Particle Identification in the HADES-Experiment ◇

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The physics programme of the HADES experiment at GSI, Darmstadt, requires a clean identification of e^+e^--pair decays from pseudoscalar (π^0, η) and vector (ρ, ω) mesons produced in hadron and heavy ion induced nuclear reactions. At typical collision energies of E = 2A GeV, the identification of relativistic electrons and positrons is affected considerably by the abundant presence of charged hadrons and suffers from strong background contributions induced by pair conversion of photons in the detector materials. Particle identification (PID) in the HADES spectrometer is performed by analysing three observables: a) particle velocity (β) from a time of flight (TOF) measurement, b) particle momentum ($\vec{p}$) from a track curvature measurement in the magnetic field, and c) energy loss from a charge deposition measurement in the tracking and TOF detectors. In addition, and most important, electrons and positrons are discriminated by a Cherenkov ring detection in the hadron blind RICH and by an electromagnetic shower signal in the forward PreShower detectors. Based on these observables, we have developed two PID methods for the HADES data analysis. Here, we present and compare the $e^{\pm}$ identification capabilities for both methods.

The **hard-cut method** applies carefully optimized detector parameter cuts to the sample of e^+/e^--candidates selected by the RICH signal. The cuts are determined from kinematic considerations and full scale Monte-Carlo detector-simulations. False candidates due to electronic noise in the RICH are removed by a conservative cut on the ring quality, i.e. the pattern quality, number of firing pads, pulse height etc.

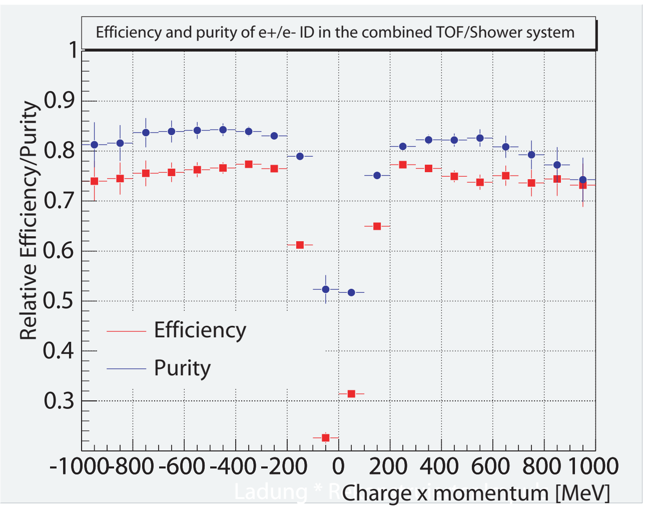

Fig. 1: e^+/e^- identification quality of the hard-cut approach.

The remaining sample is cleaned from slow pions and protons by a $\vec{p}$-dependent cut on the particle velocity. Finally, fast hadrons are supressed by a $\vec{p}$-dependent cut on the shower signal. In the momentum region of interest (p≥ 200 MeV/c), the resulting $e^{\pm}$ recognition efficiency reaches $75-85\%$ at an average purity of 75% (see Fig. 1).

The **probabilistic method** computes for each particle track the conditional probability $P(s|\vec{x})$ that it belongs to a certain particle species s. This is achieved using Bayes Theorem:

$$P(s|\vec{x}) = \frac{P(s) \times P(\vec{x}|s)}{\sum_i P(i)) \times P(\vec{x}|i)} \qquad (1)$$

Here $P(\vec{x}|i)$ is the normalized Probability Density Function (PDF) of observables for each species i and $P(i)$ is the relative abundancy of i. The sum runs over all particle species i. For this method, either dedicated measurements (e.g. $\beta\, vs.\, \vec{p}$) or high statistics Monte-Carlo Simulations (e.g. RICH-response) of all particle properties are required. The relative particle abundancies are obtained from fits to measured spectra or from data in the literature. Figure 2 displays the relative e^+/e^- efficiency and purity achievable with this method.

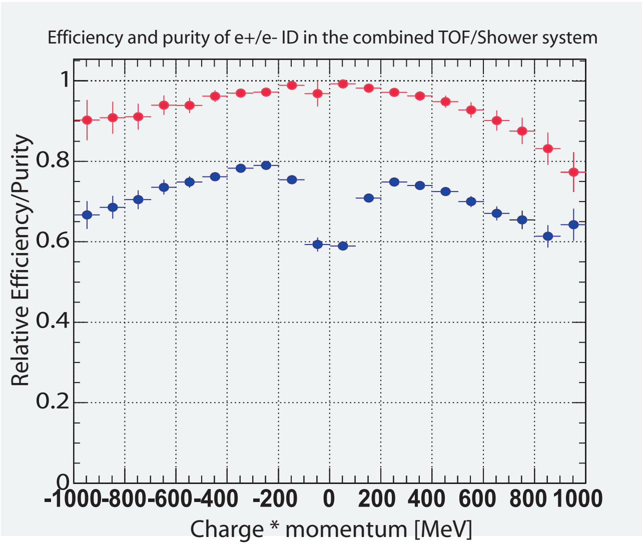

Fig. 2: $e+/e-$-identification quality in the probabilistic approach.

The probabilistic approach offers a significantly better recognition efficiency but suffers from slightly higher contamination of hadrons in the electron sample. The main source of these false electrons comes from wrong detector hit combinations. However, we expect that the purity can still be improved by applying a better two track separation in the tracking detectors and a new method of momentum reconstruction. This analysis is still going on and has already given first promising results.

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