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Reshaping SRF Cavity Resonance Management with Smart Techniques

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Motion control is assuming an increasingly pivotal role within modern large accelerator facilities, such as 4th generation storage ring-based light sources, SRF accelerators, and high-performance photon beamlines. For very high-Q SRF linacs, such as LCLS-II, the precise management of cavity resonance becomes indispensable for maintaining stable operations. Failing to do so would entail a significant upsurge in RF power requirements, consequently increasing operational and capital costs due to the necessity for additional RF power sources. We have developed an intelligent cavity resonance controller founded on a data-driven model, featuring an exceptionally lightweight surrogate mode engineered to address the intricate dynamics of forced cavities in the presence of microphonics and coupled with nonlinear Lorentz forces. The effectiveness of this mode has been rigorously validated through real SRF cavities at SLAC. We are currently in the process of implementing the controller on hardware, specifically the exiting LLRF system of LCLSII. Building on the success of this work, the model can be expanded to encompass general motion controls where exceptionally low-tolerance vibration is required. In this presentation, we will introduce the model and provide an overview of the latest test results.

Primary Keyword

AI-based controls

Secondary Keyword

ML-based optimization

Tertiary Keyword

active learning

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