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Proton Driven Plasma Wakefield Acceleration (PDPWA)

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A new scheme of plasma wakefield accelerator was recently proposed (A. Caldwell et al., arXiv, acc-ph: 0807.4599). The idea is to use existing high-energy proton bunches to drive a plasma wakefield. The strong plasma field then accelerates a trailing electron bunch to high energies. 2D and 3D Particle-in-Cell simulations show that a proton bunch with particle energy of 1 TeV, a bunch length of 100 μm, and 1011 protons can accelerate an electron bunch to beyond 500 GeV in a single plasma channel. A key element in realizing PDPWA is the production of a very short proton bunch. This is currently under study and recent results will be presented. A proof-of-principle experiment based on PDPWA is then proposed for consideration as a future CERN project. A proton bunch extracted from the PS or SPS would first be compressed through conventional magnetic compression and then enter into the plasma channel to exciting the plasma wakefield. In a first stage, the properties of the plasma wave could be studied without an electron bunch. Upon success of this stage, an electron bunch could be injected in the plasma and acceleration gradients demonstrated. Properties of the electron bunch would be studied in detail. A general facility for plasma wakefield studies could be envisaged.

Summary

Plasma wakefield driven by the high energy, high intensity and short proton bunch may accelerate the electron bunch to the energy frontiers. Simulation results show that a single stage of plasma channel can bring the electrons to beyond 500 GeV. By using the conventional magnetic compressor, we can achieve the short proton bunch which can drive high electric field to accelerate the witness electron bunch.

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