$\pi^0$ reconstruction via conversion method in Au+Au at 1.23AGeV with HADES

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Lepton pairs emerging from decays of virtual photons are excellent probes of dense hadronic matter. The interpretation of the corresponding experimental results calls for a detailed understanding of conventional sources. Comprehensive information on meson production is therefore an important prerequisite. In this context, the neutral pion and eta mesons are of particular interest as they contribute largely to the dilepton spectrum via their Dalitz decays $\pi^0/\eta \rightarrow \gamma e^+e^-$. HADES [1] measured the collision system Au+Au at the highest (achievable at SIS18) beam energies of $E_{kin}=1.23$ GeV/u in April/May 2012. In total $7.3 \times 10^9$ events, corresponding to 140 TByte of data, have been collected. Data taking was triggered for events with apparent hit multiplicity in the outer time-of-flight detector system ToF Mult $\leq 20$ (PT3) translating to the 50% most central collisions.

Since HADES has no photon detector yet, the measurement of the electromagnetic decays of $\pi^0$ is only possible via external pair conversion of photons in detector material. The average conversion probability for $\pi^0$ decay photons was obtained from simulations and amounts to approximately 1.6% (taking into account the Au target, the target holder, the beam pipe and the radiator).

To study the $\pi^0$ reconstruction performance we selected leptons through their characteristic correlation between their velocity ($\beta$) and their momentum (the black box in Fig 1).

![Figure 1: Velocity versus momentum $\cdot$ sign|$q$| in the RPC region of the HADES spectrometer.](image)

In the next step of the analysis, topological selection criteria on opening angle between the leptons of a given pair were used to identify conversion pairs ($\alpha < 2.5^\circ$) and Dalitz pairs ($\alpha < 20^\circ$) at the same time (for details see [2,3]).

Such identified leptons have then been combined into opposite-sign $e^+e^-$ pairs and further into $e^+e^-\pi^0\pi^0$ multiplets. In addition, a condition was applied on the relative angle between the two dileptons in a multiplet, namely $\theta^{\gamma*\gamma*} > 5^\circ$, to suppress spurious counts at low invariant mass. Figure 1 shows a preliminary invariant mass spectrum of $e^+e^-\pi^0\pi^0$ multiplets (within the HADES acceptance, uncorrected for efficiency and acceptance). A clear signal peak is visible at the nominal mass of the $\pi^0 (135$ MeV). The data points were fitted with a model function consisting of a 4th-order polynomial and a gaussian distribution. We extract 4000 counts from the $\pi^0$ peak. This result demonstrates that the $\pi^0$ can in principle be reconstructed in Au+Au collisions via the conversion method. In the next step, the uncertainties of the efficiency and acceptance corrections will be investigated.

References

