

RF pulse conditioning to reduce field emission in FRIB SRF cryomodules

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Field emission (FE) is a major contributor to degradation in the high-field performance of Superconducting Radio Frequency (SRF) cavities. The driver linac for the Facility for Rare Isotope Beams (FRIB) has been operating for user experiments since May 2022, using 104 quarter-wave resonators and 220 half-wave resonators in 46 cryomodules. We have used pulsed RF conditioning to mitigate the FE X-rays and maintain the cavities' performance. During conditioning, we observe "electrical breakdown," a rapid ($<1\mu\text{s}$) collapse of the field. We have found that the FE X-rays may be greatly reduced after a single to several electrical breakdown events, which are accompanied by a local discharge in the vacuum and burning out of the emitter on the cavity surface. On the other hand, when a slow ($\sim\text{ms}$) thermal breakdown (known as quench) is seen, it limits the field and hampers further FE conditioning. We have also investigated the field enhancement factor and the effective area of FE emitter, inferred by Fowler-Nordheim fitting of FE X-ray dose rate vs accelerating gradient. In this paper, we will present RF pulse conditioning results and analysis thereof for about 50 cavities in FRIB cryomodules.

Footnotes

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