ID contributo: **227** Tipo: **Poster (student)**

Instability and Efficiency in Beam-Driven Plasma Wakefield Accelerators

martedì 19 settembre 2023 19:00 (1O 30m)

Beam-driven plasma-wakefield acceleration has the potential to produce accelerating fields up to three orders of magnitude stronger than those in traditional accelerators using RF cavities. However, in recent years, an efficiency-instability relation has been proposed, which limits the energy transfer from the wake to the trailing bunch that can be achieved without causing detrimental transverse instabilities. We discuss the efficiency-instability relation for a misaligned trailing bunch and methods that can be used to mitigate this effect, such as ion motion and operating in the quasilinear regime. Using start-to-end simulations, we simulate intra-beam transverse instabilities seeded by a misaligned trailing bunch in a plasma acceleration stage. These studies will be the basis of the upcoming E302 experiment at the FACET-II facility.

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Classifica Sessioni: Poster session

Classificazione della track: WG1: Plasma-based accelerators and ancillary components