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Beam Loading in the Superconducting Cavities at the European Spallation Source Linac

Tuesday, October 21, 2025 6:00 PM (30 minutes)

During the commissioning of the ESS LINAC in early summer 2025, we recorded beam-loading transients from a 5 µs, 5 mA beam in 47 superconducting cavities: 26 Spoke and 21 Elliptical Medium Beta. We compare the beam-induced cavity voltage and current phasors with a standard beam-loaded cavity model that includes coupling, loaded Q, and detuning, thereby validating model parameters across the installed sections. Leveraging this agreement, we invert the measured response to compute the beam's synchronous phase on a cavity-by-cavity basis without external timing references. The inferred phase is then used to set the optimal accelerating phase and to quantify residual phase errors and detuning during routine operation. We report sensitivity to measurement noise, pulse-to-pulse reproducibility, and the robustness of the method over the commissioning dataset, and we outline a practical procedure to commission and periodically retune SRF sections at ESS using beam-loading observables alone.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

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