Artificial Intelligence for the Electron Ion Collider (AI4EIC) 2025

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Book of Abstracts

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Use of AI/ML for higher brightness and higher polarization of hadron beams

We report on the use of AI/ML techniques to advance the pursuit of higher brightness and polarization of hadron beams in the RHIC/EIC injector chain. Bayesian inference applied to individual magnet strengths reduced quadrupole field uncertainty by a factor of two while shifting mean values away from prior expectations, thereby improving the reliability of accelerator models. Bayesian optimization has enabled automated, high-performance tuning of injection alignment and matching, reaching results comparable to expert operators but at faster timescales. Reinforcement learning agents have achieved one-shot optimization of RF voltages for bunch merging and are now being trained for the stabilization of Booster-to-AGS beam transfer under drifting machine conditions. Collectively, these developments demonstrate the capacity of AI/ML methods to deliver adaptive and precise control strategies in support of next-generation polarized hadron beams.

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Machine Learning for the pfRICH Particle Identification subsystem

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We present an overview of the proximity-focusing Ring Imaging Cherenkov (pfRICH) detector developed for the ePIC experiment at the Electron-Ion Collider (EIC). Designed for the backward pseudorapidity region (-3.5 ⊠ η ⊠ -1.5), the pfRICH enables at least 3σ separation of pions, kaons, and protons up to 7 GeV/c, which is crucial for Semi-Inclusive Deep Inelastic Scattering (SIDIS) studies. In this talk, we explore the use of AI/ML techniques for pattern recognition of Cherenkov photon rings on photosensors in order to improve the PID capabilities of the pfRICH as a function of particle momentum. We use data from simulations of optical photon transport in Geant4, accelerated with NVIDIA OptiX and GDML-based detector geometries.

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DeepSub: Deep Image Reconstruction for Background Subtraction in Heavy-Ion Collisions

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