Investigation of energy spread in laser-wakefield acceleration of electron bunch in non-linear regime

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The success of laser-wakefield accelerators (LWFA) depends significantly on the ability to provide quasi-monoenergetic acceleration of short electron beams to high energies [1–3] while maintaining low emittance. One of the limitations of LFWA is related to the intrinsic field of the accelerated beam arising due to its motion in the plasma (beam-loading effect) [4]. This backward influence effect limits the charge that can be accelerated because the longitudinal component of this field has the opposite sign compared to the original accelerating field of the traveling wave, which mainly affects the acceleration rate of the beam tail. This leads to a decrease in the energy of particles in the tail of the beam in particular, to a decrease in the energy of the beam as a whole, and, consequently, to a larger spread in the energy of accelerated particles for large beam charges [5]. Therefore, consideration of this effect is a very important task, especially if the goal is to obtain accelerated beams with as small energy spread as possible. In this paper we will consider and analyze the propagation and acceleration of an electron beam in a plasma wakefield excited by a laser pulse, as well as the influence of the beam-loading effect on the accelerated electron beam parameters.

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