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Micro-bunching of an electron beam by Hermite-Gaussian laser pulses

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Abstract

A novel approach for generating a train of electron microbunches was proposed and demonstrated numerically. Electron bunches with femtosecond-to-picosecond durations [1] have broad applications in free-electron lasers, wakefield acceleration, and coherent emission in the THz-frequency range. Many schemes for the generation of electron microbunches have been recently proposed and implemented, such as, an emittance exchanger combined with transverse beam masking [2] and the EEHG (Echo-Enable Harmonic Generation) Technique [3]. In this work, we find that a train of electron microbunches can be produced in the interaction of a long electron beam with a TEM(10)+TEM(01) combined Hermite-Gaussian laser pulse [4]. In this process, a part of electrons is focused transversely while another part of electrons is defocused, depending on the electromagnetic field at these positions. Finally, a train of electron microbunches with a periodicity of laser wavelength are formed and their density are much higher than those microbunches obtained by the EEHG techniques. In contrast to the EEHG techniques that based on the longitudinal density modulation, our scheme is based on the transverse focusing. Our analytical model is verified by PIC(Particle-In-Cell) simulations.

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