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Fabrication of higher-order mode couplers for HL-LHC crab cavities at JLab

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The superconducting Radiofrequency Dipole (RFD) crab cavities for the Large Hadron Collider's High-Luminosity upgrade (HL-LHC) incorporate hook-style Horizontal Higher-Order Mode (HHOM) couplers to extract and damp HOMs, minimizing beam-cavity interactions. These couplers, fabricated from high-purity niobium, must maintain superconductivity under operational conditions at 2 K. As part of the U.S. contribution to the Accelerator Upgrade Project (AUP), Thomas Jefferson National Accelerator Facility (JLab) is responsible for the full fabrication and qualification of HHOM couplers for series-production cryomodules. The process includes vacuum brazing, electron-beam welding (EBW), precision metrology, and RF qualification. Couplers are first tested in a dedicated RF test box before integration with dressed RFD cavities, followed by qualification at 2 K in JLab's Vertical Test Area (VTA). Prototype HHOMs were fabricated and tested to validate design tolerances, assess performance on prototype cavities, and establish repeatable fabrication protocols. This paper presents key fabrication challenges, RF test results, and the current status of series production.

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Footnotes

Funding Agency

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