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Reconstruction of J/⊠ Mesons via Dimuon decay channel using Machine Learning Technique for the CBM Experiment at FAIR

The Compressed Baryonic Matter (CBM) experiment, being built at the Facility for Antiproton and Ion Research (FAIR)[1] accelerator complex in Darmstadt, Germany, aims to study the phase diagram of strongly interacting matter in the realm of high net baryon densities and moderate temperatures. The SIS-100 accelerator ring at FAIR will deliver accelerated ions up to beam kinetic energies 29 GeV for protons and 11 A GeV for heavy-ions. The identification of muon pairs coming from the decay of J/ψ mesons is recognized as a crucial physics observable for analyzing the hot and dense matter formed during collisions. The Muon Chamber (MuCh)[2] detector system is being built to identify the muon pairs in a background mostly populated by muons from weak decay of pions and kaons produced in the collisions.

Simulation results on the physics performance of reconstructing for J/ψ mesons through the di-muon decay channel will be presented for p+Au collisions at 29 GeV and Au+Au collisions at 10 A GeV using various machine learning models. These results will then be compared with those obtained from traditional di-muon cut-based analysis method. The traditional cut-based approach for distinguishing signal from background relies on track selection criteria such as number of hits associated with a reconstructed global track in the Silicon Tracking System (STS), Muon Chamber (MuCh), Transition Radiation Detector (TRD), and Time of Flight (TOF) detector, along with χ^2 values for the Vertex, STS, and MuCh, and a 2σ TOF mass cut. These same parameters are also used for both training and testing the machine learning models. The performance of the Boosted Decision Tree Gradient (BDTG) model [3] in enhancing reconstruction efficiency (ϵ) while maintaining the Signal-to-Background ratio (S/B) will be reported.

Category

Experiment

Collaboration (if applicable)

Compressed Baryonic Matter(CBM) collaboration

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