Investigations concerning the set of MVA input variables*

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To reconstruct a dilepton spectrum measured by HADES in the Au (1.23 GeV) + Au reaction one first has to apply several cuts on the data to identify leptons. Besides the so-called "hard cut" method, the multivariate analysis (MVA) can be used to apply a multidimensional cut, which reaches higher lepton sample purity and a higher efficiency.

Each particle which was detected in HADES is characterised by a set of observables, like the velocity β, the reconstructed momentum, specific energy loss in drift chambers and in Time of Flight detector, electromagnetic shower information and ring properties as provided by the RICH detector. Each observable can help to distinguish between leptons (signal) and hadrons (background). The most powerful one is the ring matching quality, called richQa variable, which is defined as

$$\text{richQa} = \sqrt{(\Delta\phi sin\theta)^2 + \Delta\theta^2} \qquad (1)$$

with

$$\Delta\theta = \theta_{Ring} - \theta_{Runge-Kutta}, \qquad (2)$$
$$\Delta\phi = \phi_{Ring} - \phi_{Runge-Kutta}, \qquad (3)$$

where ϕ_{Ring} is the azimuth angle and θ_{Ring} the polar angle of the reconstructed ring center, combined with the corresponding track angles reconstructed by the Runge-Kutta method. The input samples for training the neural network of the MVA are defined by the richQa value. Signal (leptons) has a richQa $< 0.5°$, whereas the background (hadrons) has a richQa $> 7°$. After training the neural network, which is offered by the TMVA [1], with the signal and background data samples one gets an Multi Layer Perceptron (MLP) classifier as a response, taking values between 0 and 1. After a cut on the MLP and richQa value, around 70 % of all lepton candidates survive with a lepton purity larger than 99 %. The β versus momentum distribution before and after a cut based on the experimental data is shown in Fig. 1. Two different cases were investigated: Training the neural network with or without using θ as an input variable. Looking through the momentum distribution in Fig. 2 (upper panel) one can conclude that there are no differences visible between the two cases. To determine purity in the experimental data the "rotated RICH detector" method is used. One rotates the RICH detector, which consists of six sectors, software wise by 60° and after pursuing the same data analysis one gets only the wrongly matched rings to reconstructed tracks, i.e. the back-ground. Also in the "rotated RICH detector" analysis one can conclude that it makes no difference if θ is included or not as an input variable to MVA. Therefore we kept θ as an input variable for further analysis.

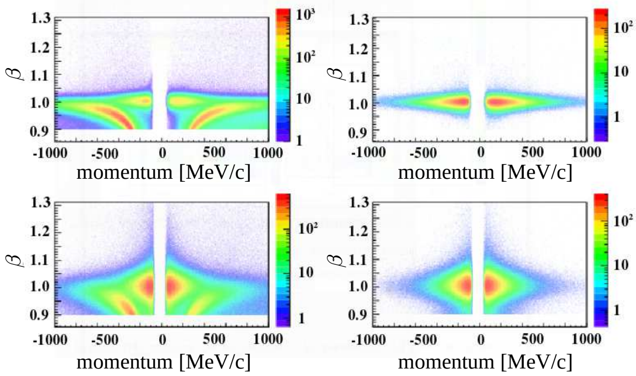

Figure 1: **Left:** Measured β vs momentum distribution without cut. **Right:** Identified leptons after a cut on MLP > 0.6 and richQa < 2.
(Upper panel: RPC detector, Lower panel: TOF detector)

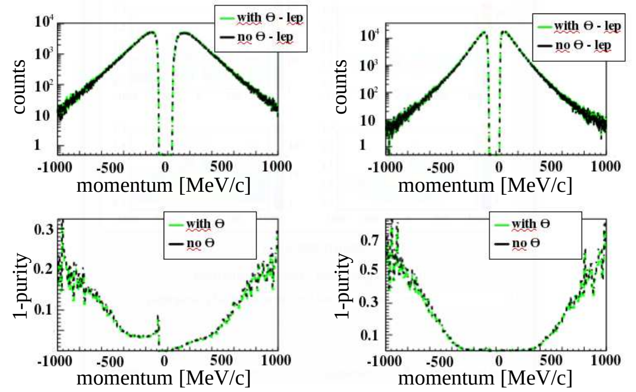

Figure 2: **Upper panel:** Momentum distribution for leptons before and after applied cuts. **Lower panel:** Rotated RICH momentum distribution divided by the "normal" momentum distribution of identified leptons.
(Left: RPC detector, Right: TOF detector)

References

[1] A. Hoecker et al., "TMVA - Toolkit for Multivariate Data Analysis", (2007) arXiv:physics/0703039

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