AI-enhanced Track Finding for Recoil Ions with ALERT and CLAS12 at Jefferson Lab

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Abstract

Decades after the discovery of the European Muon Collaboration effect, theorists and experimentalists are still working to unravel its origin and deploy new methods to understand the in-medium modifications of nucleon structure. One novel way to probe the EMC effect is to study the fundamental structure of light nuclei, such as ^2H and ^4He, via the deeply virtual Compton scattering (DVCS) process, enabling access to their three-dimensional distributions through Generalized Parton Distributions. The forthcoming CLAS12 experiment will use the newly built a low energy radial tracker (ALERT) to study tagged DVCS on ^4He with an 11 GeV beam via the detection of low-momentum recoil fragments such as ^2H, ^3H, ^3He, ^4He, and protons, down to 70 MeV/c, in a wide kinematic range for the momentum transfer squared, $1 < Q^2 < 7$ GeV^2, as well as the Bjorken-x, $0.1 < x_B < 0.7$. By integrating a hyperbolic drift chamber (AHDC) with a scintillator array (ATOF), the ALERT detector enables effective differentiation between various recoil ions.

Recent advancements in artificial intelligence (AI), such as new model architectures, have shown their usefulness in experiments where background noise is substantially elevated, like AHDC in ALERT. AI is used in ALERT experiments to enhance track-finding efficiency, accuracy, and speed compared to conventional algorithms and improve particle identification with the ATOF. This presentation will provide an overview of the ALERT physics program and an update on the development of AI-assisted tracking and particle identification methods.

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