

Investigation of π^0 induced e^+e^- pairs in C+C collisions

T. Eberl¹, T. Christ¹, L. Fabbietti¹, J. Friese¹, R. Gernhäuser¹, M. Münch¹, and B. Sailer
for the HADES collaboration²

¹Physik Department E12, Technische Universität München

With the HADES experiment becoming operational we have started to study the production of e^+e^- pairs in nuclear collisions and in the invariant mass range up to 1 GeV/c². One of the first steps in these studies is the measurement and calibration of the spectrometer response to high momentum electrons and positrons. Unfortunately, well defined electron sources like secondary e^- beams of sufficient intensity are not routinely available for these purposes. On the other hand, e^+e^- pairs from π^0 decays offer an alternative and appropriate tool to investigate HADES detector parameters and the RICH in particular. Two processes contribute, the π^0 - Dalitz decay $\pi^0 \rightarrow e^+e^-\gamma$ and the external conversion of photons from $\pi^0 \rightarrow 2\gamma$ decays. The e^+e^- pairs are characterized by small opening angles $\langle\alpha_{Dalitz}\rangle \simeq 15^\circ$ and $\langle\alpha_{Conv.}\rangle \simeq 2^\circ$. The vertices of Dalitz decays are in the target only, whereas conversion takes place mainly in the surrounding radiator and detector material. Since the Dalitz decay branching ratio (BR $\simeq 1.2\%$) and the total radiation length ($x/X_0 \simeq 2\%$) for target and RICH radiator are similar the expected yields from both processes are comparable.

We have used the data of the HADES commissioning runs performed in Nov. 2001 to investigate π^0 induced e^+e^- pairs for C+C collisions. Carbon beams with typical beam intensities of a few 10^6 ions/spill were directed to a solid carbon target of 5% interaction thickness. Data were taken at $E = 1$ AGeV and $E = 2$ AGeV and for 2 magnetic field settings ($B = 0.07$ T and $B = 0.5$ T). The low field setting in the 1 AGeV run allowed for a larger portion of low momentum e^\pm to be fully tracked and identified in all detectors of the spectrometer. Charged particle multiplicities $M > 3$ were used as 1st lvl trigger condition for event recording. All in all $8 \cdot 10^6$ and $42 \cdot 10^6$ events were recorded and analysed for $E = 1$ AGeV and $E = 2$ AGeV, respectively. We have also performed full scale simulations with the HADES detector simulation code HGEANT using measured detector parameters and eight million UrQMD events for both energies as input.

In the analysis electrons and positrons were identified by a spatial correlation of recognised rings in the RICH with tracks reconstructed from hits in the drift chambers before the magnetic field. Hit coordinates in the TOF/PreShower wall behind the magnetic field were used to determine track deflection angles and to calculate the particle momenta. Experimental and simulated distributions of single lepton deflection angles (see left panel of figure 1) show reasonable agreement in shape and yield. The lower positron yield reflects the smaller geometrical acceptance for positively charged particles bent by the B-field towards the beam axis. In the right panel of figure 1 the distribution of pair opening angles is plotted for the subset of fully reconstructed unlike sign e^+e^- pairs. The simulation shows also the decomposition into Dalitz and conversion contributions.

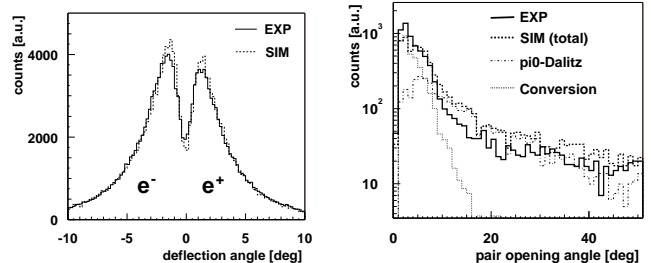


Figure 1: Experimental track deflection angles of single e^\pm candidates (*left*) and opening angle distributions of reconstructed unlike sign e^+e^- pairs (*right*) for C+C at 1A GeV in comparison to simulations. The number of primary collisions in simulation and experiment is the same.

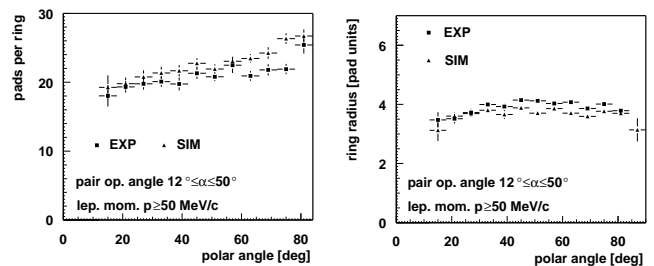


Figure 2: Polar angle distributions of pad multiplicities per ring (*left*) and Cherenkov ring radii (*right*) for single primary electrons and positrons emitted from the target. Simulation results are shown for comparison.

From this decomposition it becomes obvious that open e^+e^- pairs with angles between 12° and 50° stem predominantly from π^0 - Dalitz decays. We have used these pairs to extract the properties of Cherenkov rings detected in the RICH for single primary electrons and positrons since they come from the target and traverse the whole radiator medium. As can be seen from the left panel of Fig. 2 the average number of fired pads per ring rises for larger polar angles and reflects the increasing radiator length (from about 40 to 70 cm). We observe experimentally a mean of 19.3 ± 5.6 pads around $\Theta = 25^\circ$ and 23.0 ± 5.6 pads around $\Theta = 75^\circ$. Similar numbers are observed also for the $E = 2$ AGeV measurement. The right panel of Fig. 2 shows that the design goal of nearly constant ring radii for all polar angles is also achieved which is important for the fast online ring recognition used in the HADES 2nd level trigger.

The reported measurements show that e^+e^- pair spectroscopy with HADES has started successfully and that more data are to come in the near future.