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Wakefield mitigation in the High-Energy EuPRAXIA@SPARC_LAB LAB X-Band Linac

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EuPRAXIA@SPARC_LAB aims to be the first European research infrastructure to demonstrate the application of a plasma accelerator. The project is currently in the technical design report preparation phase. This facility combines a high-brightness electron beam in the GeV range, produced by an X-band linac, with a powerful 0.5 PW-class laser system, by utilizing a sophisticated “particle-driven configuration” to achieve highly efficient particle acceleration. This method involves an RF injector system consisting of an S-band photoinjector and an X-band linac. In the typical operating scenario, the system is designed to handle a witness beam with a charge of 30 pC and a driver beam with a charge of 200 pC. These beams are longitudinally compressed within the photoinjector and boosted in energy in the X-band linac. This work reports on beam dynamics studies devoted to investigating and comparing several methods to mitigate wakefields contributions in the X-band linac due to residual machine misalignments regarding beam quality preservation. Dedicated simulations will be performed implementing Dispersion-Free Steering (DFS) and Wakefield-Free Steering (WFS) correction algorithms with the RF track code, aimed at minimizing trajectory deviations and mitigating transverse emittance dilution, thus ensuring the beam quality required for efficient plasma injection.

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