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Direct measurement of the longitudinal emittance for a proton beam at exit of a radio frequency quadrupole

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Clarifying the longitudinal phase space distribution at the exit of a radio frequency quadrupole (RFQ) is crucial for precise beam tuning to minimize beam loss in a high-power superconducting linac. In this contribution, we introduce a method for direct measurement of the longitudinal emittance of a proton beam at the RFQ exit, which delivers an output energy of 1.51 MeV. Initially, we developed a bunch shape monitor (BSM) inspired by Feschenko's design, achieving a resolution of 20 picoseconds. To conduct the direct measurement of longitudinal emittance, we integrate this BSM with a waist-to-waist beam transfer matrix, an energy-spread dipole, and a horizontal slit with a 0.2 mm width. The horizontal slit is positioned at the first waist at the dipole' s input, while the BSM wire is situated at the second waist, at the dipole's output. This arrangement, enhanced by the waist-to-waist transfer matrix, improves the energy spread resolution to 0.01%. Using the BSM wire, we measure the energy spread and horizontal profile. Through adjusting the buncher voltage and synchronous phase, we use dipole and BSM to measure different longitudinal emittances and ascertain the effects of bunching and debunching conditions on the longitudinal phase space. Consequently, this comprehensive direct measurement setup for longitudinal emittance serves to elucidate the impact of RFQ and buncher on the longitudinal phase space distribution within a medium-energy beam transport (MEBT) system.

Footnotes

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Primary author: ZHANG, Yong (Institute of Modern Physics, Chinese Academy of Sciences)

Co-authors: Mr DU, Ze; Ms LI, Li; Mr YIN, Jia; SU, Jianjun; JIA, Huan (Institute of Modern Physics, Chinese Academy of Sciences); QIN, Yuanshuai

Presenter: ZHANG, Yong (Institute of Modern Physics, Chinese Academy of Sciences)

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