Title

Angled laser triggered electron injection in the electron driven plasma wakefield acceleration scheme: A case study in a pursuit to increase tolerance levels, based on FACET II driver parameters.

Abstract (45 words max)

Co-axial laser triggered injection of electrons in PWFA, can produce high quality witness bunches. In this study, angled laser injection was examined in a pursuit to increase the tolerance levels of synchronization and misalignments while maintaining the quality of the witness bunches.

Summary (350words max)

Many studies have already demonstrated the great potential of a laser triggered electron injection while in PWFA scheme, given the high quality of the produced witness bunches in the aspects of high brightness and low emittance. However, both the synchronization and the accuracy of the electron injection within the bubble of first blowout are challenging. As a result, the margins of experimental errors are very narrow, jeopardising the witness bunch highly sensitive quality. In this work, the use of an angled, to the axis of the electron driver propagation, laser triggered electron injection is discussed, aiming to an increase of the tolerance levels of both synchronization and misalignments, while maintaining the quality of the witness bunches.

The wakefield produced by the propagation of a Facet II specifications electron driver, in an underdense pre-ionized plasma channel, was selected as a starting point with future reference. Furthermore, a two gases mixture (with adequately different ionization thresholds) was present within the simulation channel, to enable the production of both the plasma and the laser released electrons. A laser pulse, with large spot size and in an angle to the central axis of the driver propagation, was released in time to centre the electron injection within the first blowout, while its focus was placed after the point where the shaping of the potential was completed. The generated geometry enabled the scanning of the trapping area by the laser pulse ionization front and resulted to a homogeneous electron injection. As expected theoretically and also as confirmed by initial simulations, the combination of the geometrical characteristics of the trapping area with the pulse spot size, has a great impact on both the amount of trapped charge and its quality and the tolerance levels during an experiment.

The process of selecting the appropriate injection angle, which will stabilize the laser triggered injection while maintaining high witness bunch quality, is still ongoing. Nevertheless, this is a very crucial step for the upcoming implementation opportunities of this highly advanced and promising technique.