Measurement of π^0-induced Leptons with the HADES-RICH Detector $\diamond$

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A fast Ring Imaging Cherenkov detector (RICH) [1] is the central device of the new dilepton spectrometer HADES at GSI, Darmstadt. It serves as a hadron blind trigger device for e^+e^- pairs in hadron and heavy-ion induced collisions at 1-2 AGeV incident energy. In these reactions π^0 mesons are produced abundantly and constitute the main sources of lepton pairs with small opening angles via the π^0-Dalitz decay ($\pi^0 \rightarrow e^\pm\gamma$, $<\alpha>\simeq 13°$) and external conversion ($\pi^0 \rightarrow 2\gamma; \gamma \rightarrow e^\pm$, $<\alpha>\simeq 1°$) in the target, the C_4F_{10} gas radiator and the VUV transparent CaF_2 window. It is indispensable that these lepton pairs are identified properly, as they otherwise contribute significantly to the combinatorial background which can screen completely the physics signal of interest from open pairs of vector meson decays.

Moreover, the identification of single lepton induced ring patterns on the MWPC-type photondetector from the π^0-Dalitz decay can serve as a method to determine the efficiency of the RICH detector to identify single leptons.

In order to study the properties of these particular signals in the RICH and other sub detectors of the HADES spectrometer, a dedicated experiment with an optimized setup was performed in November 2001. Using the reaction C+C at an incident beam energy of 1 GeV per nucleon, a low multiplicity and therefore well defined scenario was chosen. The magnetic field of the superconducting toroidal magnet of the spectrometer was lowered from its nominal field strength by one order of magnitude to about 0.07 Tesla. This allows to adapt the acceptance of the spectrometer to the low momenta leptons of the above mentioned processes and thus to enhance the yield of fully reconstructed pairs from these sources.

With this setup a total of about $7{\cdot}10^6$ events was recorded in which we expect roughly $3{\cdot}10^4$ π^0-Dalitz decays. A preliminary calibration was carried out for all sub detectors. Additionally, a full-scale simulation was performed for the same event statistics making use of the simulation packages UrQMD as event generator for the heavy-ion collisions and GEANT for the detector response.

Figure 1 shows an opening angle distribution of fully reconstructed pairs obtained during the beam time in November 2001 (solid line). For comparison the result of the full simulation (dashed lines) is overlaid, decomposed also into the two contributing dilepton sources. The agreement between data and simulation is reasonable. For pairs with opening angles $\geq 10°$ the leptons originate predominantly from π^0-Dalitz decays in the target and can therefore be used as probes with a well defined vertex and momentum for the response of the RICH.

In figure 2 the number of pads over threshold within a region of 13x13 pads around the recognized Cherenkov ring center is depicted for rings which were identified to result from a single lepton traversing the radiator (left). The same quantity, but for unresolved close double rings generated by a photo conversion dilepton is shown on the right. This lepton sample was prepared using the position information from the Multi-wire Drift Chamber (MDC) system and applying a suitable opening angle cut to the fully reconstructed lepton pairs.

It is obvious that the mean of the distribution for double rings is shifted to higher values and that the distribution is broader with respect to single lepton rings. However, the two distributions are not separated well enough to distinguish between single and double lepton rings. The same applies to other properties characterizing the observed Cherenkov rings. In a forthcoming analysis we will extract single lepton identification efficiencies for the RICH detector.

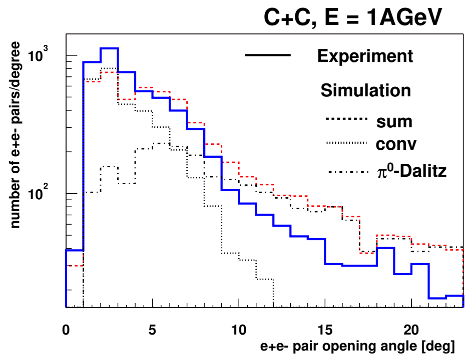

Fig. 1: Opening angle distribution of reconstructed pairs in comparison with full simulation. The simulation is decomposed also in the dominantly contributing processes: photo conversion and π^0-Dalitz direct decay (dashed lines: simulation).

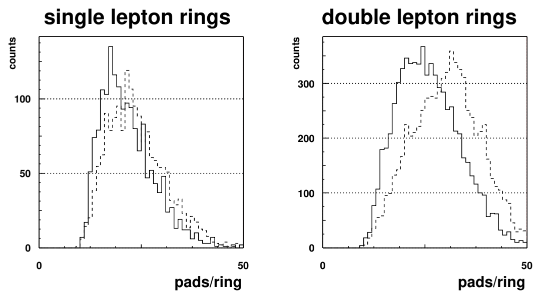

Fig. 2: Left: The number of fired pads in a Cherenkov ring generated by an identified single lepton from a π^0-Dalitz decay in the carbon target. Right: The number of fired pads in a Cherenkov ring generated by two leptons from a gamma conversion in the target, CaF_2 window or C_4F_{10} gas radiator (dashed lines: simulation).

References

[1] K. Zeitelhack *et al.*, Nucl. Instr. Meth. **A433** (1999) 201-206

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