lm_100_comparison_plot_2023-08-03_16-24-48.png
View **PNG** in Slack

Optimization Tool for Beam Alignment: The power of Tao in SLAC's cu_sxr accelerator

Chavier McDaniel

SLAC NATIONAL ACCELERATOR LABORATORY

Project Goals

Develop an innovative orbit optimization tool, written in Tao which is a modern interactive tool for developing charged particle optics.

- Fine-Tuning Corrector Magnets in LTU and BSY sections of cu_sxr accelerator.
- Investigate various algorithms:
  - Levenberg-Marquardt
  - Differential Evolution
  - SVD
- Facilitate Accurate Beamline Alignment
- Enhance Performance: Optimized alignment improves accuracy and supports aperture scan of LCLS 2 commissioning.

Motivation

- Deliver a practical tool to operators that improves performance on Cu SXR line.
- Tao is a newer tool with enhanced features to facilitate optimization problems.
- Minimize corrector magnet strengths, allowing safe, flexible performance adjustments.
- Enhance tuning speed for rapid beam alignment.
- Balances enhanced performance with operational safety standards.

Objectives & Variables

$$\mathcal{M} \equiv \sum_i w_i \left[\delta D_i\right]^2 + \sum_j w_j \left[\delta V_j\right]^2$$

Objective function (M) is quadrature sum of weighted orbit measurements (Di) and corrector strengths (Vj)

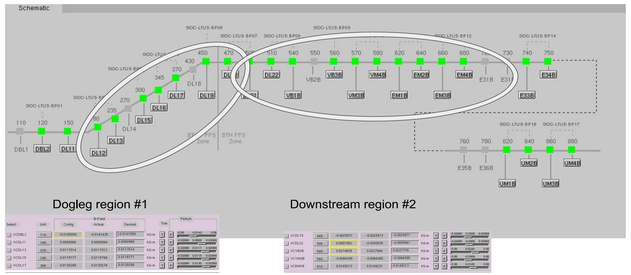


Fig. 1: The orbit through the LTU portion LCLS Cu SXR line is the objective of this optimization problem.

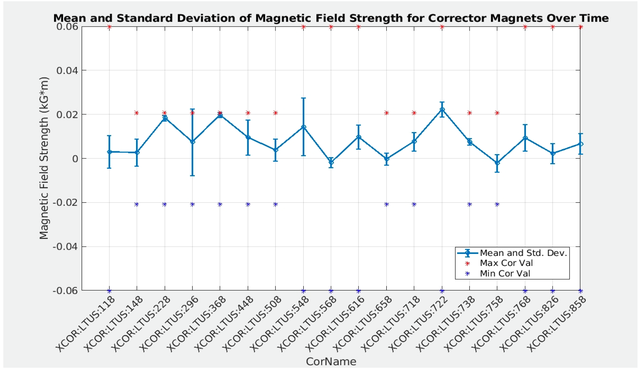
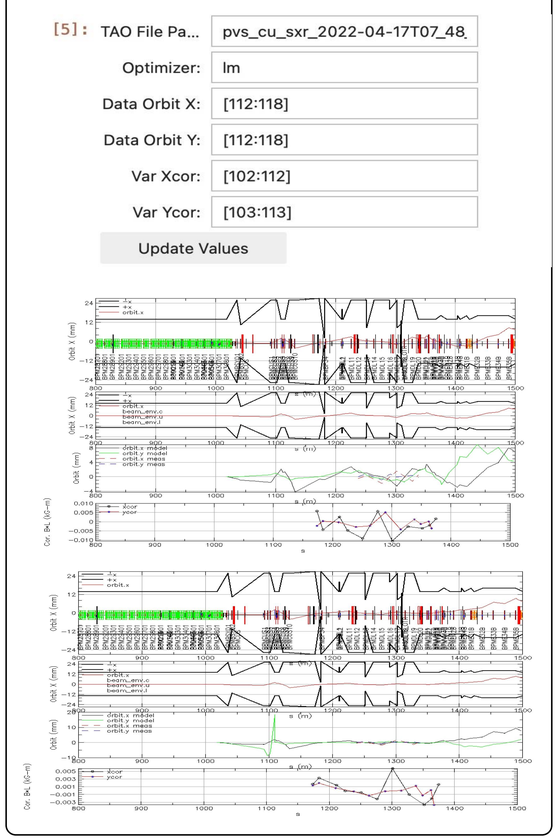


Fig. 2: Mean, Standard Deviation, Max, and Min values of corrector field strength. (top) x correctors and (bottom) y corrector. Corrector strengths are included in the objective function.

Method

- Data Acquisition: A script to extract accelerator data.
- Tao Integration: Utilize terminal to input data into Tao.
- Optimization Process: Run algorithm to find the optimum.
  - Optimizer Selection: Evaluate the most suitable algorithm using past data.
- Multiple Runs: Employ the selected algorithm on various data sets.
- Data Storage: Save optimized settings to EPICS.

Graphical User Interface



Results

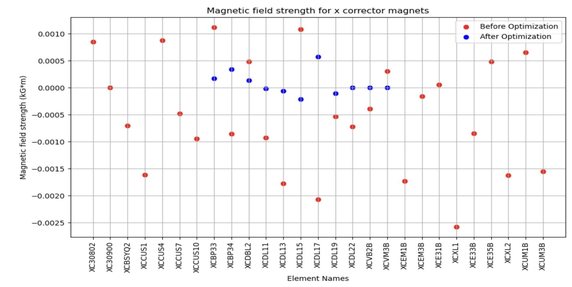


Fig. 5: Corrector strengths before and after optimization.

Fig. 6: Orbit before and after optimization.

Conclusions

- Substantial Progress cu_sxr accelerator yields significant advancement and ongoing exploration.
- Integration of Python and Tao guide data acquisition
- Comprehensive data range and corrector magnet spectrum utilization show potential for enhanced orbit flattening, driving optimism and further investigation.

Acknowledgments

I extend my sincere gratitude to Dorian Bohler and Michael Ehrlichman for their invaluable assistance and dedicated mentoring.