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Electromagnetic-thermal coupling study of the SHINE injector cavity

Monday 22 September 2025 14:30 (3 hours)

The SHINE project is a high-repetition-rate hard X-ray Free Electron Laser (XFEL) facility driven by a superconducting RF linear accelerator with an energy exceeding 8.0 GeV. The linear accelerator (LINAC) of SHINE consists of six hundred 1.3 GHz 9-cell cavities for acceleration, producing photons with energies ranging from 0.4 to 25 keV. This study focuses on the first single-cavity cryomodule of the LINAC which follows the electron gun. The injector cavity is a 1.3 GHz axisymmetric superconducting cavity with two fundamental power couplers. The accelerating gradient of the cavity reached 28 MV/m in the vertical test, but was limited below 8.1 MV/m in the horizontal test by thermal runaway. This did not meet the specification of 12 MV/m. Experiments revealed that the cause of thermal quench was insufficient cooling. Electromagnetic-thermal coupling simulation was performed to analyze this phenomenon and optimize the cooling conditions. The original cooling setup was enhanced and several new cooling configurations were proposed in the simulations. The optimization schemes showed a significant increase in the accelerating gradient. The injector cavity met the specification in horizontal test after applying the enhanced cooling scheme.

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Yes

Footnotes

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