Contribution ID: **1475** Contribution code: **THPM006** Type: **Poster Presentation**

Machine learning assisted Bayesian calibration of accelerator digital twin from orbit response data

Thursday 5 June 2025 15:30 (2 hours)

Digital twins of particle accelerators are used to plan and control operations and design data collection campaigns. However, a digital twin relies on parameters that are hard to measure directly, e.g., magnet alignments, power supply transfer functions, magnet nonlinearities, and stray fields. These parameters can be constrained by beam position and profile measurements. We use Bayesian statistical inference to estimate the parameters, and their uncertainties, probabilistically by calibrating the Bmad digital twin to beam measurements. The inference is computationally accelerated using a machine learning emulator of the physical accelerator digital twin trained to a perturbed-parameter ensemble of Bmad simulations. The result is a joint posterior distribution over parameters (control currents, individual magnet transfer function coefficients, and beam monitor errors) which is propagated to uncertainties in predicted beam positions and profiles, which we validate against beam responses measured at the AGS booster at Brookhaven National Laboratory.

Footnotes

Paper preparation format

LaTeX

Region represented

America

Funding Agency

Work supported by Brookhaven Science Associates, LLC under Contract No. DE-SC0012704 and No. DE-SC0024287 with the U.S. Department of Energy.

Authors: HAMWI, Eiad (Cornell University (CLASSE)); LIN, Weijian (Brookhaven National Laboratory)

Co-authors: KELLY, Christopher (Brookhaven National Laboratory); HOFFSTAETTER, Georg (Cornell University (CLASSE)); BROWN, Kevin (Brookhaven National Laboratory); URBAN, Nathan (Brookhaven National Laboratory)

Presenter: HAMWI, Eiad (Cornell University (CLASSE))

Session Classification: Thursday Poster Session

Track Classification: MC6: Beam Instrumentation and Controls,Feedback and Operational Aspects: MC6.D13 Machine Learning