Reconstruction Efficiency for Close Tracks in the COSY-11 Drift Chambers

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The COSY - 11 detection system is suited to investigation of close to threshold meson production in proton-proton or proton-deuteron collisions [1]. Close to threshold all outgoing particles are in a small cone in the laboratory and can be registered by means of relatively small detectors. However, the registerd signals from two particles that are too close together may be undistinguishable from the signals produced by one particle. This is because of the finite granularity of the detector used. Specifically, it means that instead of two tracks, only one is reconstructed from the signals registered by the drift chambers. If the distance Δx (see figure 1) between particles crossing the same cell at the same time is smaller than some minimum value (called the two track resolution) then only one signal will be registered by the corresponding sense wire. Thus, if this happens in many planes simultaneously, the reconstruction of both tracks is impossible.

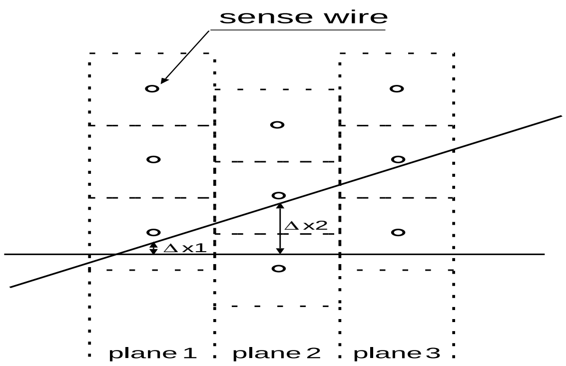

Figure 1: A schematic view of the three planes of the drift chamber. If the distance between two tracks in a given plane is smaller than some minimum value, then only a one signal will be detected on the sense wire in this plane.

The calculation of the absolute cross sections for the measured reactions requires exact knowledge of the reconstruction efficiency. As an example figure 2 shows the efficiency of the two track reconstruction as a function of the two track resolution in case of the $pp \to pp\eta'$ reaction for three different beam momenta. One sees, as expected, that the worse the resolution the smaller the reconstruction efficiency. It is worth noting that the efficiency decreases as the beam momentum reduces. This is because the mean distance between outgoing particles gets smaller. In particular for the $pp \to pp + Meson$ reactions the efficiency would be close to zero at threshold . Figure 2 shows that reconstruction efficiency in the case of the $pp \to pp\eta'$ reaction depends strongly on the two track resolution. Therefore the determination of this parameter is of crucial meaning to the calculation of the absolute cross section.

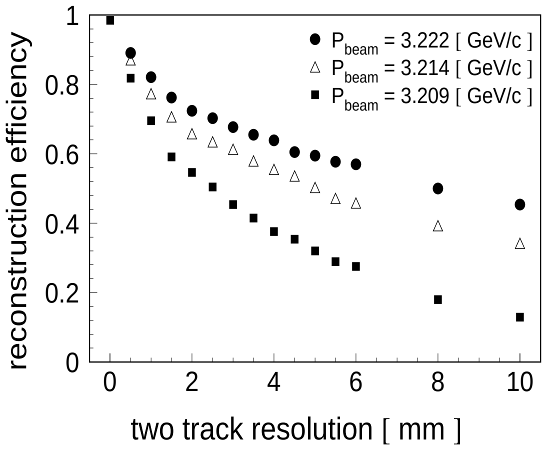

Figure 2: Efficiency of the two tracks reconstruction versus the two track resolution defined in the text. The calculations were performed for the $pp \to pp\eta'$ reaction at three different beam momenta. The threshold beam momentum of the $pp \to pp\eta'$ reaction is 3.2083 GeV/c.

In order to estimate the two track resolution for a given plane of the drift chamber used, the sample of events with two tracks was studied. For each event the distance between the tracks within the studied plane, and the number of real signals in this plane was calculated. Further more, for a given distance the ratio of the number of events with two signals to the number of all two track events was computed (see figure 3). For each event having distance between tracks (in the studied plane) larger than the two track resolution at least two signals should be observed. Thus this ratio should be equal to one for distances larger than the two track resolution and equal to zero for smaller distances. In figure 3 one sees that this ratio is equal to one for distances larger than 4 cm, which corresponds to the relevant dimension of the drift chamber cells. For the distances smaller than 4 cm the ratio is about 0.95 and at 0.3 mm drops suddenly to zero. Thus figure 3 indicates that the two track resolution of the studied plane is equal to 3.0±0.5 mm. The same value was obtained for all planes of the drift chambers used at the COSY - 11 experiment. This means, for example, that the reconstruction efficiency for the measurement at the beam momentum of 3.214 GeV/c amounts to 0.61±0.03 (see figure 2).

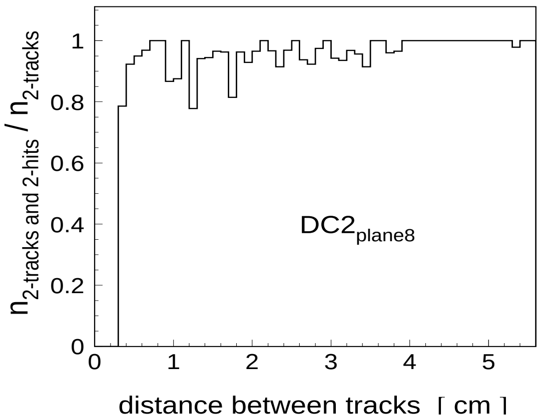

Figure 3: The number of events with two tracks and two hits divided by the number of events with two tracks as a function of a distance between tracks in the eighth plane of the second drift chamber.

References

[1] S. Brauksiepe et al.,
Nucl. Instr. & Meth. **A 376** (1996) 397