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Experimental demonstration of particle acceleration with normal conducting accelerating structure at cryogenic temperature

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Paper abstract:
In this paper, we present an experimental demonstration of the high-gradient operation of an X-band, 11.424 GHz, 20-cells linear accelerator (linac) operating at a liquid nitrogen temperature of 77 K. The tested linac was previously processed and tested at room temperature. Low-temperature operation increases the yield strength of the accelerator material and reduces surface resistance, hence a great reduction in cyclic fatigue could be achieved resulting in a large reduction in breakdown rates compared to room-temperature operation. Furthermore, temperature reduction increases the intrinsic quality factor of the accelerating cavities, and consequently, the shunt impedance leading to increased rf-to-beam efficiency and beam loading capabilities. We verified the enhanced accelerating parameters of the tested accelerator at cryogenic temperature using different measurements including electron beam acceleration up to a gradient of 150 MV/m, corresponding to a peak surface electric field of 375bMV/m. We also measured the breakdown rates in the tested structure showing a reduction of 2 orders of magnitude compared to their values at room temperature for the same accelerating gradient.

Footnotes

Funding Agency

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