Investigation of Transverse and Longitudinal Ion Acceleration Using Ultra High Intensity Few Cycles Shortwave Laser Pulses

E d'Humières[1], X Ribeyre[1], R Capdessus[1], F Brun[1], J Wheeler[2], and G Mourou[2]

[1]*University of Bordeaux, CEA, CNRS, CELIA (Centre Lasers Intenses et Applications) UMR 5107, Talence, France*

[2]*DER-IZEST, Ecole Polytechnique, Palaiseau, France*

Contact Email: emmanuel.dhumieres@u-bordeaux.fr

It is now possible to generate few cycles high intensity laser pulses in a broad range of wavelengths making these pulses promising for applications requiring high repetition rates. Moreover, several setups have recently been proposed to generate ultra-short laser pulses either by broadening the spectrum of near-infrared laser pulses to obtain single-cycle pulses that can be converted to single cycle attosecond pulses by a plasma mirror, or by directly using Doppler-boosted petawatt-class lasers. The corresponding photon energy range is from 10 eV to 1 keV. Such high energy photons are able to propagate even inside solid density targets and will allow to explore new regimes of laser-matter interaction with strong application potential.

We have investigated the interaction of high intensity attosecond pulses with solid proton–Boron targets and the associated electron acceleration, ion acceleration, and radiation generation supported by Particle-In-Cell simulations. We demonstrate the efficiency of single–cycle attosecond pulses in comparison to multi–cycle attosecond pulses for transverse ion acceleration and magnetic field generation, making this regime of interaction promising for proton–Boron fusion. We also discuss the influence of the laser and target parameters to optimize longitudinal ion acceleration and high energy radiation generation. For higher laser wavelengths, lower density targets can be used to obtain similar interaction conditions. We therefore compare the feasibility of efficient longitudinal ion acceleration using few cycles pulses for various laser wavelengths.