

Direct Photon and Neutral Pion Discrimination in Single Particle Simulations

Iain Morton, Jace Tyler, Saskia Mioduszewski

Abstract: Direct Photon and Neutral Pion Discrimination Using Machine Learning Techniques at STAR

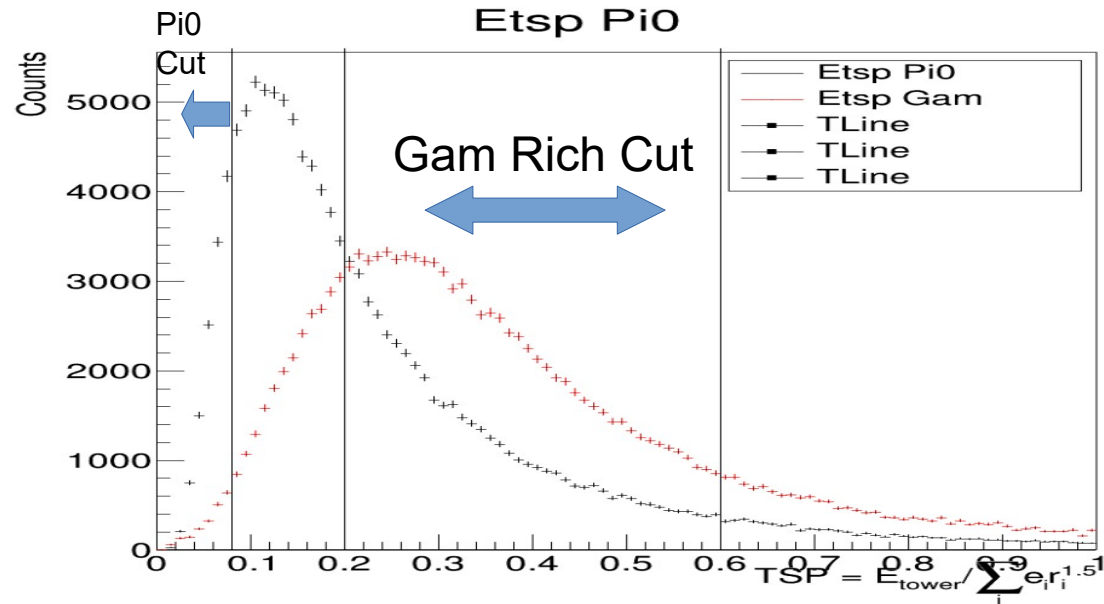
- Detection of direct photon and neutral pion coincidence with their recoil jet populations is important to study the QCD processes in proton-proton and heavy-ion collisions. Direct photon and neutral pion detection in STAR, with the Barrel Electromagnetic Calorimeter and the Barrel Shower Maximum Detector, result in different shower shapes. In this study, the TMVA library, a machine learning library in the ROOT package, is utilized to discriminate direct photon and neutral pions samples using shower-shape quantities measured in STAR. The techniques and findings of the implementation of the TMVA library will be discussed in this study.

Background

- Dependent on whether the given jet is a neutral pion or gamma photon, these can produce differing shower profile energy shapes in the BEMC.
- The purpose of this research is to provide the comparison of the shower profile energies and central tower ratios with single particle simulations for neutral pions and gamma photons. This is first done with cuts on TSP only, and without TMultiLayerPerceptron.

Histogram for Energy Shower Profile

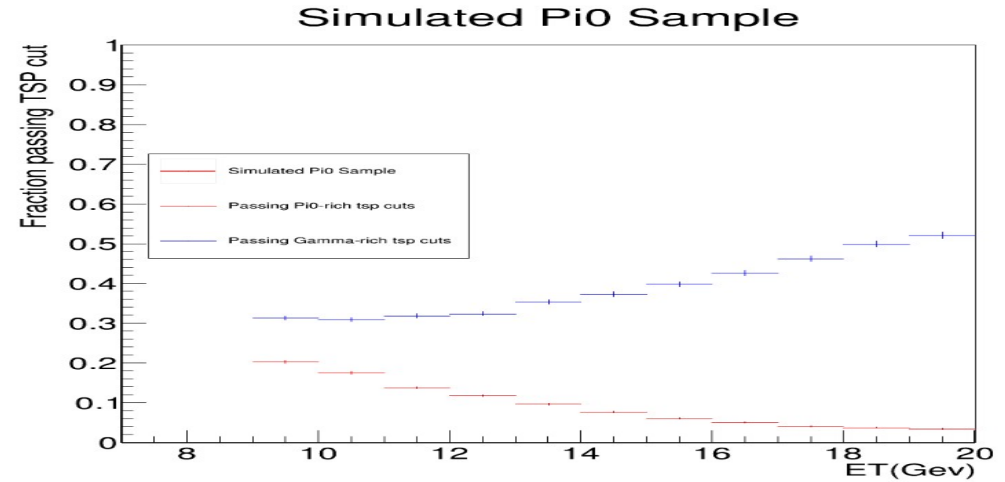
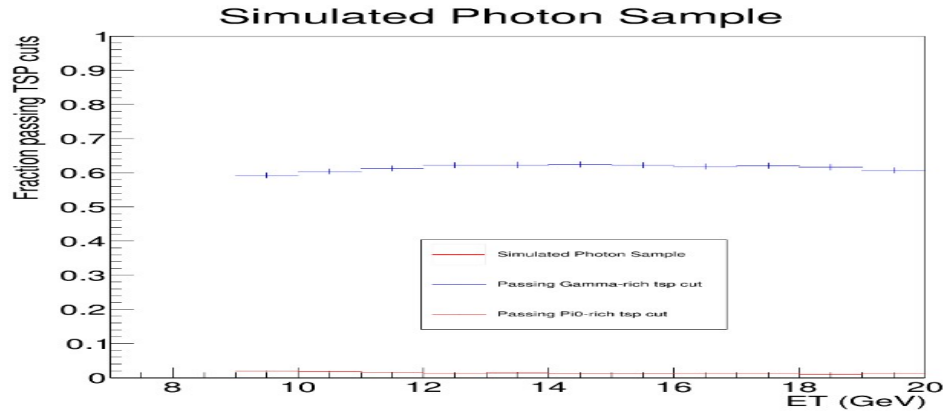
- The shower profile energy of both the neutral pion and gamma photon were plotted as follows:



- The x-axis is the transverse shower energy profile

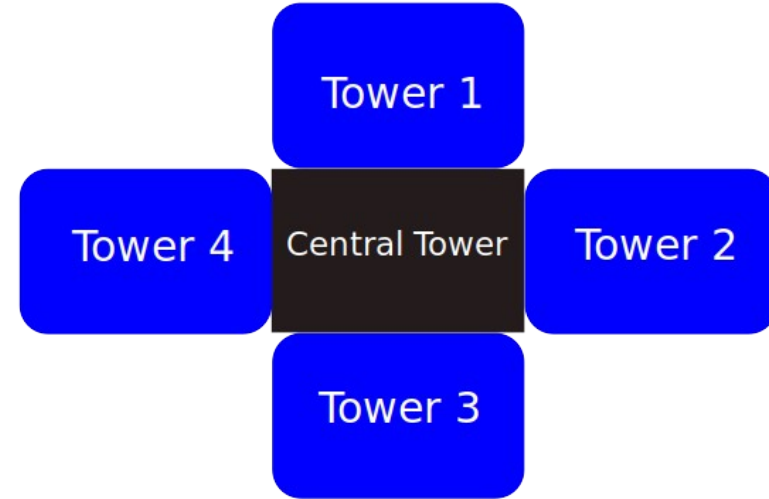
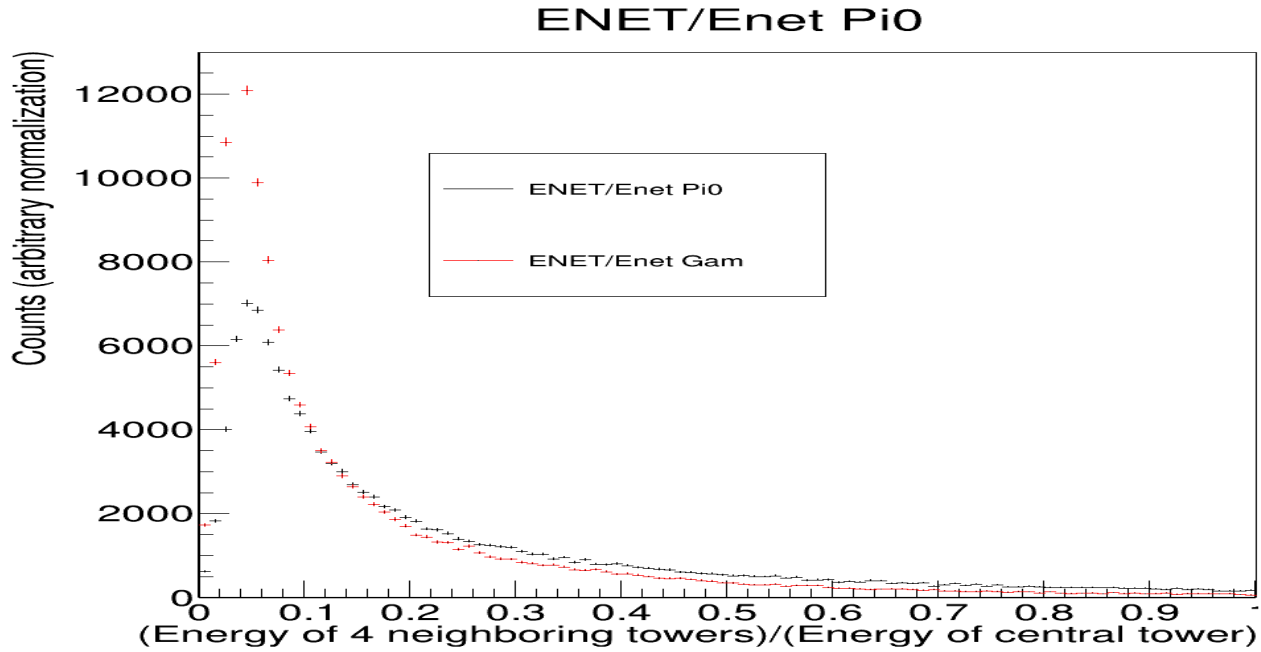
TSP Ratio Cuts

- This process was repeated, but with the total dividing both the Pi0 and Gamma samples:



- ~2% of photons pass the pi0-rich cut
- Efficiency of pi0-rich cut for pi0 is ~20% at 9 GeV decreasing to only ~5% at 20 GeV.

Histogram for Central Tower Energy Ratio



- Pi0 distribution of this ratio is broader due to wider showers than photons

TMVA

- The TMVA library in ROOT can be implemented in order to make Boosted Decision Trees (BDTs) to differentiate between neutral pions and direct photons. The current plan is to utilize the TMVA library to examine whether a decision tree can determine if the particle is either a pion or direct photon