Utilizing Deep Neural Networks for the Extraction of Drell-Yan Angular Coefficients in *pp* Collisions with a 120 GeV Beam Energy

Dinupa Nawarathne

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Abstract

Understanding the total spin of protons plays a major role in comprehending the proton's structure. The $\cos 2\phi$ asymmetry in the Drell-Yan process, where ϕ denotes the azimuthal angle of the $\mu^+\mu^-$ pair in the Collins-Soper frame, can be described by the Boer-Mulders (BM) function. This function characterizes the transverse-polarization asymmetry of quarks within an unpolarized hadron and arises from the coupling between the quark's transverse momentum and transverse spin inside the hadron. SeaQuest is a fixed-target Drell-Yan experiment conducted at Fermilab, which involves an unpolarized proton beam colliding with an unpolarized solid NH3/LD3 target. The $\cos 2\phi$ asymmetry is determined by detecting $\mu^+\mu^-$ pairs. Accurately extracting the $\cos 2\phi$ asymmetry is important for determining the BM function. Measurements obtained from experiments typically require correction for detector inefficiencies, smearing, and acceptance. Traditionally, these corrections involve "unfolding" the detector-level measurements through matrix operations. However, in higher dimensions in parameter space, these conventional methods fail to scale effectively. To overcome these limitations, we propose a novel approach that utilizes Deep Neural Networks for directly extracting the angular coefficients using high-dimensional information from the detector level. Neural networks excel in approximating nonlinear functions, making them suitable for representing the full phase space for parameter optimization. In this presentation, we will explain the design of the neural network architecture, training strategies, and outline our plans to achieve conclusive results.