Luminosity determination at ANKE via the reaction pp $\rightarrow$ dπ^+

A. Khoukaz[a], N. Lang[a]

After the installation of the cluster target at the ANKE facility [1], first data on the single pion production in the proton-proton scattering have been taken at a beam momentum of 1.083 GeV/c using a hydrogen cluster beam as target. One aim of these test measurements was to investigate the possibility of using the reaction pp $\rightarrow$ dπ^+ as reference reaction for data normalisation purposes.

To extract events of the single meson production channels pp $\rightarrow$ dπ^+/pnπ^+, events have been selected with the signature of one detected π^+ meson in the side detector of the ANKE facility. The particle identification was performed using the time-of-flight information, obtained with the start and stop scintillation hodoscopes, and the corresponding energy-loss information in the scintillator hodoscopes. The momenta of the pions, observed in a set of two multiwire proportional chambers, were determined by tracing the tracks of the ejectiles back through the known magnetic field to the interaction point. By this, a four-momentum vector determination of the detected pions was possible and the missing mass of the system of unobserved particles could be calculated as demonstrated in Fig.1 (upper spectrum). As expected, on top of an almost flat background distribution, arising from the reaction channel pp $\rightarrow$ pnπ^+, a signal from the pp $\rightarrow$ dπ^+ reaction is clearly visible at the mass of the deuteron.

The observed structure of the missing-mass distribution reflects the segmentation of the stop scintillation hodoscope. Requiring a coincident detection of a deuteron hit in the scintillation hodoscope of the forward detector, an almost clean selection of dπ^+ events with a missing-mass resolution of 4.6 MeV/c^2 (FWHM) was possible (Fig.1, lower spectrum). The observed shift of the deuteron missing-mass peak by Δm = 3.6 MeV/c^2 corresponds to an inaccuracy of less than 0.2%.

To determine the luminosity, the differential cross sections of the corresponding reaction channel must be known and the number of extracted events has to be corrected for the acceptance of the detection system, which was determined by using Monte-Carlo simulations. For experimental reasons, during this test beam time both the target beam density as well as the COSY beam intensity have been far from optimal, resulting in a relatively low luminosity. Nevertheless, during the discussed test run nearly 47000 dπ^+ events have been accumulated in less than 7 hours of beam time, corresponding to a luminosity of $L = 5.8 \cdot 10^{28}$ cm^{-2}s^{-1} $\pm 8\%$ [2]. In following beam times with improved conditions, luminosities beyond $L = 10^{30}$ cm^{-2}s^{-1} have been reached [3]. Both the quality of the spectra as well as the good statistics in combination with a rich data base for the pp $\rightarrow$ dπ^+ reaction demonstrate the applicability of this method for the luminosity determination at ANKE.

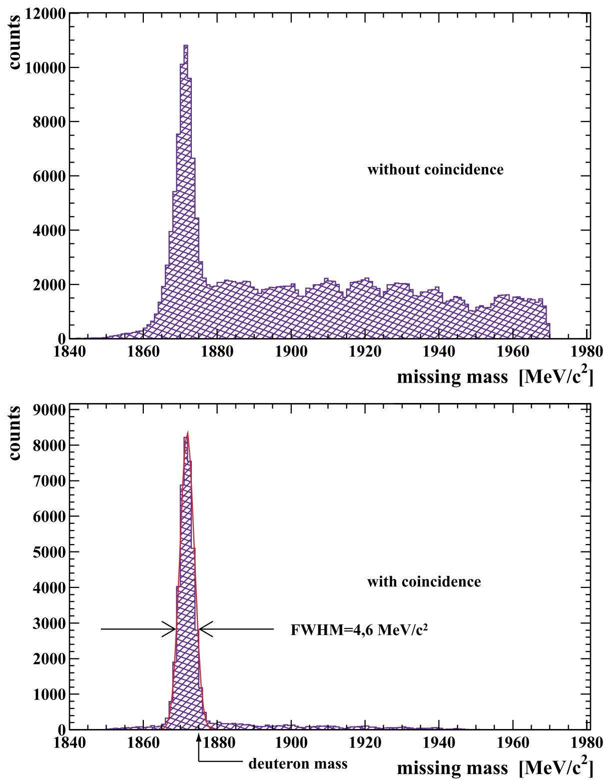

Figure 1: Missing mass distribution of the reaction pp $\rightarrow \pi^+$X at a beam momentum of p = 1.083 GeV/c for events with and without a coincident detection of a deuteron hit in the forward detector.

References:

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[2] N. Lang, diploma thesis, Westfälische Wilhelms-Universität, Münster, Germany, (2000).

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[a] Institut für Kernphysik, Westfälische Wilhelms-Universität, Münster, Germany