Experimental Demonstration of Magnetically-Assisted Fast Ignition on GEKKO-LFEX Laser Facility

Shinsuke FUJIOKA [1], Shohei SAKATA[1], Seungho LEE[1], Hiroshi AZECHI[1], Tomoyuki JOHZAKI [2], Hideo NAGATOMO[1], Yasuhiko SENTOKU[1], Hiroshi SAWADA[3], Hitoshi SAKAGAMI[4], Hiroaki NISHIMURA[1], Mitsuo NAKAI[1], Junji KAWANAKA[1], Takayoshi NORIMATSU[1], Hiroyuki SHIRAGA[1], Ryosuke KODAMA[1] and FIREX Project Team

1) Institute of Laser Engineering, Osaka University, Japan

E-mail: sfujioka@ile.osaka-u.ac.jp

2) Faculty of Engineering, Hiroshima University, Japan

3) Department of Physics, University of Nevada, Reno, USA

4) National Institute for Fusion Science, National Institutes of Natural Sciences, Japan

Large divergence of relativistic electron beam (REB) is one of critical problems of the electron-based fast ignition (FI) scheme. The path of diverging REB accelerated by high intensity short pulse laser can be guided by externally-applied longitudinal magnetic field. In magnetically-assisted cone-guided FI (MFI), REB generated inside a cone tip can be collimated by an external magnetic field to a compressed core, improving an electron-core coupling efficiency [1].

Here, we report the first integrated MFI experiment on GEKKO-XII and LFEX laser facilities. Copper oleate ($C_{36}H_{68}O_4Cu$) was used as a surrogate fusion fuel target. The x-ray emission from the Cu atoms enabled us to measure electron temperature from the spectral shape of thermal x-ray lines and to evaluate energy coupling efficiency from absolute Cu-*K*α X-ray yield [2]. Six 1.3-ns GEKKO-XII laser beams were focused on a solid bead made of Copper oleate to compress to 0.1 g/cm^2 [3]. A capacitor-coil target was irradiated by other three GEKKO-XII beams to generate kilo-tesla magnetic field [4]. The high energy, Petawatt laser LEFX with 2-kJ energy in a 1.5-ps pulse duration was injected into a gold cone at various timings with respect to the drive beams to heat the plasma core with REB.

The Li-like and He-like Cu x ray emissions from the magnetized target were observed with the LFEX beam injection at 340 and 110 ps before the maximum compression. The spectral analysis along with a model calculation indicates the plasma core electron temperature increased from 0.1 keV to 1.7 keV by the LFEX laser. The integrated simulation [5] suggests that the injection of the LFEX laser locally heats plasmas in the upstream of the converging shock, leading to an increase of the shock pressure and the temperature at the bead center.

References

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