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1000 Times Enhancement of Fusion Reaction in Relation to Fast-Ion Heating Induced by a Direct-Irradiating Fast-Ignition Scheme

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For inertial confinement fusion, the high-density compression and core heating are essential processes. National Ignition Facility (NIF) is a promising candidate for the development of a fusion power plant. However, a self-ignition scheme, that is, to burn the core in implosion itself is not straightforward as expected. A potential solution for this is the fast-ignition scheme, because this scheme can separate and optimize the process of fuel compression and its heating respectively. In this paper, we proposed and performed a new-scheme fast-ignition which includes direct ion heating of an imploded core. The Laser for Fast Ignition Experiment (LFEX) directly heated a pre-imploded core, enhancing D(d, n)^3He-reaction neutron (DD neutron) yields by a factor of 1000 (5×10^8 n/4pi sr) from that of pre- imploded core. This is the best ever obtained in fast-ignition scheme. Temperature of a part of the core increased by a factor of two, i.e., from 0.8 keV to 1.8 keV. The laser-driven hot electrons and fast ions contribute to the core heating. The thermal fusion neutron yield of 6.4×10^7 n/4pi sr also breaks the previous record of 2×10^7 n/4pi sr. STAR ID hydro-code predicts that deuterons are related to beam fusion and carbons to thermal fusion, respectively. The proposed scheme here is a potential path to fast-ignite the core at high gain fusion. We would like to stress two points, (1) Not only hot electrons, but also energetic ions can fast ignite the core. (2) The neutron yield has increased as high as 1,000 times than that achieved before, which is a record of the fast ignition scheme.

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