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HOM-Damping Studies in a Multi-Cell Elliptical Superconducting RF Cavity for the Multi-Turn Energy Recovery Linac PERLE

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Higher order modes (HOMs) damping is a crucial issue for the next generation of high-current accelerators. Beam-induced HOMs can store sufficient energy in the superconducting RF (SRF) cavities giving rise to beam instabilities and increasing the heat load at cryogenic temperature. To limit these effects, the use of HOM couplers on the cutoff tubes of SRF cavities becomes crucial to absorb beam-induced wakefields, consisting of all cavity eigenmodes. These couplers feature probe or loop antennas designed to couple ERL optics-related dipole cavity modes and to reject the fundamental mode sufficiently. The study presented here focuses on a 5-cell 801.6 MHz elliptical SRF cavity designed for PERLE (Powerful Energy Recovery Linac for Experiments), a multi-turn ERL currently under study and to be hosted at IJCLab in Orsay. Several coaxial coupler designs are firstly analyzed by means of equivalent circuit models. A subsequent coupler optimization is made on a 3D geometry of the coupler to enhance the damping of dipole HOMs of the 5-cell cavity. The broadband performance of HOM damping and power deposition is also confirmed by the time-domain wakefield and the frequency-domain simulations. In addition, the thermal behavior of the HOM couplers is investigated. A comparison between various HOM-damping schemes is carried out to guarantee an efficient HOM power extraction from the cavity.

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