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Autonomous beam alignment through quadrupole triplets using Bayesian Algorithm Execution

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A common challenge in online accelerator operations is aligning beams through a series of quadrupole magnets, especially when in situ beam position monitors are not present. Accelerator operators generally use a trial-and-error approach to solve this problem by sequentially measuring the centroid deflection of the beam as a function of quadrupole strengths. This is a challenging process that necessitates dedicated effort by operational experts, requiring significant beam time and personnel resources to configure basic accelerator operations. In this work, we use Bayesian Algorithm Execution (BAX) with virtual objectives to autonomously control steering magnets at the Argonne Wakefield Accelerator to center the beam through a quadrupole triplet. This technique uses virtual objectives to reduce the number of measurements needed to converge to an optimal solution, resulting in a turn-key algorithm for finding the optimal steering configuration for a set of accelerator magnets from scratch.

Footnotes

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