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SRF Cavity Resonance Control by Machine Learning

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For advanced high-Q SRF linacs like LCLS-II, achieving precise control of cavity resonance is crucial to ensuring stable operations. Inadequate control can lead to a substantial increase in RF power demands, thereby escalating both operational and capital expenses due to the need for additional RF power sources. To tackle this challenge, we have developed an innovative cavity resonance controller that leverages a data-driven approach, incorporating a highly efficient surrogate model designed to manage the complex dynamics of cavities under the influence of microphonics and nonlinear Lorentz forces. This model's efficacy has been thoroughly validated with real SRF cavities at SLAC. We are currently integrating this controller into the hardware, specifically the existing LLRF system of LCLS-II. This foundational work paves the way for expanding the model to broader motion control applications where extremely low-tolerance vibration control is essential. In this presentation, we will showcase the model and share the latest test results.

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