Contribution ID: **2325** Contribution code: **WEPL004** Type: **Poster Presentation**

Differentiable beam optics optimization and measurement

Wednesday, 10 May 2023 16:30 (2 hours)

Particle accelerators require extensive optics measurement and correction. Due to the complexity of analytic treatments, numerical optimizations are often employed. A disadvantage of this approach is the lack of gradients, limiting optimization methods to derivative-free ones such as simplex or genetic algorithms. We explore a reformulation of beam optics that preserves gradient information by making use of efficient automatic differentiation tools from machine learning frameworks. First, standard beam dynamics computations are converted to a graph of operations on tensors that calculates objectives. Backpropagation is then performed to find parameter gradients and higher order derivatives. Using gradient-aware optimizer algorithms, we showed improved performance in beamline optics matching over existing tools. We also demonstrated an important use of differentiable models in Bayesian inference, whereby probabilistic estimates of magnet parameters and linear optics functions can be obtained from experimental measurements. Our results on test problems showed robust performance and estimates in agreement with standard LOCO methods.

Funding Agency

The work is supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, under Contract No. DE-AC02-06CH11357.

Footnotes

I have read and accept the Privacy Policy Statement

Yes

Primary author: KUKLEV, Nikita (Argonne National Laboratory)

Presenters: KUKLEV, Nikita (Argonne National Laboratory); SAJAEV, Vadim (Argonne National Laboratory)

Session Classification: Wednesday Poster Session

Track Classification: MC5: Beam Dynamics and EM Fields: MC5.D01: Beam Optics Lattices, Correction Schemes, Transport