First studies of K^+ production in proton-neutron collisions at ANKE

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There have been extensive measurements of the $pp \to K^+\Lambda p$ cross section at COSY with various degrees of sophistication. These range from the study of single-arm K^+ detection [1], K^+p correlation studies [2], to full reconstruction of the $K^+p\,(\Lambda \to p\pi^-)$ four-body final state [3]. In contrast, very little is known experimentally about K^+ production in proton-neutron collisions.

There have been several attempts to deduce the difference between K^+ production on the proton and neutron by using different nuclear targets and beams [4]. The most direct estimates of the $\sigma(pp \to K^+X)/\sigma(pn \to K^+X)$ ratio was obtained by using data collected within the same experiment on hydrogen and deuterium targets at four different beam energies using ANKE spectrometer [5]. A value of $d\sigma^{K^+}_{pd}/d\sigma^{K^+}_{pp} \approx 1.4$ was extracted for the cross section ratio. This seems to depend weakly upon the proton beam energy and an average value of $\sigma^{K^+}_{pn}/\sigma^{K^+}_{pp} = 0.5 \pm 0.2$ was extracted from the experimental data using a three-channel model [5].

To determine the total cross section for the $pn \to K^+n\Lambda$ reaction, and hence the ratio of total cross sections $\sigma^{K^+n\Lambda}_{pn}/\sigma^{K^+p\Lambda}_{pp}$, a first experiment has been undertaken at ANKE in March 2011 using the COSY proton beam and deuterium cluster-jet target [6]. In this measurement two Silicon Tracking Telescopes (STTs) were used, together with the ANKE range telescopes, to identify the reaction of interest and reconstruct the excitation function. The momentum of the proton beam (2.6 GeV/c) was chosen such that, using the STTs, it was possible to cover a wide range of excess energies for the $pn \to K^+n\Lambda$ reaction while still staying generally below the Σ threshold. The K^+ mesons were identified in the ANKE range telescopes using the delayed veto techniques, which led to a very significant background suppression. Therefore, by detecting only two particles in the final state, it is possible to estimate the total cross section for Λ production in proton-neutron collisions near threshold and hence get information about the $n\Lambda$ final-state interaction.

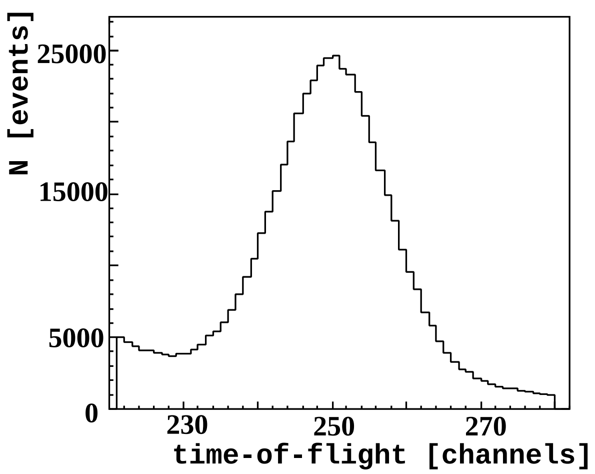

Fig. 1: K^+ meson identification using time-of-flight spectra measured in the interaction of 2.6 GeV/c protons with a deuterium target.

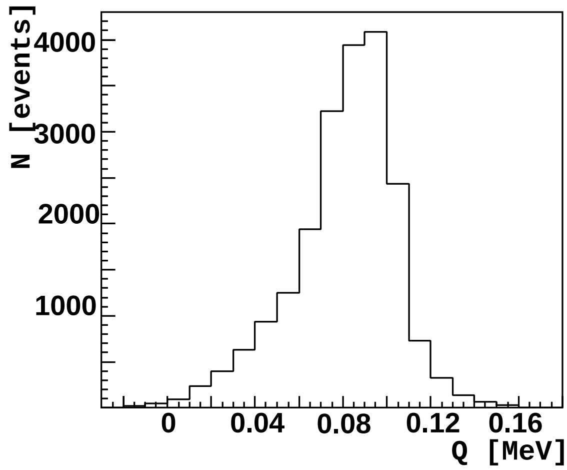

Fig. 2: Number of events measured as a function of the excess energy in the $K^+n\Lambda$ system where the K^+ was detected in the range telescopes and the spectator proton $p_{\rm sp}$ in one of the STT.

A time-of-flight spectrum for the K^+ mesons detected in the ANKE range telescopes is presented in Fig. 1. Using moderate cuts on the delayed veto signal, it was possible to reduce the background under the K^+ peak to $\approx 20\%$ without using any STT information. Since in this experiment we rely on the ANKE K^+ range telescopes to identify the reaction, the cuts must be further optimised in the final analysis.

Figure 2 shows the number of events as a function of the excess energy in the $K^+n\Lambda$ system. From this it is seen that the statistics will be sufficient to determine the total cross section in 10 MeV bins in Q. Information about the $n\Lambda$ final state interaction will be extracted, not only from the $K^+p_{\rm sp}$ inclusive spectra, but also from the excitation function of the reaction.

During the experiment in March 2011 adequate statistics were accumulated to reach the goals of the proposal. The detailed analysis is continuing.

References:

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