MATTER AND TECHNOLOGIES

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Correction of monotonic instability in SRF cavities using a fast tuner feedback controller

Due to the advancements of superconducting radio frequency cavity fabrication, there is a proposal to add a continuous wave mode of operation to the European X-Ray Free Electron Laser. Because of technical constraints, this upgrade requires an increase of the cavity loaded quality factor to values in the range of 3-6 ·10 7 in the injector section. Due to the change in cavity coupling, Lorentz force detuning produces a resonance frequency shift that is more than ten times the cavity half bandwidth for gradients of 16 MV/m−1 . As a consequence of this frequency shift a ponderomotive instability, called monotonic instability, is generated and it may result in the sudden drop of the accelerating gradient for cavities near the resonance. These drops are triggered by detuning drifts or errors in manual cavity tuning. Therefore, it is necessary to develop a method to prevent the occurrence of these field jumps to allow the accelerator to operate reliably. This poster illustrates the design of a feedback controller that keeps the cavity gradient from dropping using the fast piezoelectric tuner. A small signal state space model of a superconducting cavity that describes the interaction of the cavity accelerating field with the mechanical modes was used to derive the controller. Tests performed on an accelerating cryomodule equipped with eight TESLA cavities at an average gradient of 13 MV/m−1 and QL = 3·10^7 show the ability of the synthesized controller to correct the monotonic instability related issues.

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