DPP12-2012-000160

Abstract for an Invited Paper
for the DPP12 Meeting of
the American Physical Society

Detailed Implosion Modeling of DT-Layered Experiments on the National Ignition Facility[1]

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Several dozen Inertial Confinement Fusion (ICF) implosion experiments with cryogenic DT layers have now been performed on the National Ignition Facility (NIF). Each of these yields a wealth of data: x-ray image shape and size, primary and down-scattered neutron image shape and size, neutron down-scatter fraction, burn-averaged ion temperature, neutron yield, etc. Compared to radiation-hydrodynamics simulations, however, the measured capsule yield is usually lower by a factor of five to ten, and the ion temperature varies from simulations, while most other observables are well matched between experiment and simulation. In an effort to understand this discrepancy, we perform detailed post-shot simulations of a subset of NIF implosion experiments. Using two-dimensional HYDRA simulations of the capsule only, these simulations represent as accurately as possible the conditions of a given experiment, including the as-shot capsule metrology, capsule surface roughness, and ice layer defects as seeds for the growth of hydrodynamic instabilities. The radiation drive used in these capsule-only simulations can be tuned to reproduce quite well the measured implosion timing, kinematics and low-mode asymmetry. In order to simulate the experiments as accurately as possible, a limited number of fully three-dimensional implosion simulations are also being performed. The post-shot simulation procedure and the ensemble of post-shot implosion simulations will be described, and the remaining discrepancies with the data discussed as they suggest the need for possible modifications to the physics models included in simulations or alternate directions for the experimental campaign.

[1]Work performed under the auspices of the U.S. D.O.E by Lawrence Livermore National Laboratory under Contract No. DE-AC52-07NA27344.