Nanoparticle-Assisted Injection for Laser Wakefield Accelerator in Self-Waveguided Regime

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Laser wakefield acceleration (LWFA) targeting electron energies above 10 GeV requires precise guiding of the driving laser pulse to extend its propagation distance, hence, the acceleration length. While plasma guiding structures have been successfully demonstrated, achieving stable electron injection in these systems remains challenging, particularly in the low-density plasmas ($n_e \approx 10^{16}$-10^{17} cm^{-3}) necessary for efficient guiding.

We investigate nanoparticle-assisted injection as a promising solution, where an ionized nanoparticle is used to trigger electron injection into the plasma wave. This approach enables controlled electron injection even at reduced plasma densities. We present experimental results from the ELBA platform at ELI Beamlines demonstrating nanoparticle-assisted injection in Bessel beam-generated plasma channels, achieving stable electron beam generation.