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Direct heating of imploded plasma by fast-ions in the fast ignition scheme

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In the conventional fast ignition scheme of inertial confinement fusion (ICF), the heating laser energy is transferred to energetic fast electrons towards the imploded plasma core and heats it while the high dense core is maintained. We propose direct heating of the imploded core by the ultra-intense laser in the fast-ignition scheme. When the high pressure of imploded core plasma breaks the tip of the cone up, the heating laser directly irradiates the imploded plasma expanding into cone and generates the fast-ions as well as the fast-electrons. Both fast-ions and electrons are generated and they contribute to the heating of the imploded core plasma simultaneously. In order to estimate the temperature scaling of the core heated by fast-ions and electrons in this scheme, we investigated the conversion efficiency and the kinetic energy of generated energetic particles. Then, we calculated the transport of particles in the imploded core. We obtained the calculated results that the core temperature reached beyond 5 keV for the laser intensity of 1021W/cm2, in which the core peak temperature was obviously larger than that with electron heating only for the same laser condition. Also, we conducted a preliminary experiment in this scheme by using 1kJ 1.5ps ultra-intense heating laser (LFEX) and Gekko XII laser system at Osaka University. To confirm that the heating laser directly irradiates the imploded core plasma, we use the tip-less DLC cone attached CD shell target. We had three shots with different LFEX injection timing, -200ps to +200ps from maximum compression of the imploded core. We observed increasing neutron yields of 2 - 3 x 106, compared to the yields of 1 - 3 x 105 without heating laser.

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