Reconstruction of Ejectile Momenta in ANKE Experiments

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For the analysis of data from ANKE experiments, the information from the start and stop detectors (the latter being positioned in the side-detection system close to the focal surface of the spectrometer dipole [1]) and from the hitted wires in two multi-wire proportional chambers (MWPC's) is utilized to determine ejectile momenta.
The momentum calibration of the spectrometer is performed with "monoenergetic" pions from the two-body reaction pp $\to$ dπ^+. Such calibrations have been made for telescopes 6 to 15 and for low values of the magnetic field in D2, $B = 0.6493 \ldots 0.8946$ T. The COSY-beam momenta were varied between 0.8262 and 1.1357 GeV/c. The π^+ momenta from the two-body reaction are then between 0.12078 and 0.35200 GeV/c, respectively. The momentum resolution is characteristic for the ANKE spectrometer, however, the accuracy of the obtained values depends on the method used for momentum reconstruction.
Fig. 1 shows the results of a simulation using the ANKE-GEANT [2] package. For stop detector #8, the dependence of the average ejectile momenta on the start detector number has been determined. The same tendency, which is observed for other detectors as well, is caused by the placement of the stop detectors a few cm in front of the focal plane of D2.

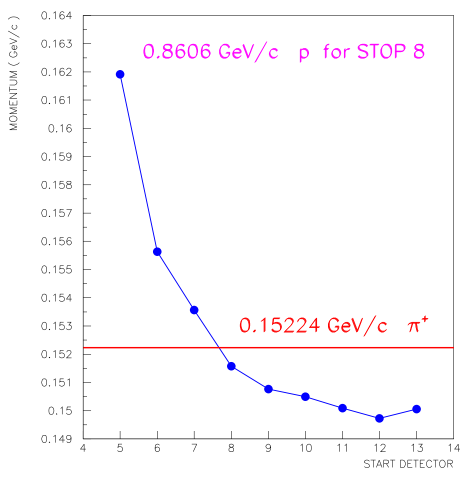

Figure 1: Dependence of the average ejectile momenta on the start-detector number, calculated for stop detector #8 and a proton-beam momentum of 0.8606 GeV/c. The momentum of 0.15224 GeV/c corresponds to the π^+ momentum from the two-body reaction 0.8606 GeV/c pp $\to$ dπ^+.

In Fig. 2 momentum distributions in the start detectors are shown for the 0.8606 GeV/c p+p reaction for stop detector #8. The calculated width of such distributions is ~9% and it is almost independent on the start-stop detector combination.
Typical simulated distributions of hitted wires from the 0.8606 GeV/c p+p reaction are shown in Fig. 3.

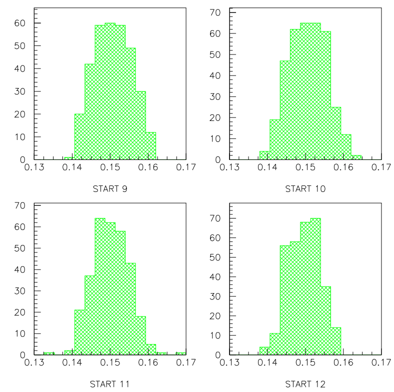

Figure 2: Simulated momentum distributions (in GeV/c) for pions from 0.8606 GeV/c p+p reactions observed for stop detector #8 and different start detectors

Such distributions can be used to find inaccuracies in positions of the ANKE detectors, the magnetic field shape, COSY beam momentum etc., by comparing the simulated with measured distributions. For example, a beam momentum error of 1 ‰ causes a π^+ -momentum difference between 7.0 and 2.3 ‰ at a beam momentum of 0.8262 GeV/c (value used to calibrate stop detector #6) and 1.1357 GeV/c (stop detector #15), respectively.

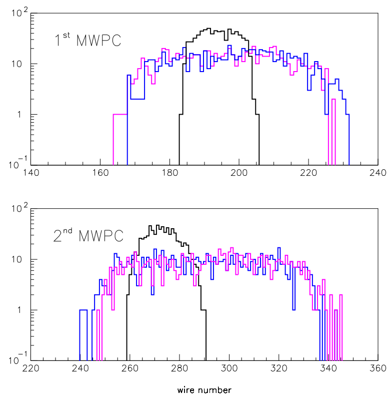

Figure 3: Simulated distributions of hitted wires in the 1st (upper) and 2nd (lower) MWPC in the 0.8606 GeV/c p+p reaction for start detector #8 and stop detector #8. The narrower distribution corresponds to the plane with vertical wires in chambers, the broader one - with inclined.

To obtain the momenta of ejectiles detected in a certain stop detector, it is assumed that there is a unique dependence between the momentum and the 6 hitted wires in the two MWPC's. A 2nd order polynomial of 6 variables with 28 coefficients is fitted through a set of simulated data points (were the ejectile momenta are known) with standard MINUIT.

The accuracy of the momentum reconstruction is estimated in the following way: if we look for the hitted wires and allow for a difference in their numbers not larger than 2 between wires in the same plane (this corresponds to realistic estimations of experimental determination of the hitted wires), an accuracy of the momentum reconstruction was found not to be lower than 2.4% with multiple scattering included into simulations and 2.0% without. The value from simulations with multiple scattering included depends on the start detector and in most cases is about 3%. Fig. 4 shows a distribution of the momentum difference for simulations of the 0.8606 GeV/c p+p reaction.

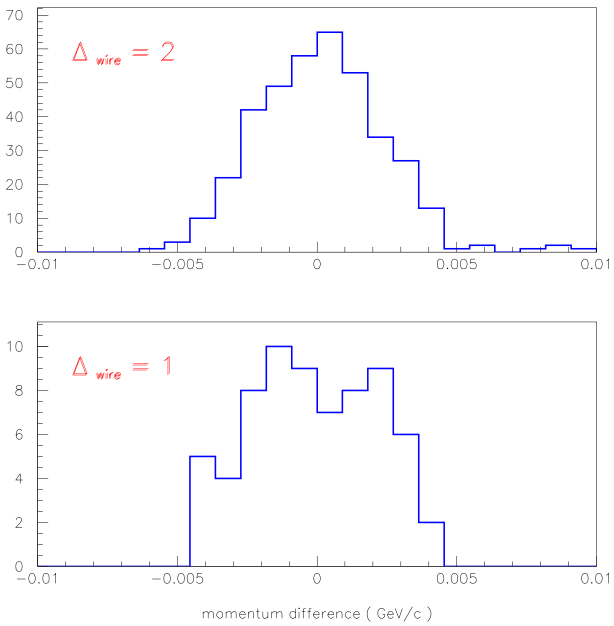

Figure 4: Momentum difference for the 0.8606 GeV/c p+p reaction observed in stop detector #8 and start #13 for the difference in hitted wire number equal to 2 (upper) and 1 (lower). The resulting momentum resolution (FWHM) is ∼3%.

Coefficients which are obtained from ANKE-GEANT simulations can be then used to reconstruct momenta from measurements but only for the set of events which fulfill conditions applied in simulations, especially only events with the same vertical and horizontal angle distributions must be chosen. Fig. 5 shows the reconstructed π^+ momenta, both for simulated and measured two-body events. It can be seen that the resolution for measured data is slightly worse than the expected value. The reconstructed momentum resolution is independent on the particle type in the simulations. The momentum range of particles in the simulations should be broader than the expected momentum spread in the investigated stop detectors.

Information about the ANKE geometry and all programs necessary to make momentum reconstruction can be found under the following address: http://ikpd15.ikp.kfa-juelich.de:8085/doc/Anke.html.

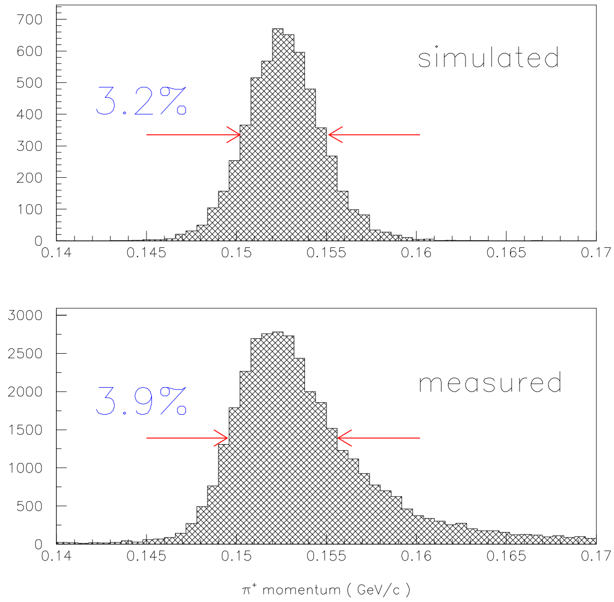

Figure 5: Reconstructed momenta of π^+ from the 0.8606 GeV/c p+p two-body reaction (simulated and measured events). The coefficients were calculated for stop detector #8 and start detectors #7,8 and then applied for stop detector #8 and all start detectors.

References:

[1] M.Büscher et al., contribution to this report, p.

[2] I.Zychor, Annual Report 1999 of the IKP, FZ Jülich (2000), p.23

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