Identification of Deuterons with High Momenta at ANKE

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Apart from the full three momentum determination of fast ejectiles, the forward detection system[1] [1] provides direct particle identification at ANKE. Protons, deuterons and even pions with momenta around 1 GeV/c can be well separated using their energy losses, due to a good resolution in the forward scintillation hodoscope [1]. However, there is a strong need to distinguish particles at higher momenta. E.g. in the reaction: $pd \to p_{sp} d\omega$ at threshold [2] one has to distinguish deuterons with ≈ 2 GeV/c momentum from a 100 times larger proton background.

To allow deuteron and proton separation under such conditions, inclined Čerenkov counters have been installed [3]. As the response of these detectors is strongly momentum dependent, a dedicated procedure has been developed, to calibrate the proton suppression and deuteron efficiency within the momentum range of interest in order to equalise their proton suppression factors [4]. The scatter plot in Fig. 1 was produced from data obtained during the above mentioned experiment at 2.77 GeV/c beam momentum after the suppression of protons by Čerenkov detectors to less than 5% of their initial amount. Despite of the clear indication on the deuteron band the contribution of protons is still significantly stronger.

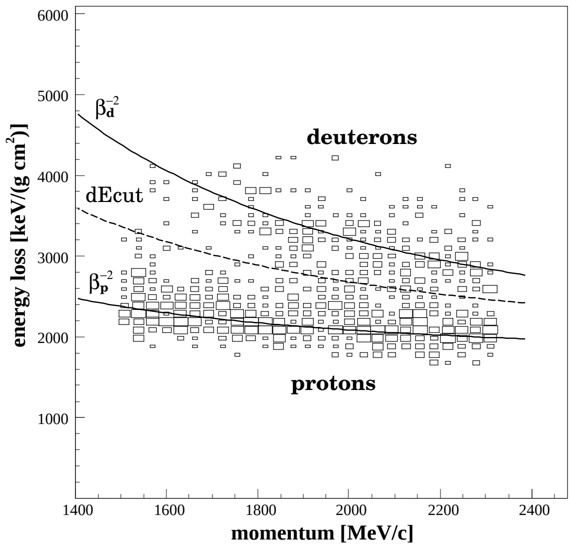

Fig. 1: Momentum dependent cut on the energy loss in the 1st layer of the forward hodoscope after 97% proton suppression; the bands from protons and deuterons can be approximated well by functions of β^{-2}.

It is necessary to take into account, that at high proton-suppression efficiencies by the Čerenkov counters also some part of the deuterons are rejected. An optimal combination of the ΔE-cut and the proton-suppression factor providing a negligible loss of deuterons was found by simultaneous varying the ΔE-cut level and the Čerenkov-efficiency level. Using the chosen suppression factor, Fig. 2 shows projections along the β_d^{-2}-line of a plot as in Fig. 1 but for the 2nd hodoscope layer (dotted line). If one applies the energy-loss cut in the 1st layer (marked "dEcut" in Fig. 1), the contribution of protons under the deuteron peak decreases already below 20%(solid line). Moreover, the remaining proton background can be easily determined using the energy loss distribution of suppressed particles (scaled)(dashed line). To more than 95% those events are protons.

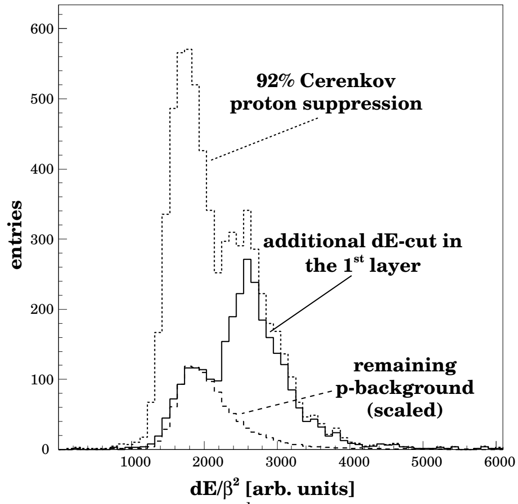

Fig. 2: Energy loss in the 2nd layer of the forward hodoscope (scaled with β_d^{-2}) using only Č-suppression (dotted), dE-cut in the first layer (solid), proton contribution extrapolated by an active selection of these particles and scaled (dashed)

To apply this subtraction for other physical observables, one has to prove that the corresponding distributions for the background protons (to be subtracted) are not affected by the cuts applied to select deuterons. As an example Fig. 3 shows the momentum and polar angle distribution with 60 and 90% efficiency for the proton identification in the Čerenkov counters. As the vast majority of particles selected by this method are protons, one can treat them as background. The curves in Fig. 3 scale with the efficiencies, but their ratios are constant within the statistical errors.

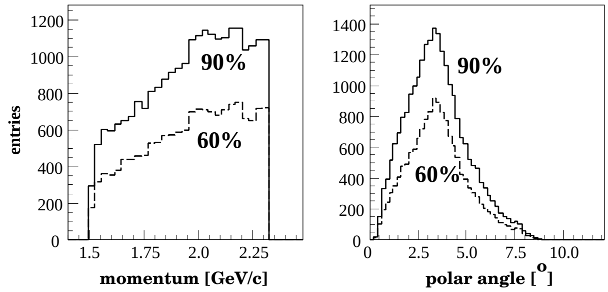

Fig. 3: Momentum and angular distributions of the background (mostly protons) for 60% (dashed) and 90% (solid) proton-identification efficiency in the Čerenkov counters; the shape does not change with the applied cut level.

Thus, deuteron identification at momenta around 2 GeV/c proves to be feasible with the ANKE forward-detection system alone. Also the remaining background of less than 20% can be subtracted on a statistical basis.

References:

[1] V.Komarov et al. *Binary process ... forward scintillation hodoscope ...*, IKP Ann. Rep. 2000, page 21.

[2] Cosy-Proposal #75

[3] A.Kachavara et al. *Beam Test of Cerenkov...*, NIM A376, 356 (1996)

[4] M.Büscher et al. *Momentum dependent efficiency of ... Čerenkov counters ...*, IKP Ann. Rep. 2000, page 22.

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[1] consisting of three multi-wire proportional chambers (MWPC), two layers of scintillators and 16 Čerenkov counters