

Wakefield dynamics and electron acceleration in guiding structures

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The compression and acceleration of an external electron bunch into the laser wakefield is studied and compared to analytical predictions. It is shown, for a laser propagating in a plasma channel, that the nonlinear laser pulse dynamics together with the finite laser spot size influence the electron bunch compression and acceleration due to the reduction of the laser pulse group velocity. The transverse bunch dynamics and loading effect determine the final bunch charge and density and restrict the compressed sizes of the trapped and accelerated electron bunch. A comparison of different codes for modelling of multi-GeV accelerator stages are presented and discussed.

The problem of precise focusing and pointing stability of the laser pulse, necessary for the regular structure of the wakefield generated in a capillary is analyzed. The three-dimensional theoretical model is elaborated and used to describe the propagation of laser pulses in dielectric capillary waveguides under imperfect coupling and focusing conditions with broken cylindrical symmetry. It is demonstrated that matching cones can considerably increase the transmission of laser pulses through the capillary, but cannot mitigate the requirements on the precision of the laser pulse focusing into a capillary.

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