Ultra-energetic electron bunches from surface plasma wave excitation by laser with wavefront rotation in the ultra-high intensity regime

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Recent experiments [1] have demonstrated that the resonant excitation of surface plasma waves (SPW) by ultra-high intensity fs lasers impinging on a solid-density target strongly enhances the laser-plasma coupling and provides a new path for generating relativistic, high charge electron bunches emitting radiation with interesting characteristics. In this work, we show that laser wavefront rotation (WFR) [2] acts to both shorten the duration (down to very few optical cycles) and increase the intensity of SPW [3], thus favoring the production of ultra-short, energetic electron bunches. Optimal laser parameters were identified analytically and verified by means of Particle-In-Cell (PIC) simulations with the open-source code SMILEI [4]. The laser pulse with WFR was combined with a smart grating target design. In the laser-plasma relativistic regime of interaction (i.e. $I\lambda^2 = 3.4 \times 10^{19}$ W/cm^2 μm^2), we show that this set-up may produce SPW with ~3.6 cycles duration which accelerate high-charge (few 10's of pC), high-energy (up to 70 MeV) electron bunches of few fs duration [5]. Key parameters for SPW excitation in the ultra-high intensity regime ($I\lambda^2 > 10^{21}$ W/cm^2 μm^2) are also discussed [6].

References

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