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Towards lossless beam transmission in the first LHe-free Nb_3Sn SRF e-linac

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Superconducting radio-frequency (SRF) electron linear accelerators (e-linacs) provide significant advantages over conventional room-temperature accelerators, especially in their capacity to accelerate high-intensity continuous-wave (CW) beams. Recently, the first liquid helium-free (LHe-free) Nb_3Sn SRF cavity was successfully operated at the Institute of Modern Physics of the Chinese Academy of Sciences (IMP, CAS), achieving 5 MeV, 200 mA CW beam acceleration and demonstrating the feasibility of miniaturized SRF e-linacs. However, the lack of time structure in the injected beam and its velocity mismatch with the cavity's optimal beta value lead to approximately 50% beam loss within the SRF cavity, presenting a critical challenge for long-term operation. This paper presents an upgrade design of the existing e-linac, ensuring 100% transmission in the SRF cavity while maintaining a compact configuration. Detailed beam dynamics design and multi-particle simulation results are discussed.

Footnotes

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