Status and Calibration of the New Detection System for Negatively Charged Ejectiles at ANKE

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The accepted ANKE experiment "Subthreshold K^- production" [1] requires the detection of K^- mesons. A detector system was constructed [2, 3] and the final setup of the detector elements and electronics was finished in summer 2002. It is placed partly inside the return yoke of the C-shaped D2 dipole magnet (stray field up to $\approx$ 200 mT) (Fig. 1). At the maximum field of D2 (1.6 T) negatively charged ejectiles can be measured in the momentum range from 120 to 1000 MeV/c. The horizontal and vertical angular acceptances are roughly: $\alpha_{hor}=\pm 12°$; $\alpha_{ver}=\pm 8°$ at 120 MeV/c and α_{hor}= -2° to 12°, $\alpha_{ver}=\pm 5°$ at 1 GeV/c.

With this detection system negatively charged pions can also be detected. Thus in combination with the positive detection systems additional reactions on elementary and nuclear targets can be investigated at ANKE.

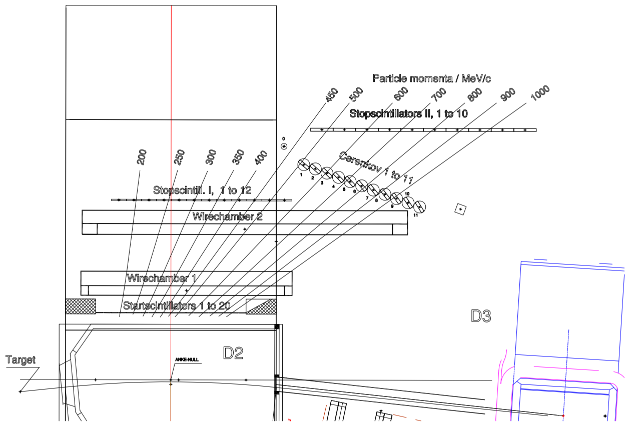

Fig. 1: The detection system for negatively charged ejectiles at ANKE.

For time of flight (TOF) measurements the system contains 2 mm thin START, 10 mm and 20 mm thick STOP scintillator counters for the low and high momentum region respectively. The measured time resolution between the START and STOP counters is about 1 ns, slightly inferior compared with the positive particle detector. This time resolution is insufficient to differentiate between π^- and K^- with momenta above 500 MeV/c. To obtain a better particle separation, dedicated curved Čerenkov counters are installed in front of the high momentum STOP counters. Two multi wire proportional chambers - the same construction as for the pos. charged ejectiles [2] - are placed between the START and STOP counters for the particle momentum reconstruction.

In Spring 2002 a first week of beam time to measure the reaction $pp \to pp\phi$ [4, 5] — without fully equipped Čerenkov counters — has been carried out with the new system. This short beam time also included time for the calibration of the detection system.

The momentum determination can be checked with the collected data itself. Here we use the fact that our fast TOF trigger electronics [6] for K^+X^- events is also open for $pp \to pK^+\Lambda$ events, which means that a proton and K^+ are detected in the pos. system simultaneously with a decay product from $\Lambda(1116)$, i.e. a π^-. Figures 2 a) and b) show the missing mass spectrum of pK^+, and $pK^+\pi^-$, respectively. The peaks of the Λ and proton are located at the correct mass within 0.5%.

For the time calibration we measured during several hours with an open X^+X^- trigger, which accepted mainly $\pi^+\pi^-$ or $p\pi^-$ events. The trigger was set up such that the start signal for the TDC modules is always derived from the STOP counter at the pos. side. This trigger allows an absolute time calibration of the neg. counters using track and momentum information.

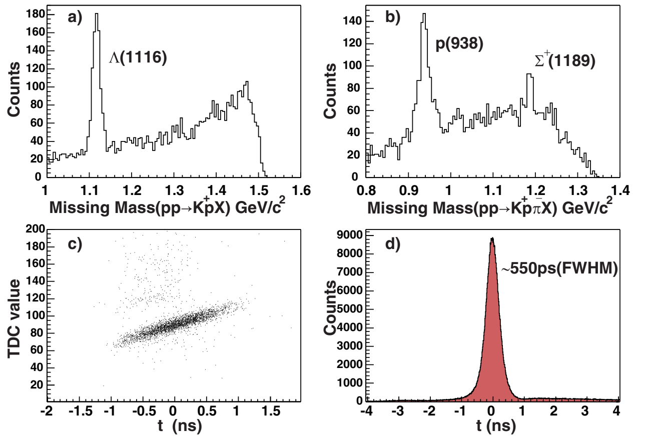

Fig. 2: Missing mass a,b) and time calibration c,d) spectra.

For this purpose we select a π^+ particle by TOF between pos. START and STOP counters - which is possible with a small background contribution. If one rejects scattered background by tracking, practically only π^- remain on the neg. side. The reconstructed momenta of the $\pi^+\pi^-$ pair can be used to calculate the absolute time difference. This can be compared with the TDC value obtained from the neg. counters (Fig. 2 c). The cleanly visible $\pi^+\pi^-$ band can be parameterised by a straight line. This absolute calibration allows one to identify the neg. particle, for a given pos. particle and the knowlegde ot the two momenta. The TOF from the target up to the neg. STOP counters follows from the TDC calibration and from the π^- momentum. Fig. 2 d) shows the difference between these two values. The sum of all pos. and neg. STOP combinations is given. The achived time resolution is $\approx$ 550 ps FWHM. The TOF differences between π^- and K^- from the target to the neg. STOP counters are in a range from 1.8 up to 5 ns. This allowes to separate K^- from π^- in the full accepted momentum range [5]. In the same way all the STOP detectors — incl. the forward detector — can be calibrated against a selected STOP counter.

References:

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