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Fermilab Booster beam loss modelling and rebalancing using Bayesian methods

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To meet PIP-II upgrade requirements, Fermilab Booster losses need to be reduced by 50\% compared to present levels. So far, simulations are not good enough to predict loss patterns. Thus, an extensive Booster tune up will be necessary to achieve required performance. In this paper we present an effort to build a data-driven loss model using Bayesian techniques, and subsequently to rebalance losses for higher trip margins. We first created several sets of spatially and temporally isolated orbit and optics knobs, and trained Gaussian process models for each beam loss monitor as well as beam current. Novel techniques of uncertainty constraints and approximate GP fitting were introduced to handle safety and timing requirements. We then performed single and multi-objective tuning using scalarized objectives comprised of critical beam loss locations. We achieved significant rebalancing of losses, increasing margins by 25%, as well as an overall improvement in transmission efficiency of 0.4%. Automated data collection is being developed so that more accurate surrogate models can be trained over time.

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Yes

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

No

Footnotes

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Yes

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