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Advanced ML methods for beam tuning at FRIB

Thursday 14 August 2025 09:00 (30 minutes)

Experiments with rare isotope beams at FRIB are highly time-constrained, making rapid setup and delivery of high-quality ion beams critical to maximizing scientific output. The Bayesian framework is particularly well-suited for this challenge, offering sample-efficient optimization, principled incorporation of prior knowledge, and uncertainty-aware inference. In particular, Bayesian Optimization (BO) has proven to be an efficient and general approach for the non-sequential, static nature of beam-tuning tasks. To further accelerate convergence, Prior-Mean-Assisted Bayesian Optimization (pmBO) was developed, enabling rapid adaptation from prior belief to real-time machine conditions with minimal computational overhead. In parallel, a virtual diagnostic for the beam's transverse quadrupolar moment (BPM-Q) has been developed to provide non-invasive, fast measurements of beam envelope information. To optimize the reconstruction of Courant-Snyder parameters from BPM-Q data, Bayesian Active Learning (BAL), employing a differentiable beam envelope simulator as a surrogate model, has been implemented. Together, these developments illustrate the power of Bayesian methods in achieving faster, more accurate beam-tuning.

Please consider my poster for contributed oral presentation

Yes

Would you like to submit this poster in student poster session on Sunday (August 10th)

No

Footnotes

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I have read and accept the Privacy Policy Statement

Yes

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Session Classification: Beam Instrumentation, Controls, AI/ML, and Operational Aspects (Invited)

Track Classification: MC6 - Beam Instrumentation, Controls, AI/ML, and Operational Aspects