π⁰ reconstruction through a γ-conversion method with KF Particle Finder in the CBM experiment∗

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The CBM experiment is being designed to study heavy-ion collisions at extremely high interaction rates and track densities. One of the main observables for CBM are light vector mesons decaying through dilepton channels, that are of the particular importance for the physics program of the experiment. Because of the low branching ratio the key issue for reconstruction of light vector mesons is background suppression. Being a major source of this background, π⁰ and γ-conversion have to be carefully studied.

The main decay channel of π⁰ is a π⁰ → γγ channel with a branching ratio of 98.8%. The γ can be reconstructed in the Silicon Tracking System (STS) when it was converted into an electron-positron pair on the material or support structures of the detector: γ → e⁺e⁻. To study this decay π⁰ reconstruction through a γ-conversion method was implemented in the KF Particle Finder package for short-lived particle reconstruction.

![Figure 1: Distribution of γ-particles reconstructed z-position. The obtained histogram represents position of the target, a beam pipe window and four stations of the STS detector.](image1.png)

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At the first stage tracks from electrons and positrons registered in STS are selected using particle identification (PID) information from the Ring Image Cherenkov Detector (RICH), Transition Radiation Detector (TRD) and Time of Flight (ToF) detector. Selected tracks are combined into γ-candidates. Based on the Kalman filter mathematics, the KF Particle Finder package allows to achieve high reconstruction quality of the particles. For example, distribution of the reconstructed z-position nicely represents the structure of the detector: the target at 0 cm, the beam pipe window at 26 cm and four stations of the STS detector at 30, 40, 50 and 60 cm (see Fig. 1). Then the γ-candidates within 3σ region around the peak position (0 MeV/c²) are selected and combined with each other. High quality of the γ-candidates allows reconstruction of π⁰ with a width of 1.7 MeV/c² and signal to background ratio of 0.77 already for 5 million central AuAu events at 25 AGeV (see Fig. 2).

![Figure 2: Mass distribution of γγ pairs for 5 million central AuAu events at 25 AGeV using PID information from RICH, TRD and ToF detectors. The peak from π⁰ is nicely seen with a width of 1.7 MeV/c² and a signal to background ratio of 0.77.](image2.png)

Figure 2: Mass distribution of γγ pairs for 5 million central AuAu events at 25 AGeV using PID information from RICH, TRD and ToF detectors. The peak from π⁰ is nicely seen with a width of 1.7 MeV/c² and a signal to background ratio of 0.77.

Average gamma conversion factor within the STS detector is about 6.5%. This gives a probability of 4 · 10⁻³ for both γ-daughters to produce tracks. Taking into account efficiency of the track finding, PID detector and particle construction the overall π⁰ reconstruction efficiency is about 10⁻⁶. However, the big advantage of the method is high resolution and signal to background ratio.

Summarizing, π⁰ reconstruction was implemented in the KF Particle Finder package. High quality of the obtained π⁰ particles makes it possible to study the background for dielectron decays of the rare probes.

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