

Latent evolution model for time-inversion of spatiotemporal beam dynamics

Monday 26 August 2024 16:00 (2 hours)

Charged particle dynamics under the influence of electromagnetic fields is a challenging spatiotemporal problem. Current physics-based simulators for beam diagnostics are computationally expensive, limiting their utility for solving inverse problems in real time. The problem of estimating upstream six-dimensional phase space given downstream measurements of charged particles is an inverse problem of growing interest. In this work, we propose a latent evolution model to invert the forward spatiotemporal beam dynamics. In this two-step unsupervised deep learning framework, we first use a variational autoencoder (VAE) to transform 6D phase space projections of a charged particle beam into a lower-dimensional latent distribution. We then autoregressively learn the inverse temporal dynamics in the latent space using a long-short-term memory (LSTM) network. The coupled VAE-LSTM framework can predict 6D phase space projections in upstream accelerating sections given downstream phase space projections as inputs.

Footnotes

Funding Agency

This work was supported by the LANL LDRD Program Directed Research (DR) project 20220074DR.

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Session Classification: Monday Poster Session

Track Classification: MC1: Beam Dynamics, Extreme Beams, Sources and Beam-Related Technologies; MC1.1 Beam Dynamics, beam simulations, beam transport