Determination of the Interaction Point at ANKE Using a Spectator Detector*

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The knowledge of the precise position of the ANKE spectator detector relative to the beam/target interaction point is essential for the data analysis using spectator kinematics. Here we present a method to determine this position using track information of scattered protons, detected in the spectator detector, which consists of three layers of silicon counters [1, 2]. Different to the unsegmented first layer the second and the third layers are segemented perpendicular to the COSY-beam direction and allow for a spatial resolution of particle hits. The second layer consists of 32 strips of 1 mm width and 15 mm length which are read out individually. The third layer consists of 200 strips which are read out by four resistor chains for 50 strips each. Particles with kinetic energies of 8 to 30 MeV can be detected and stopped with signals in all three detector layers.

To determine the position of the interaction point relative to the spectator detector arrangement, only protons are used, which have been identified by the $\Delta E/E$-information of the second and third layer. To minimize uncertainties on the particle trajectory introduced by angular straggeling in the detector material or influences of the magnetic field, protons with energies in the range of 20 to 30 MeV are favourable. In spite of this limitation the statistics is good enough to allow for a run by run analysis which enables to verify the COSY beam position at the interaction point steadily.

The idea of the method described is based on the principle of a pinhole camera. One of the strips of the second layer, acting as a pinhole, induces a picture of the interaction region on the third layer, as it is illustrated in Fig. 1. For each event the deflection angle α can be reconstructed using the hit information of the detector layers. In Fig. 2 the resulting angular distribution is presented for one fixed strip of the second layer. The gap at $\sim -1^\circ$ is an effect of the read-out electronics based on resistor chains. The observed shape of the distribution is mainly given by the differential cross sections for the reaction $pd \to pX$ as well as by the acceptance of the detection system. However, this shape is of minor importance for our method. Instead, to determine the position of the interaction point, only the knowledge of the borders of this distribution (vertical lines) is of interest. The arithmetic median of these limits is interpreted to correspond to trajectories originating from the center of the interaction point. In principle this method can be applicated for all strips of the second layer, leading to a set of independend measurements. However, for acceptance reasons some of the strips can not be used for this kind of analysis.

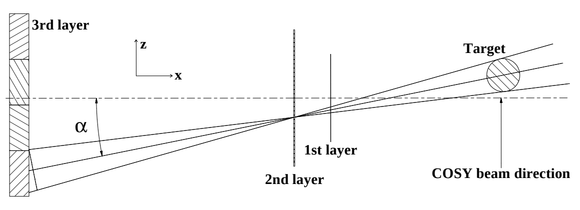

Fig. 1: Sketch of the spectator detector arrangement at ANKE.

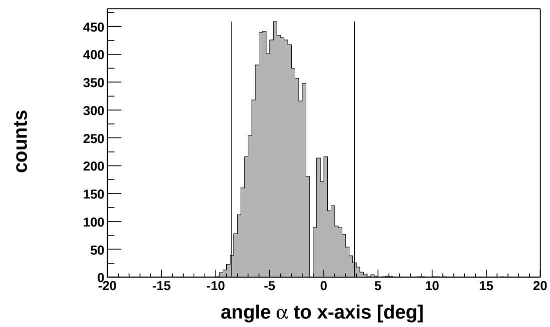

Fig. 2: Angular distribution calculated with the pinhole method for one fixed segment of the second spectator detector layer.

In Fig. 3 a few reconstructed trajectories are displayed relative to the centre of the 2nd layer. Obviously, the position of the centre of the interaction region can be extracted with high accuracy. The systematic error has been determinened to be ± 0.2 mm in z-direction (COSY-beam direction) and ± 2 mm in the x-coordinate. The statistical error is lower or similar in size. Therefore, a total uncertainty of less than 0.4 mm and 4 mm, respectively, can be achieved. Since for experiments using the spectator detector the precise determination of the z-position of the interaction region is of highest importantance, the method described here is highly suited for this purpose and can even be utilized during data taking to verify experimental conditions.

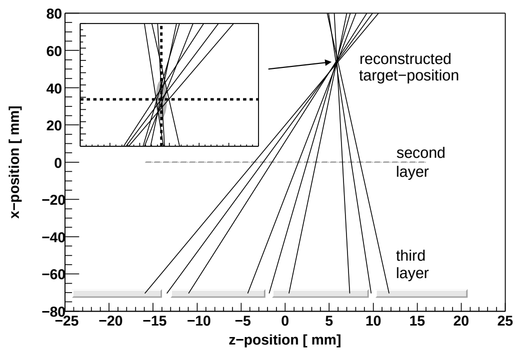

Fig. 3: Reconstruction of the interaction region at ANKE.

References:

[1] I. Lehmann, *Studies on a Detection System for spectator Protons at ANKE*, diploma thesis, Universität zu Köln, 2000.

[2] I. Lehmann, *ω Meson Production in the $pn \to d\omega$ Reaction at ANKE*, doctoral thesis, Universität zu Köln, 2003.

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