Strong-Field QED with Doppler-Boosted Laser Beams

L Fedeli[1], P Bartoli[1], K Oubrerie[1], A Leblanc[2], and H Vincenti[1]

[1]*LIDYL, CEA, Universite Paris-Saclay, Gif-sur-Yvette, France*
[2]*Laboratoire d'Optique Appliquee, ENSTA, Palaiseau, France*
Contact Email: luca.fedeli@cea.fr

Strong-Field Quantum Electrodynamics (sf-QED) is characterized by a background field sufficiently strong to allow the creation of electron/position pairs via the non-linear Breit-Wheeler process, as well as the emission of high-energy photons via the non-linear Compton process. However, studying this QED regime requires huge electromagnetic fields, of the order of the so-called "Schwinger field": $\approx 1.32 \times 10^{18}\mathrm{V/m}$. Therefore, sf-QED is essentially "terra incognita" from the experimental point of view. The Schwinger field is more than 3 orders of magnitude stronger than the strongest fields available on Earth: those produced by ultra-intense femtosecond lasers. In our group, we study strategies to overcome this challenge. When an ultra-intense laser interacts with a solid target, it generates a so-called "plasma-mirror", which oscillates at relativistic velocities. The reflection of the laser on the oscillating plasma surface generates a train of attosecond pulses via Doppler effect. At the same time, the radiation pressure of the laser induces a curvature of the target, which can focus the Doppler-boosted beam up to high intensities, potentially enhancing the focused intensities by three orders of magnitude (according to state-of-the-art 3D Particle-In-Cell simulations). In this contribution we present how these focused Doppler-boosted beams can be leveraged to explore the strong-field regime of QED either by making them interact with a solid target or with a high-energy electron beam. We investigate these scenarios by means of Particle-In-Cell simulations carried out with the open-source code WarpX.