Thesis abstract Carmelo Barbagallo

« Design and Optimization of Higher Order Mode Couplers for the Superconducting Cavities of the PERLE Energy Recovery Linac »

The Powerful Energy Recovery Linac for Experiments (PERLE) is an energy recovery linac (ERL) facility based on superconducting radio-frequency (SRF) technology to be hosted at the Laboratoire de Physique des 2 Infinis Irène Joliot-Curie (IJCLab) in France. With a target beam power of 10~MW, PERLE aims to demonstrate the high-current, continuous wave, multi-pass operation to validate options for future high-energy machines, such as the 50 GeV ERL proposed for the Large Hadron electron Collider (LHeC) and the Future Circular electron-hadron Collider (FCC-eh), and host dedicated particle physics and nuclear experiments. In high-current ERLs, the regenerative Beam Breakup (BBU), emerging from the beam and cavity Higher Order Modes (HOMs) interaction, is a major concern for their stable operation. Beam-induced HOMs can increase the cavity heat load at cryogenic temperature and cause beam instabilities. HOM couplers are installed in the cavity beam pipes to absorb HOM energy and mitigate these effects. This thesis presents the design and optimization of several coaxial HOM couplers for the 5-cell 801.58 MHz elliptical Nb cavities of the 500 MeV PERLE ERL configuration. The RF transmission of the HOM couplers was optimized to enhance the damping of the most dangerous HOMs. The optimized HOM couplers were integrated into endgroups to simulate their damping performance and thermal behavior. The optimized HOM couplers were 3D-printed in epoxy and copper-coated. Low-power RF measurements were conducted on the produced HOM couplers installed in copper PERLE-type cavities to validate their damping performance and propose several endgroups for the PERLE 5-cell cavity to mitigate HOMs below the BBU instability limits.