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Design guidelines and longitudinal dynamics for plasma-based, extreme compression

Tuesday 3 June 2025 16:00 (2 hours)

High-brightness, ultra-high peak current electron beams are of significant interest to applications including high-energy colliders, strong field quantum electrodynamics, and laboratory astrophysics. Despite such interest, compressing tightly-focused electron beams to attosecond pulse durations and mega-amp peak currents while preserving beam quality remains a challenge. In this work, we examine the feasibility and challenges involved in generating such extreme beams using plasma-based compression. Using simulations, we demonstrate that the large electric field gradients in plasma wakefields enable orders of magnitude higher compression than conventional radiofrequency compressors. Scalings of various beam properties with respect to accelerator and plasma parameters are explored with limitations on achievable final beam brightness evaluated. Optimal beam and plasma conditions are investigated for different applications, with the goal of experimentally demonstrating this technique at the FACET-II facility at SLAC National Accelerator Laboratory. Insights gained from this study will help design the next-generation of high-brightness beams for new frontiers in scientific research.

Footnotes

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