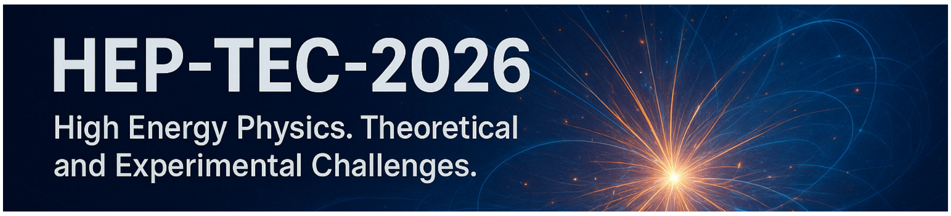

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DEPENDENCE OF SELF-INJECTED BUNCH PARAMETERS ON LASER AMPLITUDE IN LWFA WITHIN CONICAL PLASMA CHANNELS

Thursday, January 15, 2026 3:20 PM (20 minutes)

Laser wakefield acceleration (LWFA) is considered as modern and effective method [1, 2] of achieving TV/m acceleration field amplitudes [3] for electron bunches acceleration. An increasing in acceleration efficiency has been achieved when plasma channels used, especially demonstrated by the generation of GeV-scale electron beams within centimeter-length capillaries [4]. While various acceleration-system optimizations, such as hollow plasma-dielectric waveguides, have been considered to improve beam transport and focusing [5], different channel geometries (conical channels) also were considered.
The self-injected bunches parameters control remains difficult task. The way to increase the longitudinal momentum is to dynamically decrease the wake bubble size as the bubble moves through the plasma. This leads the self-injected bunch to be located in the end part of the wake bubble in the region of the maximum acceleration field. This work demonstrates how this effect can be achieved using a conical plasma channel. The main result is the obtaining the dependences of the bunch parameters from the laser amplitude.
It was demonstrated by numerical simulation WarpX code [6] that there is an optimal value of laser amplitude value for self-injected bunch acceleration: if the amplitude higher than optimal, the bunch is absorbed by the end wall of the wake bubble; if the amplitude lower than optimal, the bunch leaves the region of maximum acceleration and enters the zero-accelerating field. The optimal amplitude normalized found value is a0=3.0. At his value the maximum bunch charge and a longitudinal momentum of 57.4 mec with the longitudinal accelerating field in the bunch region of about 580 GV/m were obtained. Normalized laser amplitudes in the range from a0=2.0 to a0=4.4 were considered.

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