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Characterization of beam optics considering fringe fields of quadrupole magnets in a LIPAc 5 MeV beamline

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The 5 MeV beamline of Phase B+ which is an intermediate commissioning stage of the Linear IFMIF Prototype Accelerator (LIPAc) consists of an MEBT, an MEBT Extension Line (MEL) where the SRF will be installed, a HEBT, and a beam dump. It has 17 quadrupole magnets, and some quads have small aperture-to-length ratios and are also densely installed in the MEBT and HEBT sections. In the early stages of Phase B+, we optimized the beam optics with the conventional hard-edge model for all the quads. However, we observed unwanted particle losses and discrepancies in the rms beam sizes between measurements and simulations due to significant fringe fields and magnetic interference. After considering the field maps and the magnetic interference of the quads in the beam optics, we could obtain the matching beam and reduce the particle losses. In this paper, we characterize the beam optics by comparing the transfer matrices with and without the fringe fields and the interferences using a conventional hard-edge model and a more accurate hard-edge model equivalent to the field maps.

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