

## Cross section determination for the $dd \rightarrow \alpha K^+ K^-$ reaction with ANKE\*

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An attempt to measure the  $dd \rightarrow \alpha f_0 \rightarrow \alpha K^+ K^-$  process at maximum COSY beam momentum of  $p_d = 3.7$  GeV/c has been carried out using the magnetic ANKE spectrometer. The  $K^+$  mesons have been selected in the ANKE side detector (SD) [1] mainly by a time-of-flight criterion. The coincident fast  $\alpha$  particles were identified in the forward counters (FD) [2] via their detection time and energy losses. Using the reconstructed  $\alpha$  and  $K^+$  momenta, the non-observed  $K^-$  mesons have been selected via a missing-mass criterion.

As the first step of the analysis, the  $K^+$  selection has been tuned with  $dK^+$  pairs that are produced at a much higher rate than the  $\alpha K^+$  events of interest. Figure 1 shows that after selection of deuterons in the FD (upper),  $dK^+$  correlations can be separated from  $d\pi^+$  background events (lower).

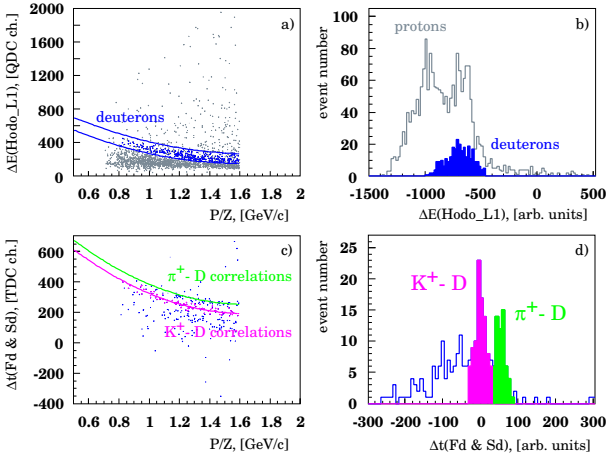


Fig. 1: a), b):  $d$  identification by energy losses in the FD. The filled histogram in b) depicts the remaining  $d$  candidates within the cut shown in Fig. a). c), d): Deuterons correlated with  $K^+$  &  $\pi^+$  can be identified.

In the next step, the FD information of fast particles — detected in coincidence with  $\pi^+$  mesons from the SD — has been investigated, see Fig. 2a) and b). Since  $m_\alpha \approx 2m_d$  and  $Z_\alpha = 2Z_d$ ,  $\alpha\pi^+(K^+)$  events are hidden under the time-of-flight band of  $d\pi^+(K^+)$  pairs. The necessary  $d-\alpha$  discrimination can be achieved from energy losses in three scintillator layers of the FD. Figure 2d) (blue histogram) shows the energy loss in one of these layers for the  $d$  and  $\alpha$  events from solid blue histogram in b). Most of the background deuterons can be removed by the cut indicated in c), leaving the events marked in green. After applying corresponding cuts in the remaining two layers, about 100  $\pi^+\alpha$  events survive (red).

After applying the selection criteria for  $K^+$  (Fig. 1) and for  $\alpha$  (Fig. 2), 15  $\alpha K^+ K^-$  candidates with a missing mass in the  $K^-$  region remain, see Fig. 3a). These events also fulfill the selection criteria shown in Figs. 3b)–f).

With the integrated luminosity  $L_{\text{int}} = 35 \text{ pb}^{-1}$  [3], a total production cross section of  $\sigma_{\text{tot}} = (9 \pm 3_{\text{sta}} \pm 4_{\text{SysLumi}} \pm 1_{\text{SysAcc}}) \text{ pb}$  for these  $\alpha K^+ K^-$  events has been determined.

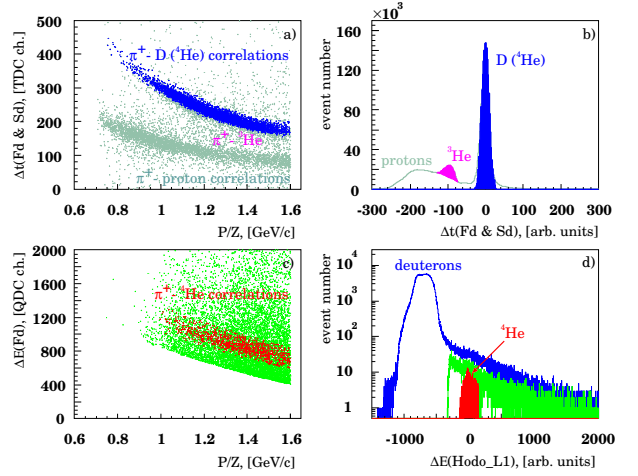


Fig. 2: a), b):  $\Delta t(\text{FD}-\text{SD})$  vs. rigidity plot of FD particles correlated with  $\pi^+$  mesons. c), d): The  $\alpha$  band in a  $\Delta E(\text{FD})$  vs. rigidity plot can be determined from the energy losses in three FD scintillator layers.

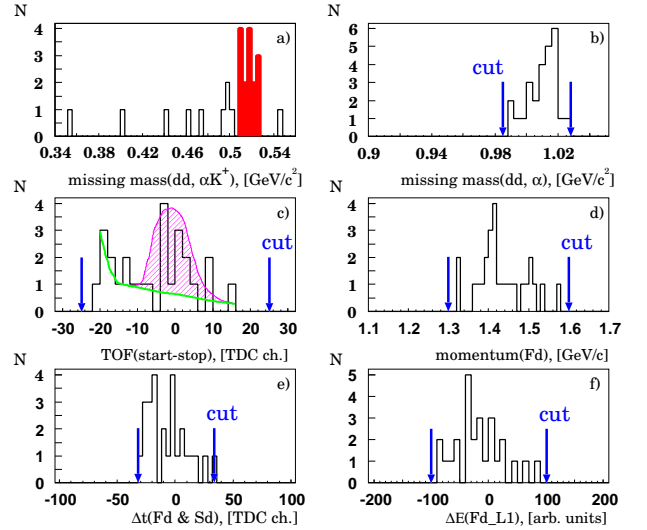


Fig. 3: a) Missing mass spectrum of  $dd \rightarrow \alpha K^+ X$  events; b) missing  $dd \rightarrow \alpha X$  mass spectrum; c) time of flight in the SD, the expected  $K^+$  signal is indicated; d) FD momentum distribution; e) time difference between FD and SD; f) energy loss in FD scintillators.

### References:

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