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Plasma Mirror implementation on LFEX laser for Ion and Fast Electron Fast Ignition.

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Fast Ignition (FI) is an alternative approach to Inertial Confinement Fusion (ICF) based on the separation between compression and heating of the equimolar Deuterium-Tritium (DT) fuel capsule. In the FI scheme, the heating is produced by an energetic particle beam, either ions or electrons, generated by an ultra-high intensity laser pulse.
Both in Proton and Fast Electron Fast Ignition high contrast laser pulse is required in order to efficiently accelerate the particles, avoiding target foil explosion in case of Target Normal Sheath Acceleration (TNSA) of Protons or by avoiding large scale pre-formed plasma which will increase the fast electron temperature in case of Fast Electron driven FI. In synthesis both FI scenarios require high contrast laser pulses in order to be successful, therefore the laser pulse pedestal must be suppressed significantly.
In this work we show a method to reduce the laser pulse pedestal level, by implementing a Plasma Mirror (PM) device on LFEX laser.
Very high shot-to-shot pointing and focusing reliability has been demonstrated during the experiment, obtaining stable experimental results in line with the theoretical expectations. In particular the pedestal reduction was demonstrated by transverse interferometry of the target surface (see Fig. 2), showing absence of preformed plasma even 140 ps before the main pulse arrival, while in absence of PM, under-dense plasma expansion was observed as early as 1.3 ns before the main pulse arrival.
The Fast electron spectrum generated by focusing the LFEX beam on an Au block target showed fast electron temperature reduction within the range of interest for Fast Ignition in presence of PM device as shown in figure 3. This further demonstrated that the fast electron spectrum is strongly determined by the presence of pre-formed plasma. Finally ion acceleration from sub-μm (100 nm) plastic (CH) foil, obtaining a proton beam with maximum energy of 20 MeV recorded on radio-chromic film (RCF) stack, unequivocally demonstrates the extremely high contrast achieved by implementation of the PM device and opens to a wide variety of acceleration mechanisms for Fast Ignition research.

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