Multiphysics Analysis of RF Cavities for Particle Accelerators: Perspective and Overview

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Abstract

Particle accelerator technology evolves gradually towards improving reliability and efficiency of the accelerator machines, which would reduce their cost for current applications and even make them more accessible to new industrial applications. RF cavities are utilized in particle accelerator machines to propel the particle beam by properly coupling the energy from RF sources to the particle beam. Several multi-physics analyses are needed during the course of designing the RF accelerating cavities, whether they are normal-conducting copper or super-conducting niobium cavities. For copper cavities, electromagnetic heating is always an issue and careful analysis is essential to design the cooling channels and make sure that frequency shift due to mechanical stresses is manageable. On the other hand, frequency detuning is always a concern in super-conducting cavities. The ultra-high quality factor of superconducting cavities, make their bandwidth very narrow such that few tens of Hz frequency shift might get the cavity completely detuned. Frequency detuning is caused by pressure fluctuations in the helium bath or by the radiation pressure of the electromagnetic fields inside the superconducting cavity itself. In that perspective, it is imperative to investigate all sources of detuning with a multiphysics analysis that spans the electromagnetic and solid mechanics physics.

Reference


in the SSR2 Cavities of Project X Front End,“ presented at IPAC 2012, New Orleans.