The requirements of transition to non-equilibrium burn in volume ignition of simple spherical targets

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(Received 28 August 2017; in final form 17 June 2018)

Abstract
In this Research, the transition from equilibrium ignition to non-equilibrium burn was studied by DEIRA4 code for simple spherical targets with the dimensions of several mm. It consisted of inner DT fuel and outer Au layers driven by the 209Bi heavy ions beam. Because of their higher plasma opacity, it was expected that they could trap much of the produced charged particles, radiation or even fast neutrons. Therefore, fuel ignited in the volume ignition regime with the low ignition temperatures of 1-2 keV. In order to decrease the confinement time and, the driver energy, the equilibrium ignition must be developed into a non-equilibrium burn phase. To get a non-equilibrium burning stage, we have examined all the important gains and losses processes, as well as competition among them. In these calculations, the individual and total contributions of all physical heating processes such as the contribution of alpha particles generated by DT fusion, neutron heating due to the first elastic scattering and the secondary fusion reactions have been considered at the ignition and burn time scale of DT fuel. It has been shown that the role of secondary DD and D3He fusion reactions as well as the first elastic scattering contribution in the energy deposition of fast 2.45 and 14.06 MeV neutrons cannot be forgotten. Transition temperature to the non-equilibrium burn phase in these targets was reduced to 3.24 keV, as compared to the ideal non-equilibrium transition temperature of 3.6 keV; it was much lower than the ideal ignition temperature of 4.3 keV. In order to investigate the effects of the driver parameters on the transition conditions, calculations were done for various configurations of simple spherical targets, showing that multiplier reduction in the pulse duration and multiplier increase in the beam power could reduce transition temperature and in such targets.

Keywords: inertial confinement fusion, volume ignition, heavy-ion driver, equilibrium ignition, non-equilibrium burn

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