

Numerical Investigation of Bunch-Driven PWFA in Quasi-Nonlinear Regime

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In the framework of Plasma Based Wakefield Acceleration (PBFA), a new acceleration scheme has been proposed to combine high efficient blow-out regimes, where the driving electron bunch forms a totally rarefied plasma channel, with the conditions assuring resonant excitation of a plasma waves at the linear frequency. This optimal configuration can be achieved by using a train of properly interlaced electron bunches carrying small charges but still having high number density and hence pulse strength $n_b/n_0 > 1$, as necessary to form a "bubble" structure. Here we present a numerical investigation of this quasi-nonlinear configuration using the fully 3D ALADYN PIC code, as a preparatory work to design optimal conditions for the COMB experimental set-up at the SPARC-LAB laboratories. In particular we consider a bunch train containing three driving bunches with charges $Q_b = [10-50]$ pC and energy $E_b = 50-100$ MeV, followed by a smaller charge witness bunch. For plasma density $n_0 = 10^{16} \text{ cm}^{-3}$, numerical accuracy is usually assured by a proper resolution of the relevant skin depth $d_e \approx 47 \mu\text{m}$ scale. Here the computation is more demanding, since quasi-nonlinear regimes require a bunch transverse size and beam channel radius $r_b \ll d_e$

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