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Optimization of local volume ignition targets

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Inertial confinement fusion, as an important way to achieve controllable nuclear fusion, has been widely studied. Compared to laser-driven fusion, Z-pinch driven fusion has advantages in terms of the large driven energy. It can provide a large radiation power with current engineering conditions, and the energy absorbed by the target can reach the order of MJ, which could create the condition for achieving high gain.
In 2008, Prof. X. J. Peng proposed a high gain target designing that is suitable for Z-pinch drive, i.e., local volume ignition targets. It is a multi-shell target and contains two layers of DT ice. The internal fuel is the ignition fuel, and the outer fuel is the main fuel. Such target can improve the robustness of ignition. However, how to improve the energy gain and burning fraction, then ensure the ignition of the internal fuel is still needed to be studied in detail.
In this work, we theoretically studied the multi-shell ignition process by deriving the implosion formulas, which can predict the optimal target structure under given driven energy. The maximum implosion velocity before the stagnation time can be obtained theoretically, and the neutron yield can also be obtained with the optimal design. Combing the random walk method and radiation hydrodynamic simulations, we can obtain the optimal target structure under the driving current and Z-pinch structure. It is a very efficient method for targets designing and can optimize and improve the yield rapidly. The simulation results have a good agreement with our theories. The results here should be beneficial for the future volume ignitions.

Speaker's Affiliation

National University of Defense Technology, Changsha

Member State or IGO/NGO

China

Primary authors: LI, Lingrui; YANG, Xiaohu (National University of Defense Technology); ZHANG, Guobo (National University of Defense Technology); LI, Ze; MA, Yanyun (National University of Defense Technology)

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