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Design of a fast reactive tuner for 1.3 GHz TESLA cavities at MESA

Thursday 25 September 2025 14:30 (3 hours)

This work presents a state-of-the-art design of a Ferroelectric Fast-Reactive Tuner (FE-FRT), capable of modulating high reactive power in TESLA type cavities on a microsecond time scale. The Mainz Energy-Recovering Superconducting Accelerator employs superconducting radio frequency cavities operating at 1.3 GHz, achieving quality factors on the order of 10^10. However, detuning of +/-25 Hz induced by microphonics have led to the use of strong coupling for the fundamental power coupler, requiring high-power amplifiers, orders of magnitude above the intrinsic dissipation. Current solutions to mitigate microphonics rely on piezoelectric tuners, which are not fast enough for the spectral range of the microphonics. A novel alternative is the FE-FRT, a technology made possible by the development of low-loss ferroelectric materials, which offer sub-microsecond response times. Analytical results are provided along with their validation through finite-element simulations. The FE-FRT is expected to handle substantial reactive power while offering a tuning range of 50 Hz in these types of cavities, resulting in a reduction in peak forward RF power by about an order of magnitude.

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Footnotes

Funding Agency

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