Study of Preshower in the PANDA Target Spectrometer

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Introduction

PANDA (anti**P**roton **AN**nihilation at **DA**rmstdt) is one of the major projects at FAIR, GSI, Germany. The main objective of this experiment is to study the fundamental questions of hadron physics and QCD in $p\bar{p}$ annihilation using high intensity cooled anti-proton beams with momenta between 1.5 GeV/c and 15 GeV/c. To achieve high momentum resolution and full solid angle coverage, the PANDA detector is split in to two parts: target spectrometer and forward spectrometer. The target spectrometer is a complex detector consisting of several subsystems surrounding the interaction point. It is surrounded by a 2T superconducting solenoid magnet. A Micro Vertex Detector (MVD), close to interaction point, detects secondary vertices of D and Hyperon decays. The Straw Tube Tracker (STT) is the central tracking system around the MVD. A cherenkov counter named DIRC (Detection of Internally Reflected Cherenkov light), provides π/K separation for particle momenta up to 3.5 GeV/c. The barrel Time-of-Flight (TOF) detector, consists of plastic scintillator tiles with a time resolution of 100 ps. It is used to identify particles of momentum below cherenkov threshold. Following the TOF detector, an electromagnetic calorimeter (EMC) is placed to detect e^-, e^+ and γ particles. The Muon detector is the outermost part of the PANDA target spectrometer. The complete description and technical details of the PANDA detector can be found elsewhere [1].

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Preshower

The presence of other detectors in front of the electromagnetic calorimeter with a high material budget leads to the possibility for a high energetic photon to start the electromagnetic shower in front of the EMC. An electromagnetic shower started in front of the EMC is called preshower. In the PANDA detector, the material budget in front of the EMC is mostly contributed by the DIRC detector material [2]. Therefore, this study is concentrated on preshowers in the DIRC detector. A study for the BaBar experiment [3] show, that detecting the preshower in the DIRC, the energy resolution of π^0 could be improved by about 5%. The BaBar DIRC detector itself was used to detect the preshower and 50% of converted photons were recovered. However, unlike the BaBar detector, the PANDA target spectrometer is facilitated with the TOF detector between DIRC and EMC. The barrel TOF detector in the PANDA experiment is proposed to be a scintillator tile hodoscope of about 6000 small scintillator tiles, each of which has roughly a dimension of $3 \times 3 \times 0.5$ cm^3. This thin detector system is capable of detecting preshowers in the DIRC with a high efficiency and may help in the reconstruction of photon showers in the EMC.

Simulation in PandaRoot

We use PandaRoot [4] to study the preshowers. Single photon MC events of energy 1 GeV are generated using box generator. The radial part of the starting point of an electromagnetic (EM) shower can be obtained from the simulation output. A shower is identified as preshower if the starting point falls between the inner radius and outer radius of the DIRC detector. The variation of the gamma conver-

sion probability with polar angle (θ) is shown in Fig.1.

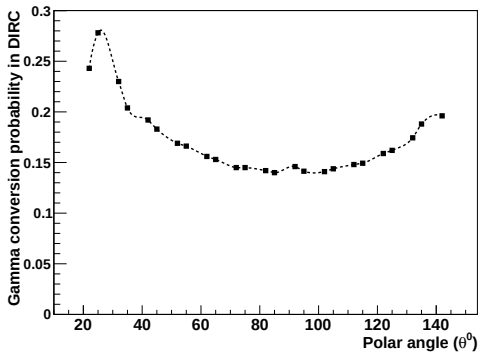

FIG. 1: Gamma conversion probability in DIRC as a fuction of polar angle (θ) for 1 GeV photons

A comparison of the reconstructed photon energies with and without DIRC preshowers is shown in Fig.2. For 1 GeV photons it is observed that for most photons there is no remarkable deterioration in photon energy resolution due to DIRC preshowers. However, some photons are reconstructed with a considerable lower energy and thus contribute to an inefficiency in photon detection and misidentification.

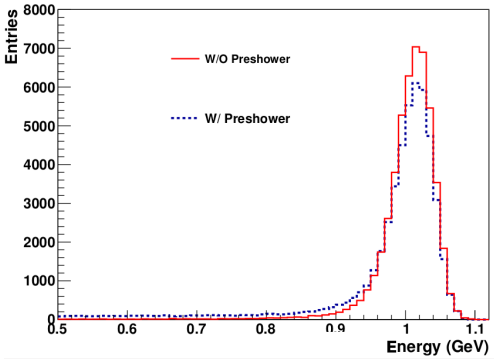

FIG. 2: Reconstructed energy of 1 GeV photons with (W/) and without(W/O) preshowers in DIRC.

Previous studies showed, that for energies above 1 GeV a preshower improves the energy resolution, while for energies below 1 GeV a preshower deteriorates the energy and position reconstruction [5]. The TOF detector can help to identify these cases and may help to improve the situation.

Conclusion

Simulation studies are in progress for better understanding of DIRC preshowers in the PANDA target spectrometer. It is also planned to recover the converted photons in the DIRC using barrel TOF detector with high efficiency.

Acknowledgments

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