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MOREHOUSE  
COLLEGE

# Optimization tool for beam alignment: The power of Tao in SLAC's Cu SXR accelerator

## 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 LCLS 2 commissioning.

SLAC

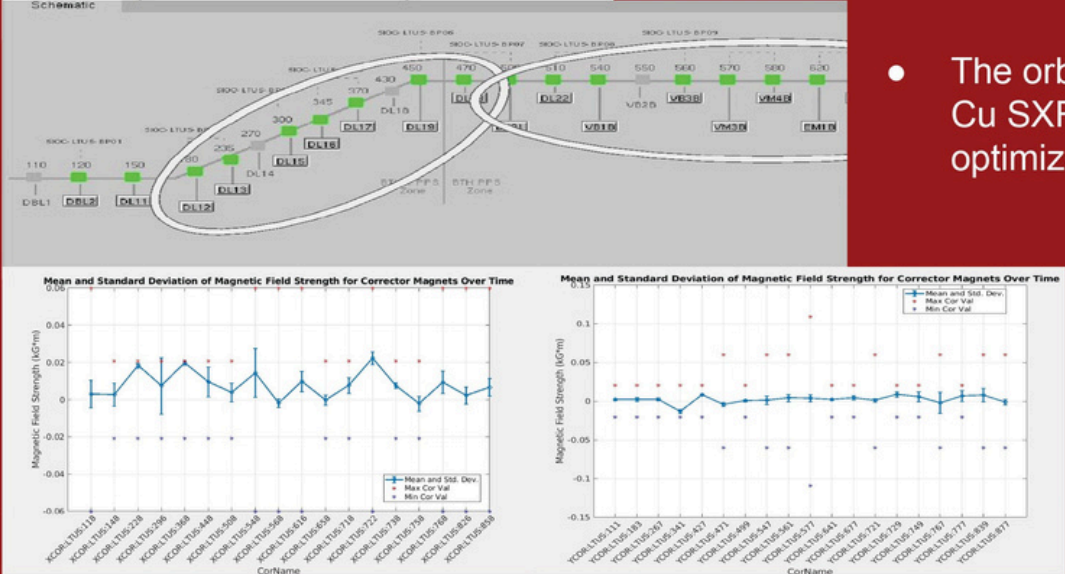
## Motivation

- 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.

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## Objectives & Variables

$$\mathcal{M} \equiv \sum w_i [\delta D_i]^2 + \sum w_j [\delta V_j]^2$$



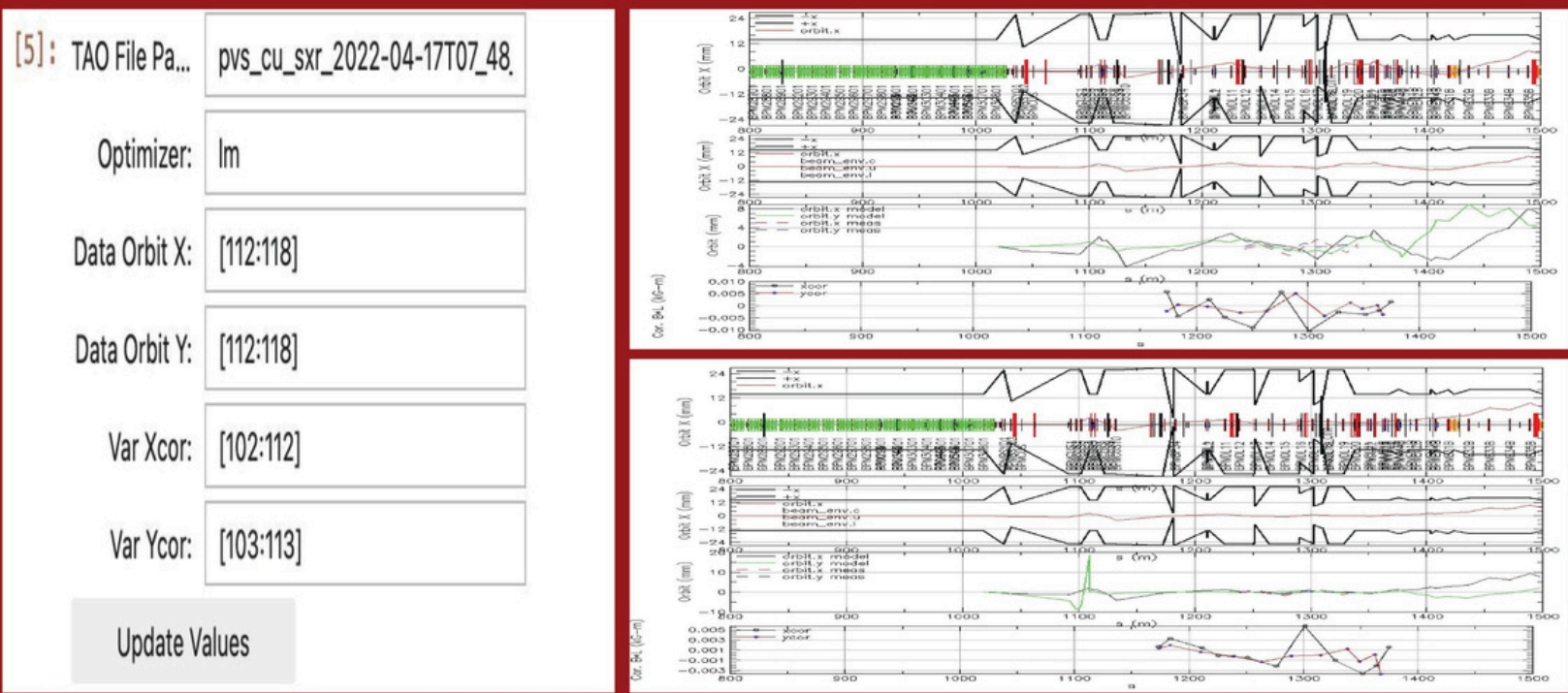
- Objective function (M) is quadrature sum of weighted orbit measurements (Di) and corrector strengths (Vj)
- The orbit through the LTU portion LCLS Cu SXR line is the objective of this optimization problem.
- Mean, Standard Deviation, Max, and Min values of corrector field strength. (top) x correctors and (bottom) y corrector. Corrector strengths are included in the objective function.

## Method

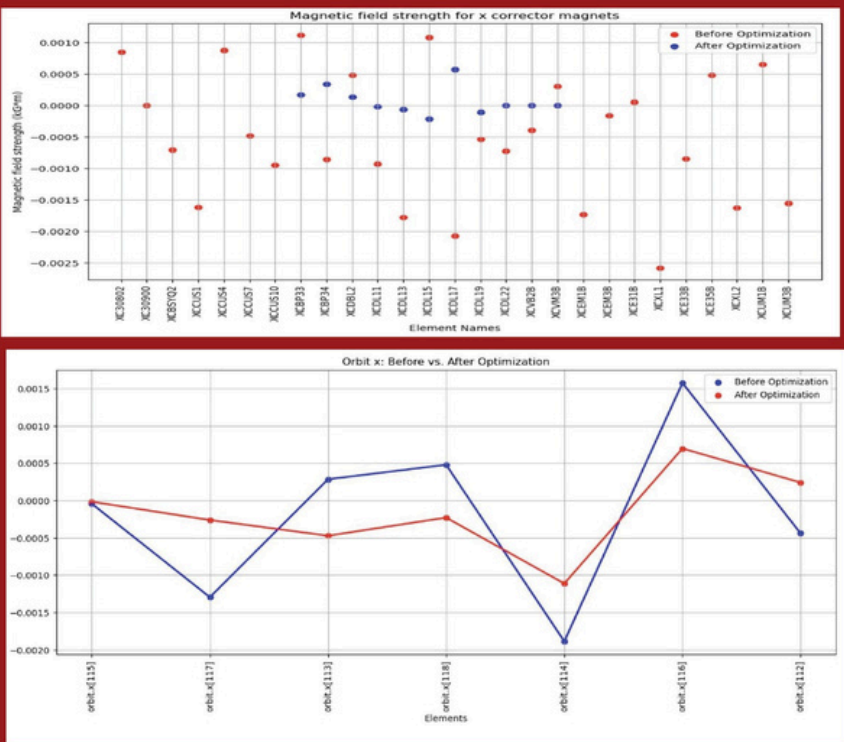
- Data Acquisition: A script to extract accelerator data.
- Tao Integration: Utilize terminal to input data into Tao.
- Optimization Process: Run algorithm to find the optimum.
  - Optimizer Selection: Evaluate the most suitable algorithm using past data.
- Multiple Runs: Employ the selected algorithm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

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## GUI: Graphical User Interface



## Results



- Corrector strengths before and after optimization.
- Orbit before and after optimization.

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Scholar Awards Celebration  
November 15, 2023



Igniting  
Innovation  
in Georgia