Contribution ID: **3038** Type: **not specified**

O5.202 Production of isolated CEP-tunable subcycle pulses in laser-driven wakes

Friday, 12 July 2019 11:55 (15 minutes)

See the full abstract here http://ocs.ciemat.es/EPS2019ABS/pdf/O5.202.pdf

Intense, ultra-short electromagnetic pulses are enabling applications such as the control of motion in solids and the observation of reaction dynamics at the electronic level. While both high-intensity and carrier envelope phase (CEP) tunability are crucial, they are hard to obtain with current methods. Laser-plasma methods, e.g. [1, 2], are scalable alternatives which, however, are either not CEP-tunable or require a controllable CEP-stable high-intensity laser.
Here, we propose a new scheme for the generation of intense, isolated, CEP-tunable, subcyclepulses by laser-driven wakes. It relies on the interaction of a low-intensity, CEP-stable, longwavelength seed pulse with a wake driven by an intense, not necessarily CEP-stable pump laser pulse. We show through 3D particle-in-cell (PIC) simulations that a seed pulse with wavelength longer than the plasma skin depth, c/pe, can extract energy from the leading density spike of the wake. As a result of localized amplification, an intense subcycle pulse is formed. Through a parametric study with 2D PIC simulations we show that the subcycle pulse is CEP-tunable by varying either the CEP of the seed pulse or the delay between the seed and pump pulses. Moreover, we show that we can control the subcycle pulse intensity, mean frequency and spectral range by varying the plasma density and pump laser intensity. In particular, relativistic intensity subcycle pulses can be obtained in the mid-IR regime, which are hard to obtain by other means.

References
[1] Z. Nie et. al, Nature Photonics 12, 489 (2018). [2] I. Thiele et al., arXiv:1806.04976 (2018).

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Presenter: SIMINOS, E. (EPS 2019)

Session Classification: BPIF

Track Classification: BPIF