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Machine Learning for Automated Gas Stopper Tuning and Stopped Beam Delivery at FRIB

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The Facility for Rare Isotope Beams (FRIB), operational since 2022, launches a new era of scientific discovery that builds upon its unprecedented primary beam power. Two complementary gas stoppers are in use to provide stopped and re-accelerated rare isotope beams to users, significantly extending FRIB's scientific program beyond fast beams. Swift and efficient gas stopper tuning is required to increase beam time for users, allowing for maximal scientific output. A computer program has been developed to aid and automate tuning the gas stoppers for optimal transmission of each beam. It employs Bayesian optimization methods to continually update knowledge of the system with new trial parameters. After briefly introducing the gas stopping system, I will explain the purpose of major parts of the codes, such as reducing the parameter space and defining the objective function. In the second half of my contribution, I will present another program that is successfully deployed to optimize beam delivery in FRIB's Stopped Beam area. It uses Bayesian optimization to correct beam misalignment in three repeated steps: varying quadrupole lens voltages, evaluating induced steering by observing beam shifts with position detectors, and applying corrections to electrostatic steerer elements. Lastly, the performance of the programs will be demonstrated.

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