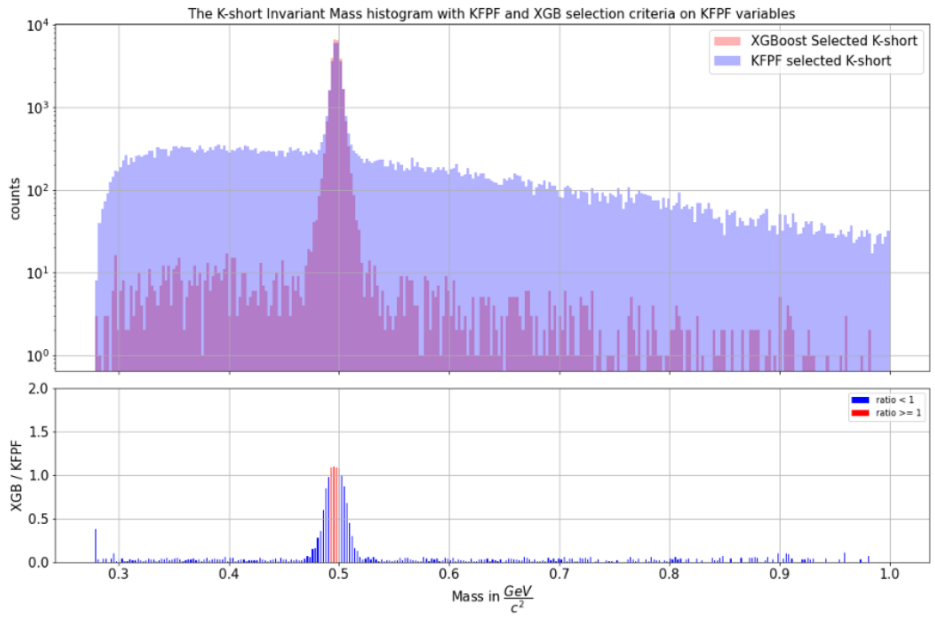
Implementation of machine learning algorithms for particle identification in the CBM experiment

AUTHOR: JULIAN NOWAK
SUPERVISOR: DR HAB. INŻ. HANNA ZBROSZCZYK, PROF. UCZELNI

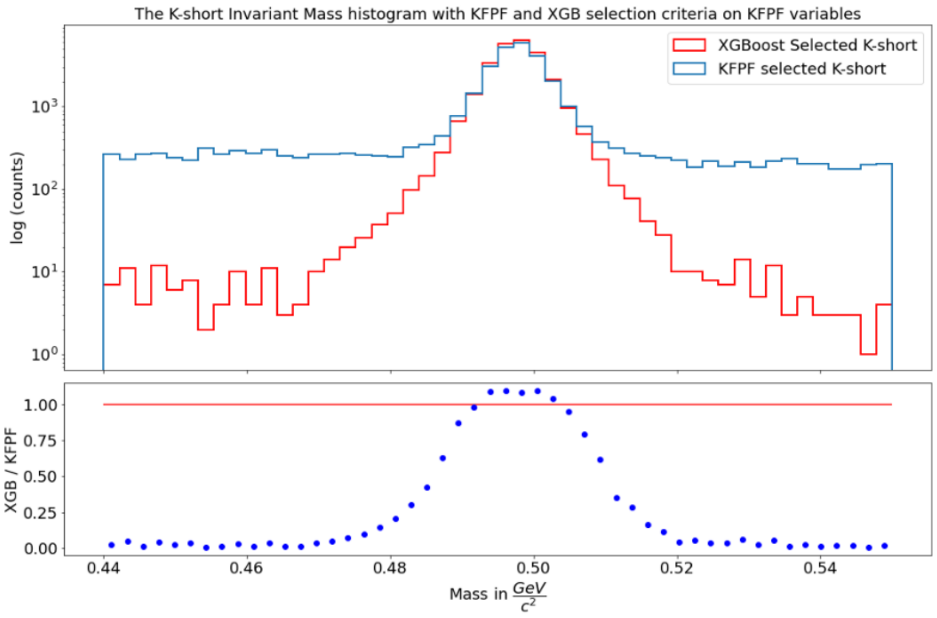
THE POSSIBILITY OF APPLYING ML ALGORITHMS FOR THE IDENTIFICATION OF PARTICLES IN THE CBM EXPERIMENT IS DISCUSSED IN THIS WORK. MACHINE LEARNING MODELS FOR RECONSTRUCTION OF SHORT-LIVED KAONS (K-SHORT) AND IDENTIFICATION OF THREE GROUPS OF PARTICLES (AS A COUNTERPART OF THE TOF METHOD) HAVE BEEN PREPARED IN THIS WORK, USING DATA FROM MONTE CARLO MODELS PASSED THROUGH SIMULATED CBM EXPERIMENT SETUP IN GEANT4.

In the first part, the application of machine learning for K-short reconstruction results in better background reduction and better efficiency (Figure 1), compared to the traditional, manual method. A complicated and extensive search of selection criteria using the manual method can be omitted this way; the same code works for different collision energies and magnetic field scaling settings as well

In the second part, the XGBoost model was trained for the identification of three groups of particles, following the traditional TOF method. It allowed receiving efficiencies of identification for protons and pions (along with muons and electrons) around 90%. However, the least represented class, kaons, achieves an identification efficiency of about 70% (Figure 2)



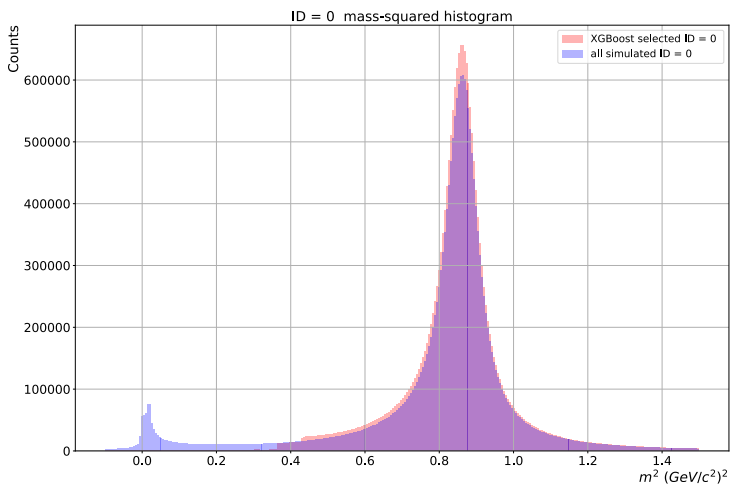
(a) Invariant mass distribution (y log scale)



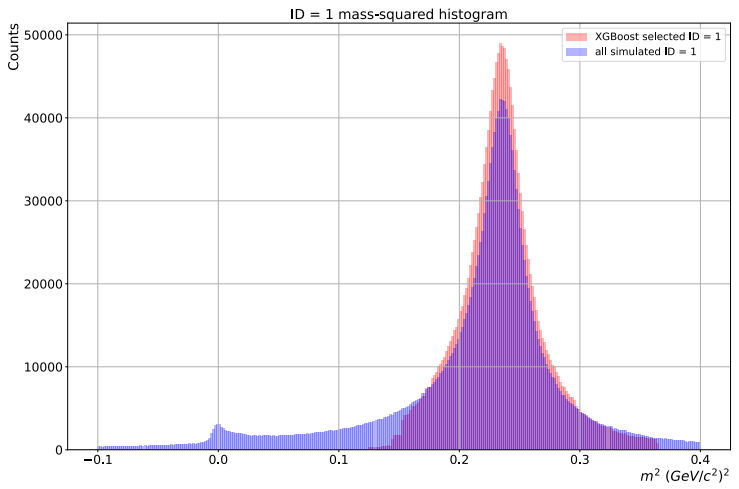
(b) Invariant mass distribution (close-up)

Figure 1. Reconstructed K-short particles' invariant mass distribution

a) protons



b) kaons



c) pions, electrons and muons

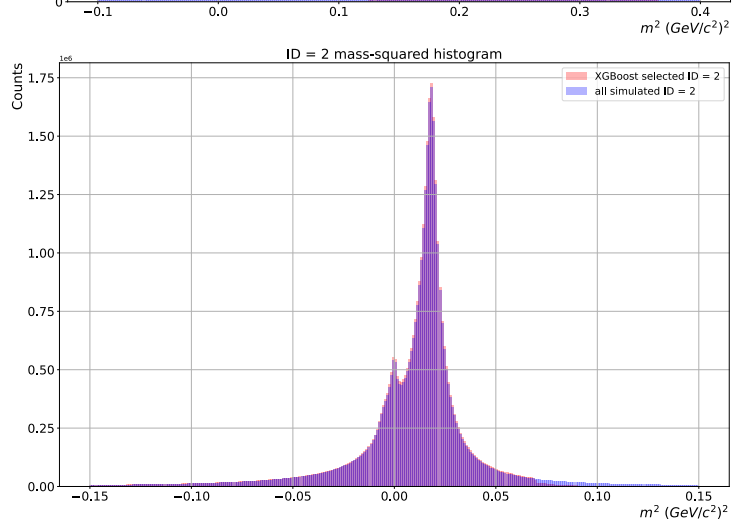


Figure 2. Mass distributions of simulated and ML-selected particles (from each group) from the TOF method

Wydział Fizyki
POLITECHNIKA WARSZAWSKA

CBM

FAIR
GSI