Electron identification in Au+Au collisions at 1.23 GeV/u in HADES using multivariate analysis*

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HADES [1] has measured Au+Au collisions at a beam kinetic energy of 1.23 GeV/u in 2012. In the data analysis, e^+ and e^- are identified by applying appropriate selection cuts to RICH ring observables, time-of-flight, PreShower and energy loss signals. Particle momenta were obtained by tracking the charged particles through the HADES magnetic field.

To achieve high purity in the reconstruction of the rarely produced electrons(positrons) a series of conditions on the PID-detector signals are usually applied consecutively. Although correlations of signals can be taken into account if graphical conditions are applied to two-dimensional spectra (correlation plots) yet a truely simultaneous assessment of all detector signals is not possible in this way.

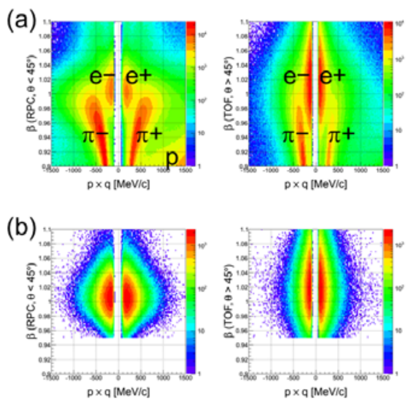

Figure 1: Particle's velocity versus momentum for (a) all particles and particles with MLP > 0.6 (b) for particles falling into different time-of-flight detectors.

A way out is to use a multivariate analysis, which allows to create a multidimensional decision boundary optimizing it in all dimensions simultaneously. In the current work the MultiLayer Perceptron (MLP) model (implemented in the ROOT framework, TMVA [2]) was used (for details see [3]).

There are two challenges in training the neural network in order to give the correct response: one is the selection of pure signal and background training samples. The other one is choosing variables with the highest separation power between hadron and lepton tracks.

The neural network output can be understood as a probability that the subjected particle belongs to signal. Finding a boundary discriminating between signal and background is a matter of compromise between purity and efficiency of the identification. A comparison of velocity-momentum correlations before and after requiring MLP to be larger than 0.6 is presented in Fig.1. It can be seen that most of the hadrons have been removed and a significant statistics of electrons has been kept.

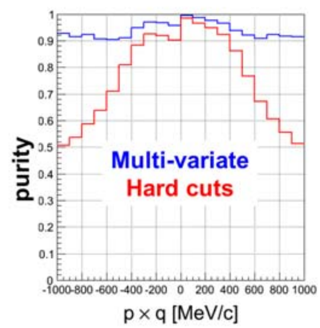

Figure 2: Lepton purity as a function of momentum, using MLP or hard cuts for PID.

The purity of the remaining lepton candidates can be estimated by extracting accidental coincidences of hadron tracks with RICH rings. The amount of such fake matches is obtained by matching way tracks reconstructed in one sector with rings from the neighboring sector.

Figure 2 shows the obtained purity of identified leptons for both PID methods as a function of momentum. Integrated values are 0.94 and 0.85 for MLP and hard cuts, respectively. It demonstrates the superior performance of the MLP method over the hard cut method for larger momenta.

References

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