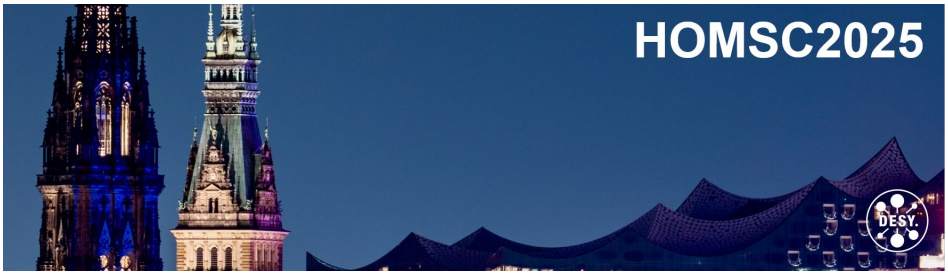

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Numerical Analysis of High-Order Modes in SRF Resonators for Particle Accelerators

Monday 6 October 2025 15:30 (30 minutes)

Over the past decades, superconducting technology has rapidly evolved towards high accelerating gradients and low surface resistance, making it possible to operate particle accelerators with high average beam currents and large duty factors. However, RF losses due to coherent excitation of the HOM become the limiting factor for these regimes. Unlike the cavity operating mode, which is tuned separately, the HOM parameters can significantly vary from one cavity to another due to finite mechanical tolerances during the manufacturing process. Thus, it is of utmost importance to know the HOM parameter spread in advance in order to predict unexpected cryogenic losses, overheating of beam line components and maintain stable beam dynamics. In this paper, we present a method for generating cavity geometry with an arbitrary spread of mechanical imperfections and numerically evaluating HOM statistics. Knowing the spread of HOM parameters, we calculated the probability of resonant HOM losses in SRF accelerating cavities used in CW beam current machines such as the PIP-II and LCLS-II linacs, as well as for the SRF crab-cavity for the ILC project. Finally, we present experimental results of HOM spectra measurements in hundreds of 1.3 GHz cavities installed in LCLS-II cryomodules. Studying the effects of HOM excitation results in specifications of the SRF cavity and cryomodule and can significantly impact the efficiency and reliability of the machine operation.

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