7th European Advanced Accelerator Conference

EAAC2025

Contribution ID: **531** Type: **Oral contribution**

Nonlinear interaction-point dynamics for plasma-accelerated beams

Monday 22 September 2025 16:20 (20 minutes)

As the next generation of particle colliders stand to require an ever-increasing real-estate footprint, interest is growing in the potential to shrink the accelerator stage by taking advantage of the high accelerating gradients present in plasma-based accelerators.

The unique advantages of plasma accelerators come with unique challenges.
Radio-frequency accelerators offer symmetric acceleration of both electrons and positrons, while plasmas do not. Electrons can be accelerated in plasma to high energy with low emittance, wheras positrons experience emittance growth.
Additionally, conventional accelerators can accelerate flat beams to give low-disruption at the interaction-point (IP), while the tendency towards circular symmetry in plasmas struggle with this.

In this work, we use numerical simulation to explore the impact of colliding round beams, to what extent focussing optics can be used to shape the beams to reduce disruption at the IP, and the collision of asymmetric beams, where the positrons have a larger emittance than the electrons. We find that competitive luminosities can be obtained with high-disruption beams, and explore methods to optimise for beams with high emittance.

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Session Classification: PS4: Theory and simulations

Track Classification: PS4: Theory and simulations