Development of an $e^{\pm}$ Track Analysis for HADES ◇

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The e^+e^- pair spectrometer HADES [1] has been commissioned at GSI, Darmstadt. It allows to measure invariant mass distributions of e^+e^- pairs in hadron and heavy-ion induced collisions at 1-2 AGeV incident energy and thus aims at reconstructing the in-medium masses of light vector mesons like ρ and ω. In a commissioning run in November 2001 single electrons and e^+e^- pairs produced in the reaction C+C at 1 and 2 AGeV incident beam energy were studied. From these runs about $7.4{\cdot}10^6$ events for E = 1AGeV and $36.2{\cdot}10^6$ events for E = 2 AGeV energy were analysed. Full-scale simulations were performed for the same event statistics making use of the packages UrQMD as event generator for the heavy-ion collisions and GEANT for the detector response. The simulation studies are crucial for the development and evaluation of analysis strategies.

The main source of $e^{\pm}$ in these reactions are abundantly produced π^0 mesons. These decay via the π^0-Dalitz decay ($\pi^0 \rightarrow e^{\pm}\gamma$, $<\alpha>\simeq 13°$) or into 2 γs which can then convert ($\pi^0 \rightarrow 2\gamma$; $\gamma \rightarrow e^{\pm}$, $<\alpha>\simeq 1°$) in the detector material. Single particle tracks and e^+e^- pairs are reconstructed with the analysis package HYDRA which was developed on the basis of the framework ROOT. First, tracks are constructed by comparing the lab coordinates of identified hits in subsequent detector systems and the momentum of the particle candidate is calculated. Then several cuts are applied to the resulting initial track sample, in order to discriminate true tracks from accidentally formed hit combinations. In a further step all tracks reconstructed in one event are systematically used to create unlike-sign (e^+e^-) and like-sign (e^+e^+,e^-e^-) pairs, the latter to calculate the combinatorial background.

It is helpful to use 3 key quantities to evaluate the applied data analysis strategies. The first one is the purity which gives the percentage of correctly reconstructed objects (tracks or pairs) in a given initial sample. The suppression indicates the reduction of false objects after the data analysis cuts are applied and the efficiency shows the loss of true objects due to the applied cuts. While these 3 values can only be determined in simulation, the remaining percentage (Rest exp/sim) of objects in the sample after a given cut can be compared for the experimental and simulated data.

Table 1 shows the resulting values of our analysis for the two different bombarding energies. For the track analysis a loose condition on the quality parameters of the RICH pattern recognition algorithm was applied. Furthermore, conditions on the PreShower signal and the particle momentum vs velocity correlation were used to improve the electron identification. Finally, a cut on the correlation between polar and azimuthal deflection in the magnetic field was used to reject false hit combinations before and after the magnetic field. The purity after the track analysis amounts to 80%. The remaining 20% false electron tracks consist of roughly 62% unresolved close pairs and 32% partially reconstructed particle trajectories. Misidentified hadrons play with only 4% a negligible role.

The subsequent pair analysis results mainly in a rejection of unphysical pairs and of unresolved close pairs. The latter is achieved by a cut on the pair opening angle of $\theta > 4°$. For E=1AGeV (E=2AGeV) a total of 2866 (10588) e^+e^- pairs could be measured with a signal-to-background ratio S/B of 3.7 (2).

Track Analysis			
		C+C 1AGeV	C+C 2AGeV
Purity	[%]	80	79
Suppression	[%]	10	13
Efficiency	[%]	85	85
Rest exp	[%]	70	65
Rest sim	[%]	75	70
Pair Analysis			
Purity	[%]	68	54
Suppression	[%]	23	11
Efficiency	[%]	17	11
Rest exp	[%]	7	6
Rest sim	[%]	12	9

Table 1: Quantitative characterization of the developed analysis for single tracks and unlike-sign pairs.

Fig. 1 shows the ratio of measured and simulated electron and positron tracks for different momentum ranges. It shows that experiment and simulation are in good quantitative agreement and the differences are below 10% for all momenta. This indicates that the detailed MC-simulations model the real experiment well enough to allow the thus developed background suppression strategies for misidentified tracks to be also applied to experimental data.

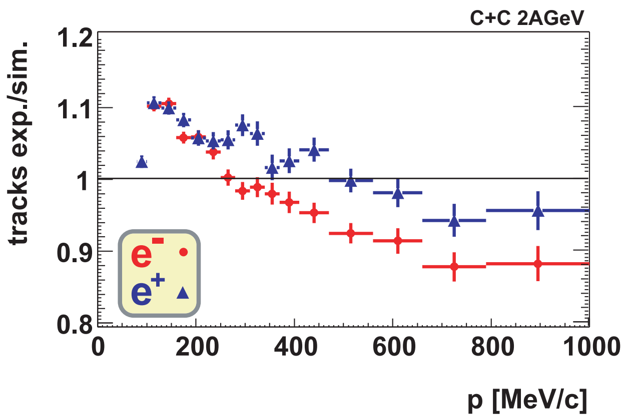

Fig. 1: The ratio between the number of measured and simulated e+ and e− tracks for different momentum ranges.

References

[1] J. Friese *et al.*, Nucl. Phys. **A654** (1999) 1017c

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