Closed-pair rejection strategies in HADES

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Although the main targeted physics signal of HADES lies in the e^+–e^- decay of the light vector mesons (ρ, ω, ϕ) produced in heavy-ion collisions, the bulk of all detected leptons stems from π^0 Dalitz decays and from converted high-energy photons. Both processes lead to narrow opening-angle distributions, with, at 2.0 AGeV beam energy, typical averages within the HADES acceptance of $<\alpha>= 15^o$ for Dalitz pairs and $<\alpha>= 2.2^o$ for conversion pairs. Most of these pairs are not resolved in the inner HADES detectors, namely the RICH (if $\alpha \leq 2.5^o$) and the inner MDC tracking chambers (if $\alpha \leq 1.5^o$), and only part of the so-called *closed pairs* are recognized as such in the outer detectors after being split in the magnetic field (Fig.1a). The remaining fraction of about 90% (Fig.1b) contribute to the combinatorial background and in fact dominate the latter, if not suppressed by other means.

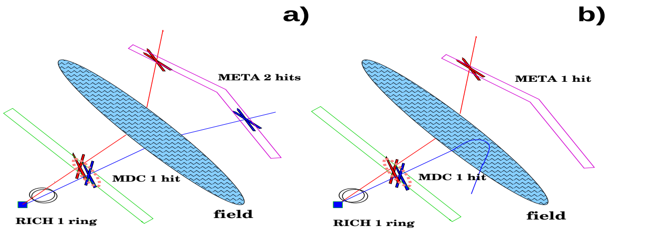

Figure 1: Schematic view of different closed-pair geometries; (a) both leptons are detected, (b) one lepton is lost in the magnetic field.

We have therefore investigated methods to recognize closed pairs from the topology of the hits in the RICH and in the inner MDCs. In extensive Geant3 simulations of the HADES response to leptons produced in 2.0 AGeV C+C collisions, we have systematically studied the different hit characteristics corresponding to single and double lepton tracks, respectively. The observables that turned out to be most sensitive to the difference between single and double hits were (1) the integrated pad charge per ring in the RICH, (2) the cluster size and (3) the number of contributing wires in the MDCs (Fig. 2). Note that, due to varying radiator lengths in the RICH and varying angles of incidence in the MDC, the hit characteristics depend on the polar and azimuthal angles.

To discriminate between single and double hits, cuts on the relevant observables have to be applied such that both the suppression of doubles and the acceptance of singles are optimized at the same time. This has been done by tabulating the single/double ratio (S/B) and the singles efficiency (ϵ) as function of the polar and azimuthal angles of a batch of simulated and tracked π^0-induced leptons from C+C UrQMD events. From this, for a singles efficiency of e.g. $\epsilon > 80\%$, a doubles rejection efficiency of 70% and $S/B = 4$ are obtained.

In order to test the assumption that the simulated hit patterns agree with the real ones, events from the November 2001 commissioning beamtime were analyzed, a sam-

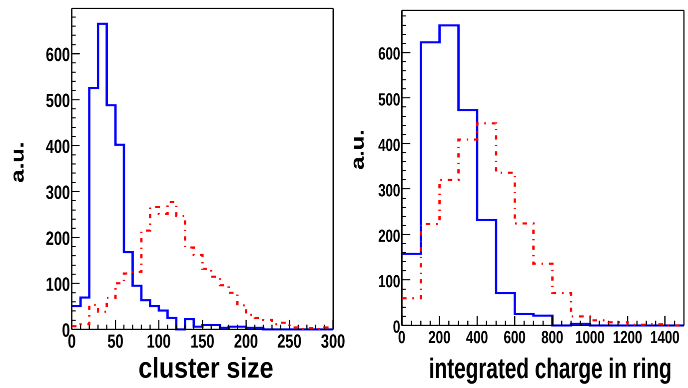

Figure 2: Simulated cluster-size distributions of hits in the MDC (left) and simulated integrated pad-charge distributions of rings in the RICH (right) for single leptons (full) and unresolved pairs (dashed) within an angular range $[\theta = 20^o - 30^o, \phi = 20^o - 40^o]$.

ple of clean lepton tracks (singles + doubles) was prepared and their hit topology was compared with the corresponding simulated hits. Systematic deviations on the 10-20% level were observed (Fig. 3), but they can now easily be corrected for.

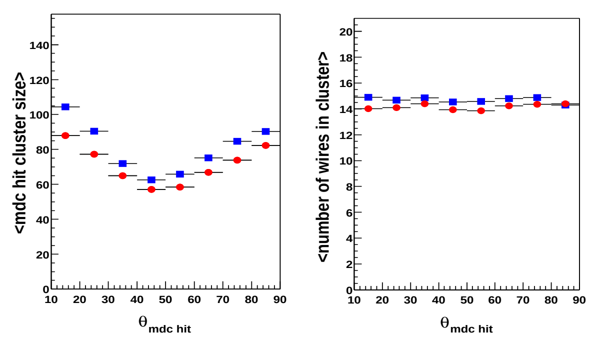

Figure 3: Comparison between simulated (circles) and measured (squares) lepton hits in the MDC: cluster size (left) and average number of wires (right) as function of the track polar angle.

In summary, we have demonstrated that the analysis of the hit topology in the inner HADES detectors offers discrimination power for closed lepton tracks, while keeping a high efficiency for single tracks. This method can still be improved by including additional observables, like the cluster and ring shapes. In addition, first exploratory studies with feedforward neural networks, which could eventually replace the tabulated multi-dimensional cuts, have been conducted with promising results.