Relativistic electron beam collimation in warm-dense aluminum using two consecutive laser pulses

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Recently a large number of methods for relativistic electron (REB) transport in warm-dense matter target conditions have been investigated in the context of a multitude application, such as fast ignition approach to inertial confinement fusion, proton acceleration, point-like x-ray sources and laboratory astrophysics. Here we report an experimental investigation of a scheme based on using of two consecutive intense laser pulses in order to optimize electron transport and collimation in dense matter. The two laser pulses, of different intensities, are focalized in a solid target at a given delay to generate two successive co-axial electron populations, where the azimuthal magnetic field generated by the first electron beam (seed) can guide the second one [1]. Previous experimental results have confirmed the general validity of the scheme: optimum delay time and intensity ratio yielding the best guiding effect [2]. Simulations pointed out the importance of the ratio between the pre-formed magnetic field extension and the diameter of the second electron beam, as this parameter plays a major role in determining the guiding efficiency [3]. A systematic investigation of the scheme, exploring the role played by the radial extension of the seed magnetic field and the delay time between seed and main laser pulses, was recently carried out on the LULI-ELFIE facility. The experimental results showed a reduction of the electron beam size according to the theoretical predictions in the optimum conditions, of both focal spot ratio and delay time between the first and the second laser pulses. In addition we also observed a temporal shift of the maximum collimating effect when changing the focal spot size of the seed laser pulse. This can be explained by the laser produced magnetic field dynamics that is clearly affected by the seed laser pulse spot size. This collimation scheme has potential to provide an efficient REB transport in dense matter for the aforementioned applications.

References

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