

Achieving efficient implosion for double-shell targets driven by Z-pinch dynamic hohlraum

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Abstract

Inertial confinement fusion (ICF) has attracted significant attention as a promising approach for achieving fusion energy. Since the Z-pinch driver can have a substantial energy input, it is a much promising scheme to realize ignition. The Z-pinch dynamic hohlraum (ZPDH) drive demonstrates notable advantages in terms of both energy input and conversion efficiency, making it an important way to drive high-gain targets. The double-shell targets, as a high-gain targets, have been widely studied. However, how to enhance the energy gain and burning fraction while ensuring the ignition of the fuel still needs to be studied in detail.

In this work, we conducted theoretical analysis and radiation hydrodynamic simulations to achieve efficient implosion of the double-shell targets driven by Z-pinch dynamic hohlraum. A theoretical model incorporating the ablator ablation, target implosion, and shell collisions are developed. The final implosion velocity can be theoretically predicted based on the given target and radiation drive parameters. The theoretical predictions exhibit a good agreement with the results from radiation hydrodynamic simulations, with deviations within 10%. Then, an optimal target structure using the random walk algorithm is designed. It is found that a target with a 3 mm radius can be ignited and yields energy of 165 MJ, under a 285.6 eV radiation driven source produced by ZPDH with a 50 MA load current. These findings provide valuable insights for designing double-shell or multi-shell targets in inertial confinement fusion.