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Production, Transport and Optical Optimization of Secondary μ^+ Beams in HFRS

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This study investigates the production, transport, and optical optimization of secondary μ^+ beams in HFRS using an integrated G4Beamline–MAD-X model incorporating the graphite target, two-stage separator, key focal planes, and the MF6 exit. Comparisons of forward π^+ production from ^{16}O and ^{18}O beams at different energies show that ^{18}O at 4.26 GeV/u provides the highest yield and the strongest high-momentum component, exceeding the corresponding ^{16}O yield by approximately 12.8% before angular selection and 15.8% after acceptance cuts. Compressing $\beta\gamma$ in the dominant loss regions increases the normalized μ^+ flux from 1.1×10^6 to 1.9×10^6 , while shifting the principal bottleneck from the PREQ789 and B910 regions to 60–70 m. Further optimization should therefore combine focal-plane matching, staged magnetic rigidity, realistic apertures, edge fields, and higher-order optics to improve flux, purity, beam size, and local-loss control simultaneously.

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