent picture of the implosion dynamics requires an integration of these disparate experimental data. This talk describes a three-dimensional model that attempts this integration. Assuming pressure equilibrium at peak compression and invoking simple radiative and equation-of-state relations, the pressure, density and electron temperature are obtained by optimized fitting of the experimental output to simple, global functional forms. The fitting procedure is sufficiently flexible to incorporate typical observational data such as x-ray self-emission, neutron time-of-flight signals, neutron yield, high-resolution x-ray spectra and radiographic images. Once consistency is obtained, many important secondary quantities can be derived such as the fuel areal density, high energy x-ray emission, neutron images, and nuclear activation. This approach has been validated by comparison with radiation-hydrodynamic simulations, producing semi-quantitative agreement and is now routinely used to characterize cryogenic implosion experiments. This talk will provide an overview of the implementation of the model and describe its application to recent experimental data.

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