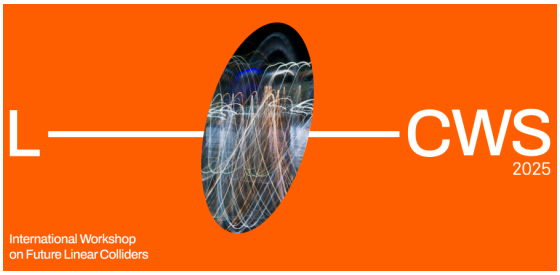

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RF Design and Optimization of Linacs for the CLIC Main Beam Injector Complex

Wednesday 22 October 2025 10:00 (20 minutes)

The design of the CLIC main beam injector complex linacs necessitates high-gradient, traveling-wave accelerating structures engineered to withstand substantial beam-loading effects due to the elevated beam current and demanding acceleration requirements of CLIC operations. In this work, we present a comprehensive design and optimization study of 2 GHz traveling-wave structures tailored to these stringent requirements. The electron and positron linacs accelerate the beams up to 2.8 GeV with a nominal bunch charge of 1 nC, followed by the booster linac, increasing the energy to 9 GeV with a nominal bunch charge of 0.83 nC. Each bunch train consists of 352 bunches, requiring careful management of beam dynamics and wakefield effects to ensure stable operation. Through detailed analytical modeling and extensive parameter sweeps, we optimized the accelerating structures'iris geometry to enhance shunt impedance, regulate surface electric fields, and suppress long-range wakefields via detuning strategies, thereby minimizing undesired beam-cavity interactions. Given the high beam current, we analysed beam-loading effects and implemented compensation techniques to minimise bunch-to-bunch energy spread, supporting reliable, high-efficiency acceleration essential for CLIC operations. This study advances the development of high-performance accelerating structures operating with high beam current, crucial for achieving CLIC goals.

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