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Transverse tolerances in the plasma-wakefield acceleration blow-out regime

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We report on recent progress in transverse instabilities and transverse tolerances for plasma-wakefield accelerators in the blow-out regime. In this regime, the transverse fields provide both strong focusing and strong deflection via transverse wakefields. The deflection effect of the wakefields on the main beam leads to limitations on the acceleration efficiency, if not mitigated. Based on comprehensive particle-in-cell simulations we summarize recent findings of the instability–efficiency relation for the blow-out regime. Ion motion and energy spread may mitigate the instability; with linac start-to-end simulations, using the recently developed ABEL framework, we demonstrate that the instability and emittance growth may be sufficiently mitigated for the colliding beams in the HALHF concept. Independent of wakefield effects, the strong focusing fields lead to very tight tolerances for the drive-beam jitter. We quantify these tolerances, using examples from HALHF start-to-end simulations. We show that the tolerances are greatly loosened by applying external magnetic fields to guide the drive-beam propagation in the plasma.

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