WAKEFIELD ACCELERATION OF ELECTRONS TO HIGH ENERGIES

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Acceleration of electrons to high, up to TeV range, energies as well as creation of compact sources of relativistic electrons and hard X-rays require elaboration of advanced methods of the high gradient particle acceleration. Among these methods, the most actively developing approaches are based on the use of wake fields generated in plasma by intense beams of charged particles (electrons or ions) or by relativistic-intense femtosecond laser pulses. Different methodsof electron acceleration in plasma are discussed in view of current and future experiments.

The resonant excitation of the nonlinear wakefield by a single proton bunch is investigated with the parameters characteristic of the AWAKE experiment at CERN. It is shown that obtained structure of the wakefield at a distance more than twenty periods behind the driver proton bunch can be suitable for the side injection and further acceleration of the witness electron bunch in the wakefield [1].

The laser wakefield acceleration of short electron bunches to multi-GeV energies with small emittance and energy spread is modelled and analyzed. Trapping and acceleration of short electron bunches externally injected into the wakefields generated by intense femtosecond laser pulse in plasma channel are optimized. The influence of the laser nonlinear dynamics and loading effect (self-action of the bunch charge) to the final energy and energy spread of the accelerated electrons is investigated. The limitations to the charge of accelerated electron bunch determined by the width of the electron energy distribution in the bunch is found [2].

Precession dynamics of the relativistic electron spin in laser-plasma acceleration is studied and optimal parameters providing minimum depolarisation of the electron in the acceleration process are determined [3].During acceleration, relativistic electrons undergo betatron oscillations and emit synchrotron radiation, which affects beam characteristics. A model has been developed and tested for numerical evaluation of the spin precession and trajectory of electrons in a laser plasma accelerator taking into account a radiative reaction force in Landau-Lifshitz form. The influence of synchrotron radiation on the polarization dynamics of an electron beam is examined for one stage of laser wakefield acceleration.

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References

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