New tuning methods of the low-mode asymmetry for ignition capsule implosions

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In the deuterium-tritium inertial confinement fusion implosion experiments on the National Ignition Facility (NIF), the measured shape of the hot spot and the surrounding main fuel layer shows the obvious P2 asymmetries. This may be caused by a large P2 radiation flux asymmetry during the peak pulse resulting from the poor propagation of the inner laser beams in the gas-filled hohlraum. The low-mode radiation flux asymmetry in the hohlraum has become a major source of performance degradation in the NIF implosion experiments. A series of 2D implosion simulations have been performed with the radiation hydrodynamic code LARED-S, and the results show that the fuel areal density asymmetry breaks up the compressed shell and significantly reduces the conversion of implosion kinetic energy to the hot spot internal energy, leading to the degradation of implosion performance [1]. To describe the effects of the fuel areal density asymmetries on the yield, a new metric of the low-mode asymmetry has been developed to accurately measure the probability of ignition, as shown in the Fig.1(left). Some new tuning methods have been studied to counteract the deleterious effects of the large P2 flux asymmetry during the peak drive [2, 3]. One tuning method uses a positive P2 radiation flux asymmetry during the early laser pulse to compensate for a same-phased P2 drive asymmetry imposed during the main pulse; and another tuning method is the asymmetric-shell ignition capsule design which adopts the intentionally asymmetric CH ablator layer or deuterium-tritium (DT) ice layer. The significant improvements of the shell areal density symmetry, hot spot shape, hot spot internal energy, and neutron yield indicate that the tuning methods are quite effective (see right figure).

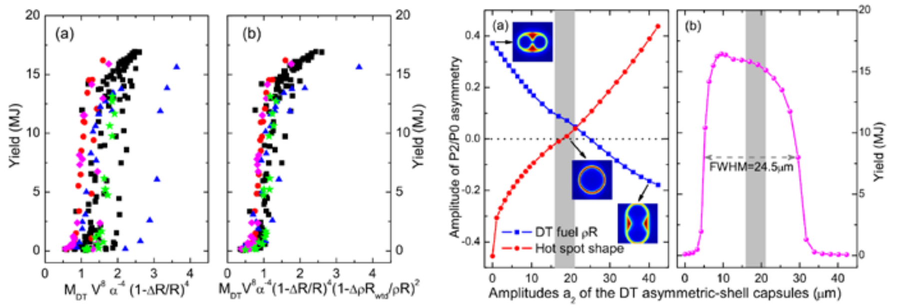

Figure 1: Left figure shows a new metric of the low mode asymmetry, and the right figure show the DT asymmetric-shell capsule design can significantly improve the implosion performance.

References

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