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Beam halo losses reduction with simulation constrained Bayesian Optimization

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The Linear IFMIF Prototype Accelerator (LIPAc) aims to demonstrate CW acceleration of a 125 mA deuteron beam up to 9 MeV using an RFQ and SRF linac. Before SRF linac installation, the beam commissioning was conducted with a 5 MeV deuteron beam. Attempts to increase the duty cycle revealed a significant pressure rise detected by sensors, presumably caused by beam halo, which had previously limited operation to ~3%. To address this limitation, a Bayesian optimization was applied to the beam optics (four quads and steerers), aiming to minimize halo-induced losses by monitoring vacuum pressure while constraining core losses. The algorithm successfully decreased the sector vacuum pressure by about 67%. Simulations also confirmed that halo formation from space-charge forces was mitigated by relaxing beam focusing in specific regions consistent with theoretical predictions of beam physics. This enabled stable operation up to 8.7% duty cycle. These results demonstrate that machine learning can effectively support optics tuning even in high-current accelerators. This talk presents beam optics before and after the optimization process and the resulting improvements in halo minimization.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

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