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Demonstration of Efficient Core Heating of Magnetized Fast Ignition in FIREX project[1]

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Extensive theoretical and experimental research in the FIREXI project over the past decade revealed that the large angular divergence of the laser generated electron beam is one of the most critical problems inhibiting efficient core heating in electron-driven fast ignition[2]. To solve this problem, beam guiding using externally applied kilo-tesla class magnetic field was proposed, and its feasibility has recently been numerically demonstrated[3]. In 2016, integrated experiments at ILE Osaka University demonstrated core heating efficiencies reaching > 5 % and heated core temperatures of 1.7 keV. In these experiments, a kilo-tesla class magnetic field was applied to a cone-attached Cu(II) oleate spherical solid target by using a laser-driven capacitor-coil. The target was then imploded by G-XII laser and heated by the PW-class LFEX laser. The heating efficiency was evaluated by measuring the number of Cu-K-α photons emitted. The heated core temperature was estimated by the X-ray intensity ratio of Cu Li-like and He-like emission lines. To understand the detailed dynamics of the core heating process, we carried out integrated simulations using the FI^3 code system. Effects of magnetic fields on the implosion and electron beam transport, detailed core heating dynamics, and the resultant heating efficiency and core temperature will be presented. I will also discuss the prospect for an ignition-scale design of magnetized fast ignition using a solid ball target.

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