LASER WAKEFIELD ACCELERATION OF SUPERSHORT ELECTRON BUNCHES IN GUIDING STRUCTURES

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High gradient acceleration of electrons by plasma waves generated in plasma channels by short intense laser pulses is analyzed. The influence of the loading effect and initial emittance on the quality of accelerated electron bunches is studied. Analytical predictions confirmed by the fully self-consistent 3-D modeling of the proposed scheme of electron bunch injection and acceleration open an opportunity for the production of low emittance and energy spread electron bunches of GeV energies and submicron sizes. The moderately nonlinear regime of the wakefield generation discussed in the paper provides a fully controllable phase of the accelerated electron bunches determined by the laser pulse timing, which permits subsequent use of these bunches for further multistage acceleration to higher energies beyond GeV range in future colliders.

The results of last experiments on the of plasma waves excitation over a length of up to 8 centimeters are demonstrated an analyzed using laser guiding of intense laser pulses through hydrogen filled glass capillary tubes. The plasma waves are diagnosed by spectral analysis of the transmitted laser radiation. The dependence of the spectral redshift, as well as the spectra measured at moderate pressures, are in excellent agreement with simulation results. The longitudinal accelerating field inferred from the simulations is in the range $1 - 10$ GV/m.