EFTC 2017
17th European Fusion Theory Conference
9 - 12 October 2017, Athens - Greece

Relativistic electron acceleration in laser plasma interaction

C. Riconda

LULI Sorbonne Université, Ecole Polytechnique, CNRS, CEA, 75252 Paris, France

The availability for the scientific community of compact sources of intense, high-power, ultrashort laser pulses, allowed a rapid growth of studies on laser driven electron accelerators. Different laser plasma acceleration mechanisms have been explored. A by now well know scheme involves the generation of huge acceleration gradients, up to 10 to 100 GV/m, due to the propagation of a TW-class laser pulse in a diluted plasma. GeV scale and very short duration (some fs) electron beams produced in this way are a natural candidate as drivers for a free-electron laser or to be coupled into undulators to produce radiation in the visible and X-ray domain.

In this talk we present an alternative approach: the generation of fast electron beams in relativistic laser-solid interaction. The studies in this domain are mainly stimulated by the possibility of having higher electron currents due to the high density. In laser-solid interaction the energy coupling between the laser beam and the target is mainly localized at the surface and the coupling efficiency needs to be optimized in order to get an energetic electron distribution. One way is to use properly-structured targets whose surface characteristics match with the laser parameters, so that surface plasma waves are excited [1].

As will be discussed, the surface plasma wave excitation on solid grating target enhances drastically the laser absorption in ultra-high intensity interaction regime ($I\lambda^2 > 1018$ $Wcm^{-2}\mu m^2$) and generates large currents of relativistic electrons. Theoretical, numerical (via the Particle-in-Cell method) and experimental studies of fast electron generation will be presented. Recently, a simple scaling for the conversion of surface wave field energy into electrons kinetic energy has been identified by our group by considering the interaction of test electrons with the evanescent high frequency field of a surface wave [2]. We were able to show that the most energetic relativistic electrons are accelerated parallel to the plasma-vacuum interface to velocities larger than the wave phase velocity. These results have been confirmed by Particle-in-Cell simulation and experiments [3].

References

[1] J. Kupersztych, M. Raynaud, C. Riconda, Phys. Plasmas , 11, 1669 (2004)
[2] C. Riconda, et al. Phys. of Plasmas 22, 073103 (2015), and ref. therein
[3] T. Ceccotti, et al. Phys. Rev. Lett. 111, 185001 (2013), L. Fedeli et al., Phys. Rev. Lett. 116, 015001 (2016), and ref. therein (2010)