Momentum dependent efficiency of the forward Čerenkov counters at ANKE

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The forward Čerenkov hodoscope at the ANKE setup serves for the identification of fast forward ejectiles. In experiments on meson production in pp interactions [1, 2], deuterons have to be separated from protons, both with momenta above the Čerenkov threshold in the radiator material (plexiglass). A new type of Čerenkov counters, based on total internal reflection, is used for that purpose. Such counters have been proposed for use at ANKE in 1994 [3] and are described in detail in Refs. [4, 5]. They were used recently for proton suppression and to identify deuterons in the momentum range 1.7–2.3 GeV/c from the reaction $pd \to p_{sp} d\omega$ at 2 GeV beam energy.

Here we describe the procedure of measuring the efficiency of proton identification in a wide momentum range including the range mentioned above and also in the range 0.85–2.15 GeV/c, where the protons have the same velocity (and, thus, efficiency) as the deuterons of interest. During the calibration measurements all counters (8 upper and 8 lower) were positioned under the same inclination angle of 10°. The detection efficiency is defined as follows:

$$\varepsilon_k(Q_{th}, p) = \frac{1}{N_k} \int_{Q_{th}}^{+\infty} s_k(Q, p)\, dQ \,,$$

where $s_k(Q, p)$ is the Čerenkov amplitude spectrum of protons with momentum p in counter number k; $Q_{\rm th}$ is the amplitude discrimination threshold, and N_k represents the number of protons hitting the k-th counter. The number N_k and the spectrum $s_k(Q, p)$ were determined for events satisfying the following criteria: *i)* straight-line track reconstruction can be achieved in the forward proportional chambers; *ii)* the track corresponds to a particle with momentum p coming from the target (selected by a 'vertical' selection $y/y\prime$ criterium and passing through the exit window of the vacuum chamber); *iii)* the track hits correct forward scintillation counters in the both planes and the particles have proper energy losses; the track hits the k-th Čerenkov counter excluding an edge area of 0.5 cm width and 1.5 cm distance to the median plane of the setup. The signal spectra for each counter were equalized to use the same threshold for all spectra.

In Fig.1 the measured momentum dependence of the proton-detection efficiency is plotted. To cover the full momentum range with overlapping sub-intervals, data obtained at three values of the beam energy have been used. Some nonregularity of the momentum dependence can be explained by the presence of a relatively small contamination of background events with improper momentum reconstruction. The efficiency shown is determined at a low cut level $Q_{\rm th} = 8$ QDC-channels (the mean amplitude for 2 GeV/c protons is at about channel 200).

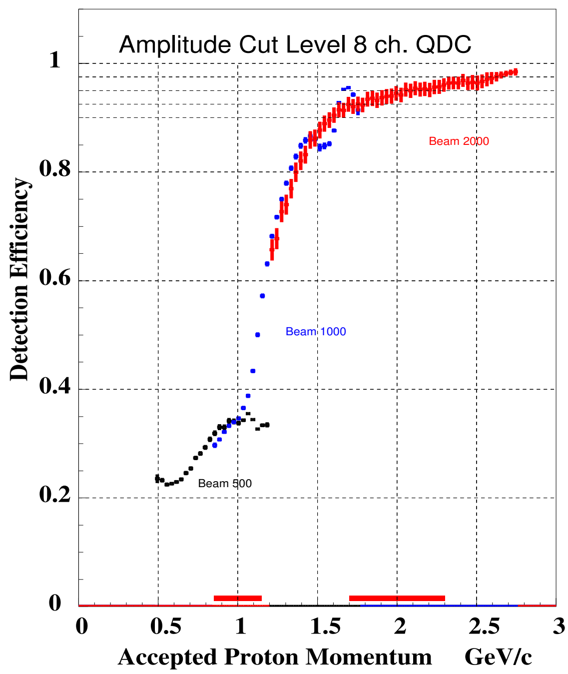

Figure 1: Proton detection Efficiency at $Q_{th} = 8\,ch$

At this cut level the achieved efficiency at 2 GeV/c beam momentum is about 95% and about 35% at 1 GeV/c. The signal amplitudes at low momenta (close to the radiation threshold at 0.85 GeV/c), are relatively small. Therefore, using of a proper signal discrimination allows to get a significant (10–20 times) proton rejection in the momentum range of interest with a small loss ($\sim$ 10%) of deuterons in the same range.

References:

[1] COSY Proposal #55, "Study of ω and ϕ-meson production in the reaction $pd \to dVp_{sp}$ at ANKE", (1998).

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[3] N. Amaglobeli et al., "New type of Cherenkov counter of total internal reflection", Preprint HEPI TSU 08-94, Tbilisi (1994).

[4] A. Kacharava et al., "Beam test of Cerenkov counter prototype for ZDF setup", NIM **A376**, 356 (1996).

[5] R. Esser et al., Annual Report 1999 of the IKP, p.29.

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