

Rapid Tuning or Synchrotron Surrogate Model at the Recycler Ring

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The 8 GeV proton-storage Recycler Ring (RR) is essential for reaching megawatt beam intensity goals for the DUNE neutrino beam at Fermilab. Custom shims on each RR permanent magnet were designed to cancel manufacturing defects and bring magnetic fields to the design values. Remaining imperfections cause the observed tune variation vs energy to deviate from what is calculated using the design fields. Using the POUNDERS (“Practical Optimization Using No Derivatives for sums of Squares”) optimization method with Synergia in the loop, we demonstrate rapid convergence to a set of additive, higher-order multipole moments of these magnetic shims which reproduce that observed variation, and show that the convergence advantage grows with the parameter-space dimensionality.

Primary Keyword

ML-based optimization

Secondary Keyword

surrogate model tuning

Tertiary Keyword

digital twins

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