SIMULATION AND ASSESSMENT OF KINETIC EFFECTS IN A DIRECT-DRIVE CAPSULE IMPLOSION EXPERIMENT

T. J. T. Kwan, A. Y. Le, M. J. Schmitt, H. W. Herrmann, and S. H. Batha
Los Alamos National Laboratory
Los Alamos, New Mexico, 87545 U. S. A.
tjtk@lanl.gov

We have carried out simulations of a direct-drive capsule implosion experiment conducted on Omega laser facility at the Laboratory of Laser energetics of the University of Rochester. The capsule had a glass shell (SiO2) 4.7μm with an inner diameter of 1094μm. It was filled with deuterium and tritium at 5.0 atmospheric pressure with equal molar concentration. The capsule was imploded with to laser beams with a square pulse length of 0.6ns of total energy of 16.3kJ. One-dimensional radiation hydrodynamic calculations with Hydra[1] and kinetic particle/hybrid simulations with LSP[2] were carried out for the post-shot analysis to compare neutron yield, yield ratio, and shell convergence in assessing the effects of plasma kinetic effects. The LSP simulations were initiated at 0.6ns with the density, temperature, and velocity profiles of the electrons, deuterium, tritium, and SiO_2 species based on output from Hydra simulations. The electrons are treated as a fluid while the ion dynamics was simulated by the standard particle-in-cell techniques. The electromagnetic fields were solved with an implicit method and implicit particle push was deployed. In our LSP simulation, we clearly observed species separation phenomenon between the deuterons and tritons during the implosion but significantly less after the compression. Additional, the ions (D and T) had a thermalized temperature distribution of about 4 keV after the compression time. The neutron yield from the LSP simulation was about $7x10^{12}$ in contrast to the experimental value of $9.1x10^{12}$. The difference could be partly due to the reduction of reactivity resulting from species separation during the implosion of the hot plasma. Detail comparison among the kinetic simulations, rad-hydro simulations, and experimental results will be presented.

Work performed under the auspices of the US DOE by the Los Alamos National Laboratory under Contract No. W7405-ENG-36.

[1] M.M. Marinak, G.D. Kerbel, N.A. Gentile, O. Jones, D. Munro, S. Pollaine, T.R. Dittrich, and S.W. Haan, Phys. Plasmas Vol. 8, No.5, p2275 (May 2001).
[2] http://www.lspsuite.com/index.html