DPP12-2012-001039

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

Mix mitigation experiments on cryogenic DT layered implosions on the NIF

TILO DOEPPNER, Lawrence Livermore National Laboratory

Inertial confinement fusion implosion experiments compress a deuterium-tritium (DT) ice fuel layer inside a low-Z ablator capsule shell, forming a central hot spot inside a high areal density DT layer. One possible obstacle to achieving ignition is mixing of ablator material into the hot spot, leading to radiative and conductive losses, cooling the hot spot, and extinguishing the incipient burn. Mix results from hydrodynamic instabilities seeded by perturbations at the outer ablator surface, the ablator-ice interface, and the inner fuel surface. We will report on a series of cryogenic DT layered implosion experiments that studied the effects of the capsule ablator thickness and silicon doping levels on the appearance of ablator mix into the hot spot, and its impact on implosion yield, temperature, and fuel areal density, as a function of the applied drive history. We use Ge dopant K-shell spectroscopy and Ross-pair imaging of the self emission to quantify the mix mass in the hot spot. We observe significant mixing when the remaining ablator mass drops below ~ 0.25 mg for ablators with large preheat shielding, which is evidence that the observed mix is mainly due to instabilities seeded by ablation front surface imperfections, consistent with simulations. In the presence of significant mix we observe a distinct drop of hot spot ion temperature (< 2 keV), a 2-4 fold neutron yield decrease, and increased hot spot x-ray yield. In order to understand and minimize mixing, we are varying the capsule ablator thickness and DT ice layer thickness, varying the ablator dopant concentration and distribution, and varying the laser pulse shape and power. An extensive series of DT layered implosion experiments will be presented, and the effect of ablator mix into the hot spot described.

This work was performed under the auspices of U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.