Title:	Recovery of merged πο,s from ECL images of the Belle II detector using CNN
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Keywords:	Recovery merged πο,s Belle
Issue Date:	May-2023
Publisher:	IISER Mohali
Abstract:	This study aims to utilize a Convolutional Neural Network (CNN) to retrieve merged π 0 mesons lost in the Belle II experiment, where they appear as individual photons. The issue arises when dealing with high momentum π 0 mesons, i.e., beyond 2 GeV in the Belle II experiment, as the shower produced by both the π 0 meson and gamma appear indistinguish- able at the Electromagnetic Calorimeter (ECL) detector. Currently, reconstruction software is utilized to match photon pairs created by the π 0 → γγ decay; however, the efficiency of this process can be affected by the γ produced by the rest of the events (ROEs), which mimic the signal. One of the most challenging tasks in particle physics research is accu- rately identifying and reconstructing subatomic particles. By the nature of the problem and its importance, accurate reconstruction of π 0 mesons is crucial for identifying various B/D meson decays, including rare decays like D 0 → γγ 8.5 × 10 −7 , D 0 → ρ 0 γ 10 −5 , and D 0 → φ γ 10 −5 . These rare decays have dominant background arising from decays like D 0 → K s π 0 1.24 × 10 −2 , D 0 → π 0 π 0 8.26 × 10 −4 , and D 0 → φ π 0 1.17 × 10 −3 . The Convolutional Neural Networks performed reasonably well on a test dataset, which is identical to real scenarios, achieving an area under the curve (AUC) of 0.86 for the Precision-Recall curve. These results demonstrate the potential of machine learning (ML) algorithms and highlight areas for improvement in the current work to enhance the effi- ciency of identifying π 0 particles with energy deposits in the ECL. The findings suggest that the 'raw' ECL images contain much more information than currently used expert- engineered features. Disclaimer:- This master thesis solely focuses on the barrel region of the ECL detector within the Belle II Experiment. Furthermore, all the results presented in this work are based on Monte Carlo simulations.
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