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HOM study for CEPC cavities: HOM damping and recent developments

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CEPC is engineered to function in four distinct operational modes (Higgs, W, Z-pole, and t-tbar), supporting a broad spectrum of beam parameters. The collider's beam energy ranges from 45.5 to 180 GeV, with a beam current varying from 5.6 mA to 1.4 A, and a synchrotron radiation (SR) power output ranging from 30 to 50 MW. The collider is a double-ring with shared cavities for Higgs operation and separate cavities for W and Z operations. The higher order modes (HOM) excited by the intense beam bunches must be damped to avoid additional cryogenic loss and multi-bunch instabilities. In this paper, the impedance, HOM damping and HOM power requirements for the CEPC collider ring are given. This HOM power limit and the fast-growing longitudinal coupled-bunch instabilities (CBI) driven by both the fundamental and higher order modes impedance of the RF cavities determine to a large extent the highest beam current and luminosity obtainable in the Z mode. The prototypes of HOM coupler have been fabricated and tested on the 650 MHz 2-cell cavity. The mechanical, RF, and cryogenic performance of the higher-order mode coupler has been verified. A full-size cryomodule with 6 cavities and 12 HOM couplers is currently under development. Finally, the deep suppression of HOMs with high-power extraction, and the associated technical challenges were discussed.

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Footnotes

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