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Plasma Mirror technology on a PW, multi-kJ class Laser to reduce the pre-formed plasma for application to Fast Ignition research.

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In the Fast Ignition scheme, the heating of the compressed Deuterium Tritium capsule is produced by a fast electron beam generated by an ultra-high intensity laser pulse, transporting the laser energy from the interaction region up to the compressed DT fuel and producing a one-sided hot spot, from which the thermonuclear burst propagates to the rest of the fuel.
In order to achieve ignition, the fast electron average temperature is required to be within the 1-2 MeV range in order to efficiently deposit the energy in a small volume of the compressed core, while the typical fast electron spectrum, instead, presents a large amount of energy carried by high energy electrons (≥ 5 MeV). This large hot electron temperature is believed to be associated to the formation of a relatively long scale length preformed plasma, related to the presence of a pedestal preceding the main laser pulse.
In this work we propose a method to further reduce the fast electron average energy by reducing the pre-plasma scale length, by implementing a Plasma Mirror (PM) device on LFEX laser.
The first test of the PM has been successfully performed at LFEX laser, a multi-PW class laser, capable in the current development state, to deliver up to 2 kJ of laser energy at 1ω (1053 nm) in about 1.5 ps. The first stage of the experiment consisted in the characterization of the PM reflectivity versus laser energy fluence, using LFEX laser with a reduced pulse energy of ~ 1 J, giving equivalent condition for high power interaction. The fluence on the PM was varied by varying the distance between the PM and target chamber center (TCC), where the LFEX beams are focused. As theoretically expected, a reflectivity of ~50% is found for LFEX fluences above 40J/cm2.
The second stage of the experiment consisted in measuring the TNSA proton energy obtained focusing the LFEX beam after PM, for a LFEX pulse energy of about 300 J corresponding to 150 J on target and 1.5 ps pulse duration, on a thin 3 μm Al foil, and a peak proton energy above 3 MeV has been obtained.
In conclusion, we confirmed and demonstrated that the Plasma Mirror Technology can be successfully implemented on LFEX laser, and work at pulse conditions relevant for the FIREX project at ILE, Osaka University.

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Author: Mr MORACE, Alessio (Japan)

Co-authors: Dr SAGISAKA, Akito (Japanese Atomic Energy Agency); Prof. NISHIMURA, Hiroaki (Institute of Laser Engineering); Prof. AZECHI, Hiroshi (Institute of Laser Engineering, Osaka University); Prof. SHIRAGA, Hiroyuki (Institute of Laser Engineering, Osaka University); Prof. KONDO, Kiminori (Japanese Atomic Energy Agency); Dr ARIKAWA, Yasunobu (Insituteof Laser Engineering Osaka University); Prof. NAKAI, mitsuo (Institute of Laser Engineering)

Presenter: Mr MORACE, Alessio (Japan)

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