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Wakefield-Induced Ionization Injection and Self-Similar Staging in Beam-driven Plasma Wakes.

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We propose a simple strategy for controlled ionization-induced trapping of electrons in beam-driven plasma accelerators (PWFA) [1]. The presented method exploits the electric wakefields to ionize electrons from a dopant gas and to capture them into a well-defined volume of the accelerating and focusing wake phase, leading to the formation of high-quality witness bunches. This injection principle is explained by example of three-dimensional particle-in-cell simulations using the code OSIRIS. The produced bunches feature multi-kA peak currents, ~1 μm transverse normalized emittances, uncorrelated energy spreads of <1% on a GeV-energy scale, and femtosecond bunch lengths. The hereby generated witness bunches fulfill all the requirements to drive the same injection principle in a largely increased plasma density. This brings up a new concept of staging that has the potential of producing electron beams with unprecedented energy and quality in PWFA.

References

[1] A. Martinez de la Ossa et al., Phys. Rev. Lett. 111, 245003 (2013).

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