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Laser wakefield electron acceleration with high power, few-cycle mid-IR lasers

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The study of laser wakefield electron acceleration (LWFA) using mid-IR laser drivers is a promising path for future laser driven electron accelerators, when compared to traditional near-IR laser drivers operating at 0.8 - 1 μm central wavelength (λ_laser), as the necessary vector potential (a_0) for electron injection can be achieved with smaller laser powers due to the linear dependence on λ_laser. In this work, we perform 2D PIC simulations on LWFA using few-cycle, high power (>10 TW) laser systems with λ_laser ranging from 0.8 - 3.2 μm. Such few-cycle systems are currently under development, aiming at Gas High Harmonics Generation applications, where the favourable (λ_laser)^2 scaling extends the range of the XUV photon energies. We keep a_0 and n_e/n_cr (n_e being the plasma density and n_cr the critical density for each λ_laser) as common denominators in our simulations, allowing for comparisons between drivers with different λ_laser, with respect to the accelerated electron beam energy, charge and conversion efficiency. While the electron energies are mainly dominated by the plasma dynamics, the laser to electron beam energy conversion efficiency shows significant enhancement with longer wavelength laser drivers.

Summary

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