



Rapid Tuning of Synchrotron Surrogate Models at the Recycler Ring

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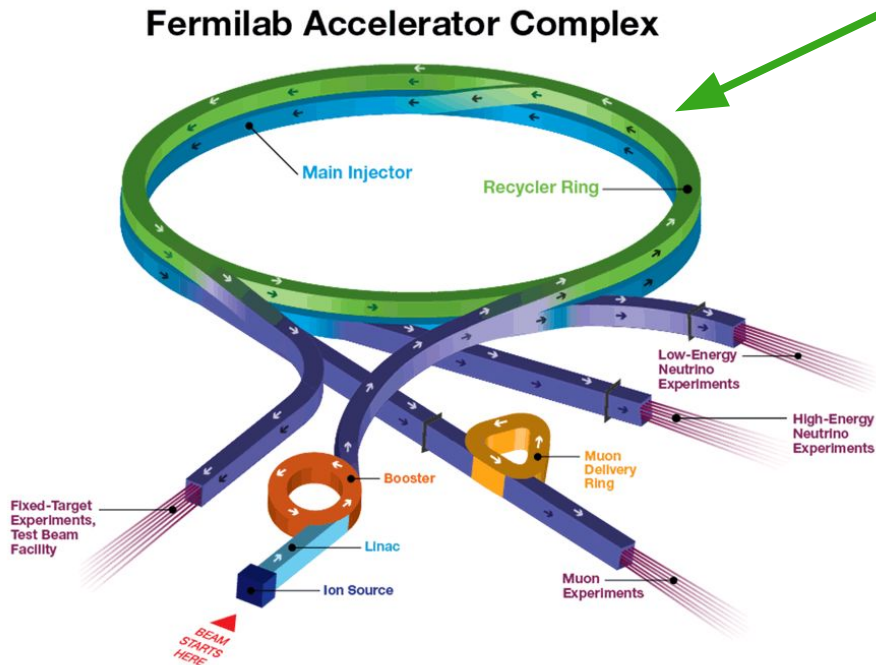
Accelerator Division

4th ICFA Beam Dynamics Mini-Workshop Machine Learning Applications for Particle Accelerators

2024.03.05-08

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.

The Fermilab Accelerator Complex

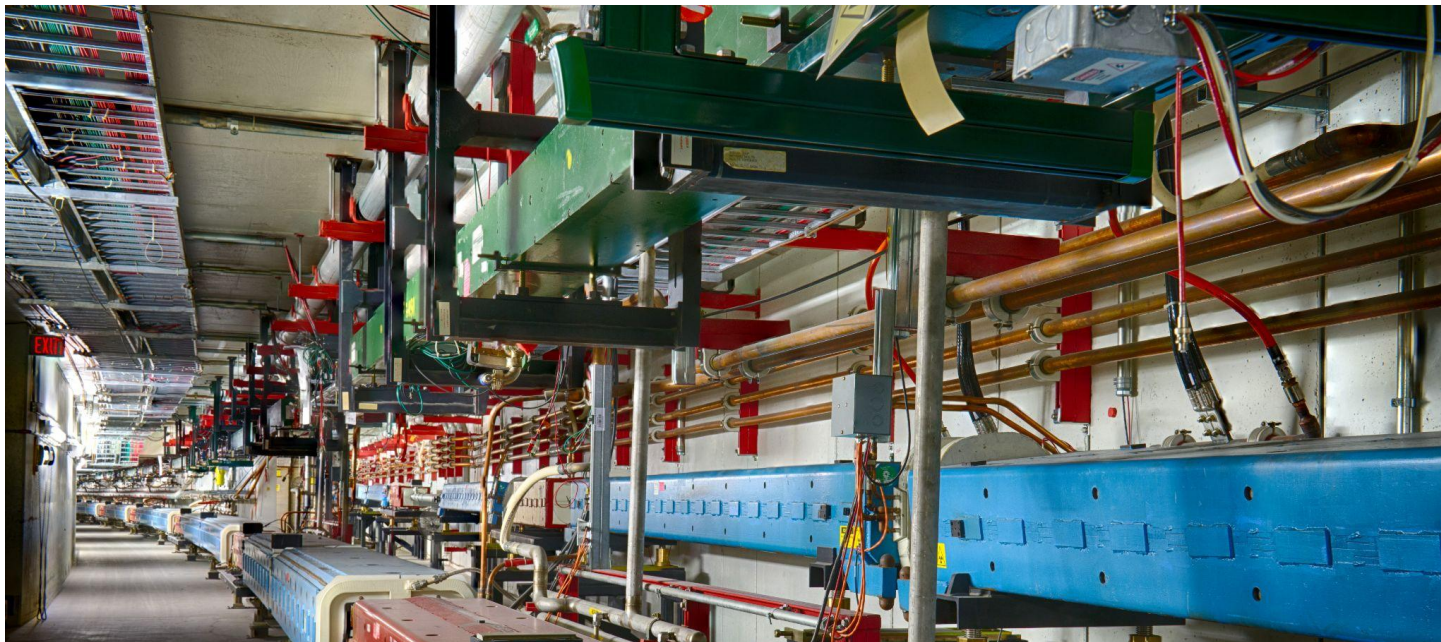


Recycler Ring is essential to Fermilab:
megawatt proton beams →
high-intensity neutrino beams

The Recycler Ring

Recycler Ring is a permanent-magnet storage ring

Matched to Main Injector 8 GeV proton KE



The Recycler Ring Multipole Shims

“Computer Generated End Shims for Recycler Ring Magnets” C.N. Brown, G.W. Foster, G. P. Jackson, J. T. Volk, Proceedings of the 1999 Particle Accelerator Conference, New York, 1999

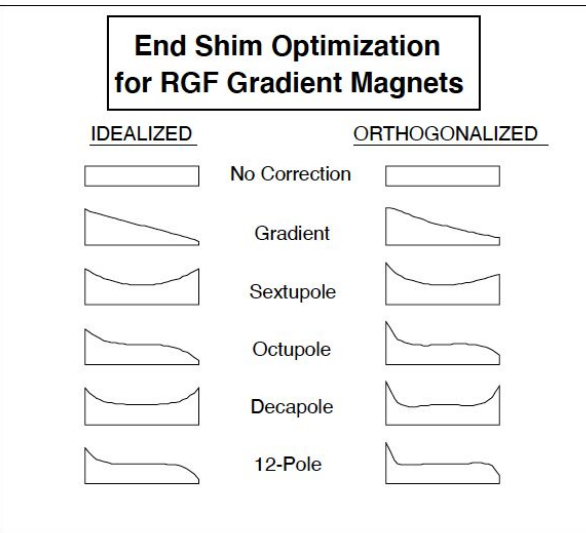
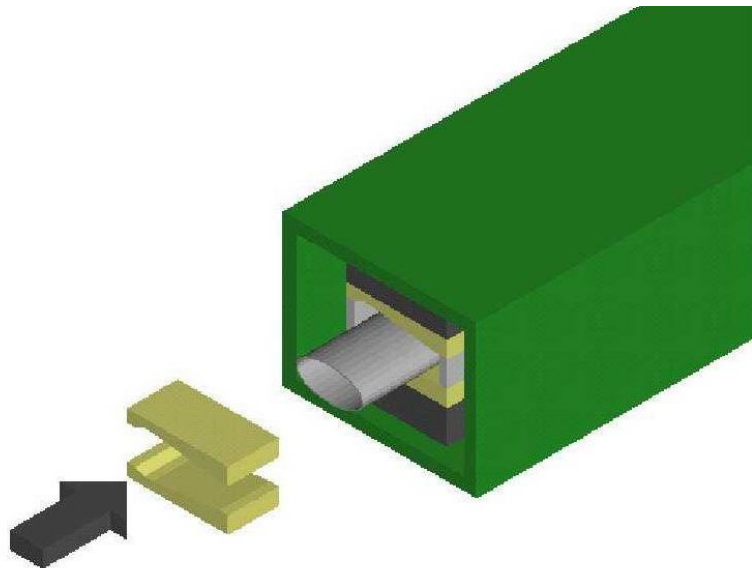
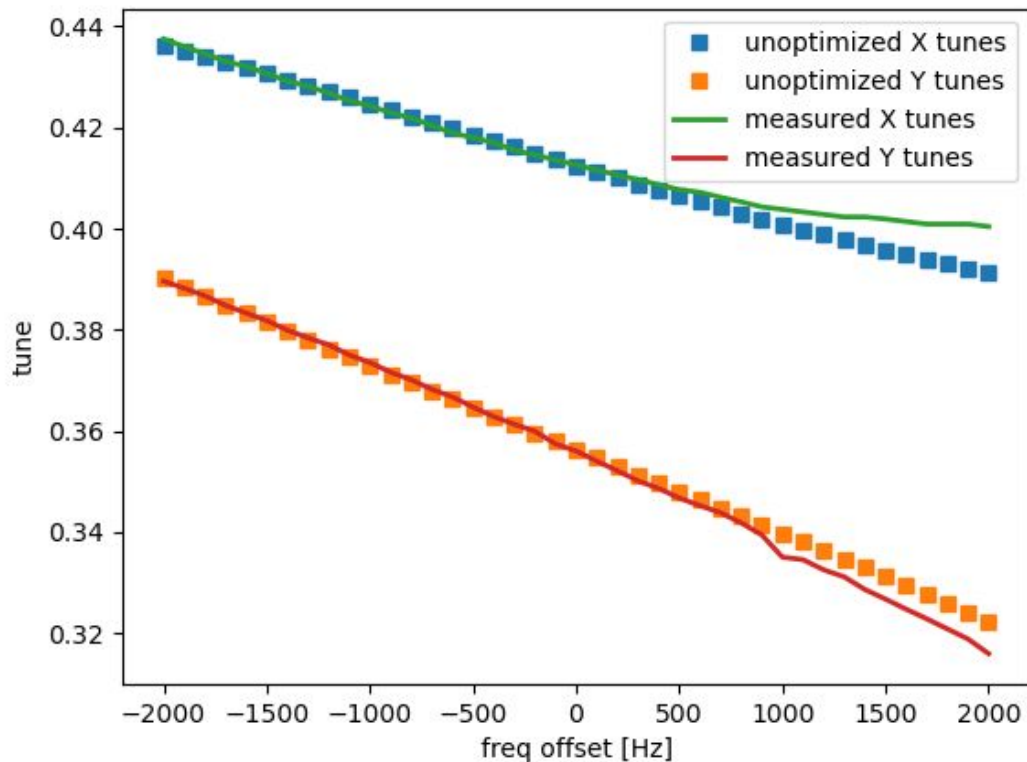


Fig. 2 – Elementary monomial Z-shim designs used as a starting point, and shim designs which were found to produce pure multipole shifts after re-orthogonalizing the multipole contributions from the elementary shims.



Magnetic shim plates were installed to correct for undesirable multiple moments observed in the Recycler.

The Recycler Ring Chromaticity

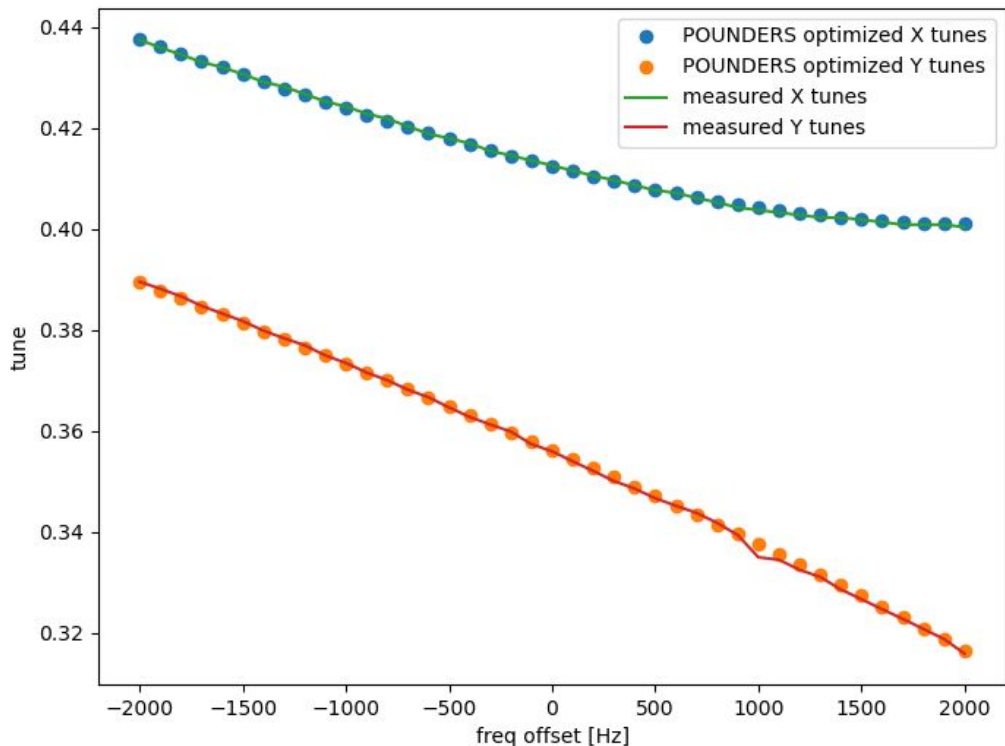


Challenge:

Tune simulated chromaticity to better match observed, using only additive corrections of multipole moments at shims.

Can small errors in shim plate shape account for the observed difference?

The Recycler Ring Chromaticity



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Yep!

Parameter Optimization with POUNDERS

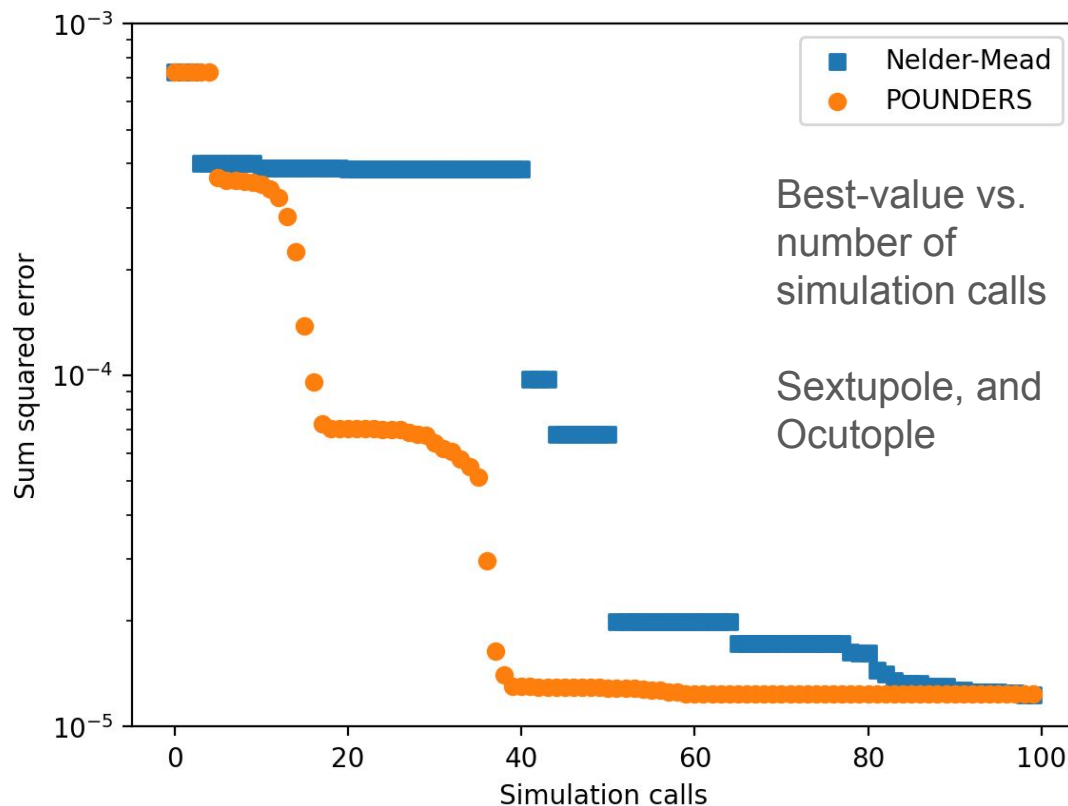
Comparison to Nelder-Mead downhill simplex method (NM). Both are set to minimize the sum of squared errors.

Different inputs:

N-M: sum sq. err's

POUNDERS: vector of sq. err's

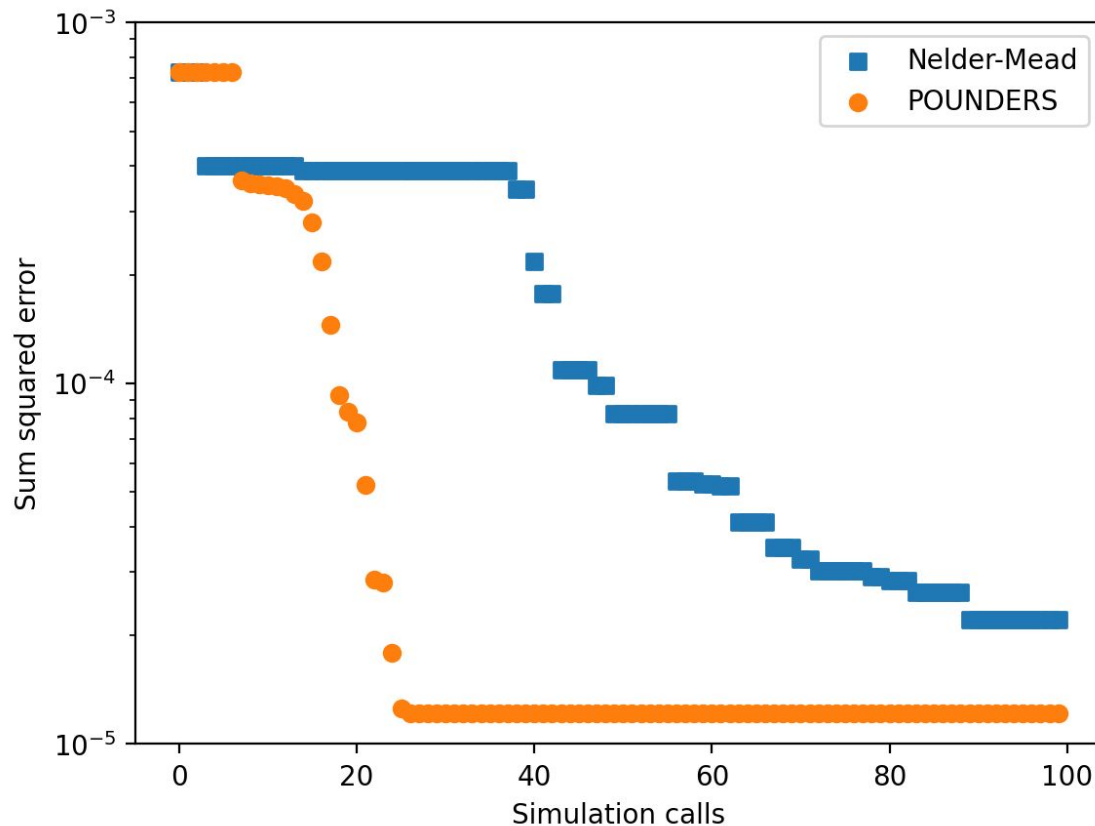
POUNDERS converges faster (~60 vs ~100 steps)



Final parameter values very close to NM result

| | H sext. | V sext. | H octu. | V octu. |
|----------|----------|----------|---------|---------|
| POUNDERS | -0.00107 | -0.00099 | 0.37075 | 0.40921 |
| NM | -0.00108 | -0.00097 | 0.34959 | 0.45167 |

A tool for self-updating accelerator models?



Best-value vs.
number of
simulation calls

Sextupole, and
Ocutople, and
Decapole