

Experimental and simulated response of ScFi detector

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Abstract

Response of fiber detector (ScFi) for two close particle is essential for “atomic” pair detection in DIRAC experiment. Comparison of an experimental and simulated response of ScFi has been performed.

Introduction

Essential fraction of “atomic” pairs ($\sim 50\%$) have small distance (1 or 2 columns) at the level of X- or Y-planes of fiber detector. It is known that PSC algorithm could suppress signal from one of the particle in the case of two neighbours columns hit by pair [1]. Therefore it is needed to be sure that present simulation of PSC algorithm provides correct description of PSC efficiency as function of distance between particles of pair.

In 2002 third plane (W-plane) of ScFi detector was introduced. For DIRAC experiment geometry it is possible to defines track parameters with two planes (“tool planes”) only and propagates track coordinates to the third plane which is under investigation. All ScFi planes are close one to another. This fact decreases influence of the multiple scattering to the accuracy of coordinate propagation. Also different angles of rotation for planes (0° for X-plane, 90° for Y-plane and 45° for W-plane) allow us to select tracks which are relatively far in the “tool planes” but could be close in investigated plane. It excludes PSC effect from track parameter measurements.

1 Accuracy of prediction

For calculation of track coordinates in investigated planes and their error estimation the Kalman filter procedures “propagation” and “smoothing” have been used. In Fig. 1 accuracy of a single track coordinate prediction is shown for all 3 planes. It is seen that the best accuracy is for W-plane because orthogonal X- and Y- planes provide better space reconstruction of track parameters than pair X- and W-planes in Y-projection and Y- and W-panes in X-projection.

2 Comparison with simulation

For investigation of experimental PSC response ARIANE selects events which have only one track in each arm. Investigated plane is excluded from tracking. Only one upstream candidate is allowed per track in DC. Also program rejects events if there are common hits in fiber detector for two tracks. Additional criterion is presents of hits in planes of DeDx.

For selected events tracks are propagated to the investigated plane. Program finds hits in the region ± 1 mm around each track coordinate. List of hits is checked to exclude double counting.

For simulated events procedure is slightly simplified. Particle coordinate at the plane is known a priori. Program only adds random number with RMS equals to coordinate resolution for experimental measurement. Because of small momentum dependence the fixed values $\sigma_X = 245 \mu\text{m}$, $\sigma_W = 142 \mu\text{m}$ are used.

Fig. 2 shows probability to find 0, 1 or 2 particles in expected regions as function of distance between tracks in X-plane. Solid line is experimental measurements, dashed line is simulation. It is seen that simulated probability to find 1 (Fig. 2b) and 2 particles (Fig. 2c) are very close to experimental data. For the case of absence of both signal (Fig. 2a) experimental dependence is higher if coordinate difference corresponds to two neighbours columns hit by pair. It means that simulation underestimates possibility of mutual decreasing of amplitudes to the level below threshold. But integrally this effect small even for this region.

Fig. 3 and Fig. 4 presents results of investigation for Y-plane and for W-plane correspondingly. It is seen that results of Y-plane are very similar to X-plane. W-plane behavior is different due to another construction [2]. Simulation for W-plane is not tuned yet. Therefore there is a difference in experimental and simulated efficiency.

Conclusions

From above it is seen that simulation of PSC response in X- and Y-planes has good quality and there is possibility to provide correct simulation for W-plane.

[1] B. Adeva et al., "Detection of pi+ pi- atoms with the DIRAC spectrometer at CERN", J. Phys. G: Nucl. Part. Phys. 30 (2004) 1929.

[2] B. Adeva et al., "DIRAC: A high resolution spectrometer for pionium detection", Nucl. Instr. Meth. A515 (2003) 467.

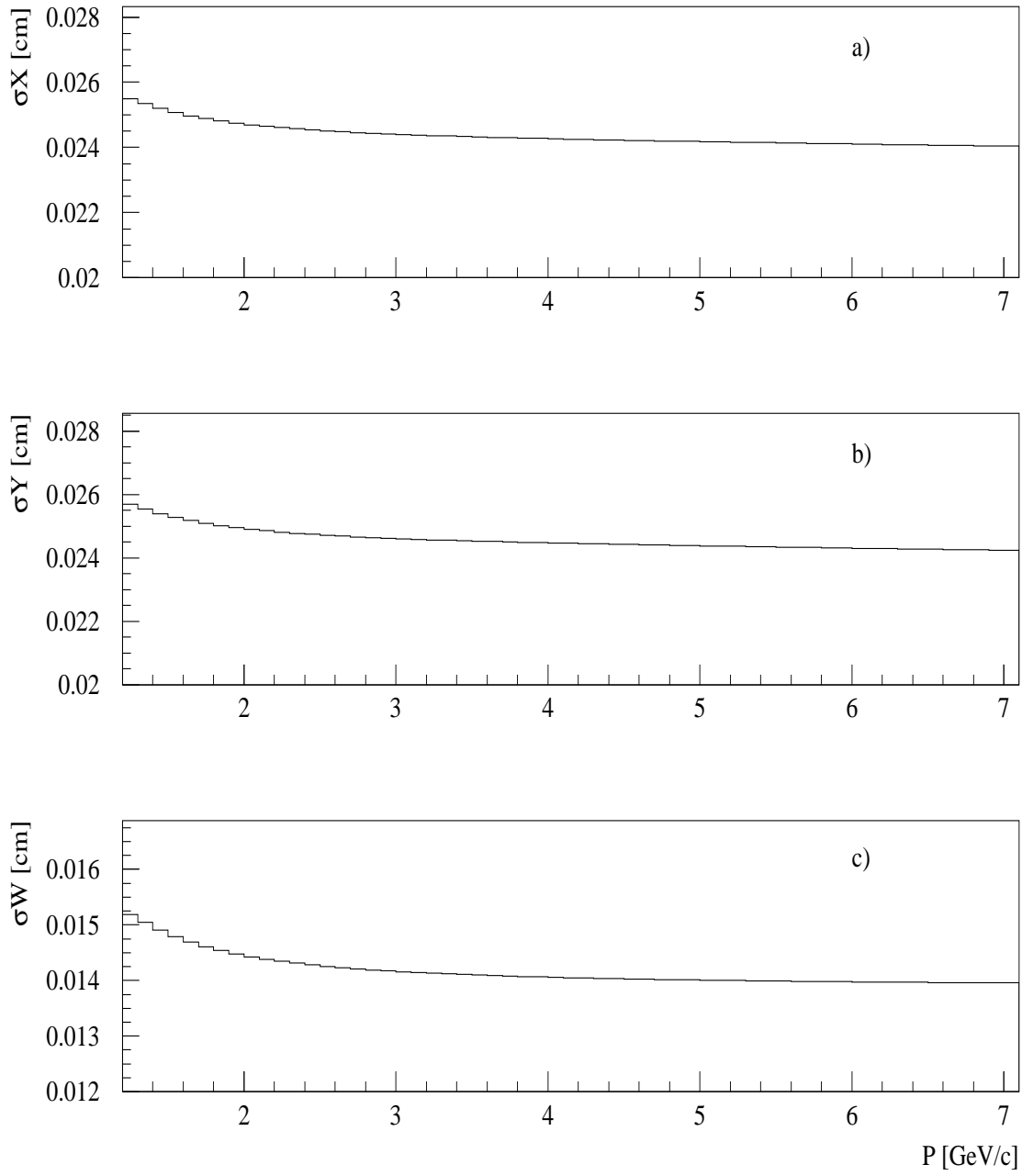


Figure 1: Dependence of track coordinate prediction accuracy on a particle momentum for different planes of fiber detector: (a) X-plane , (b) Y-plane and (c) W-plane.

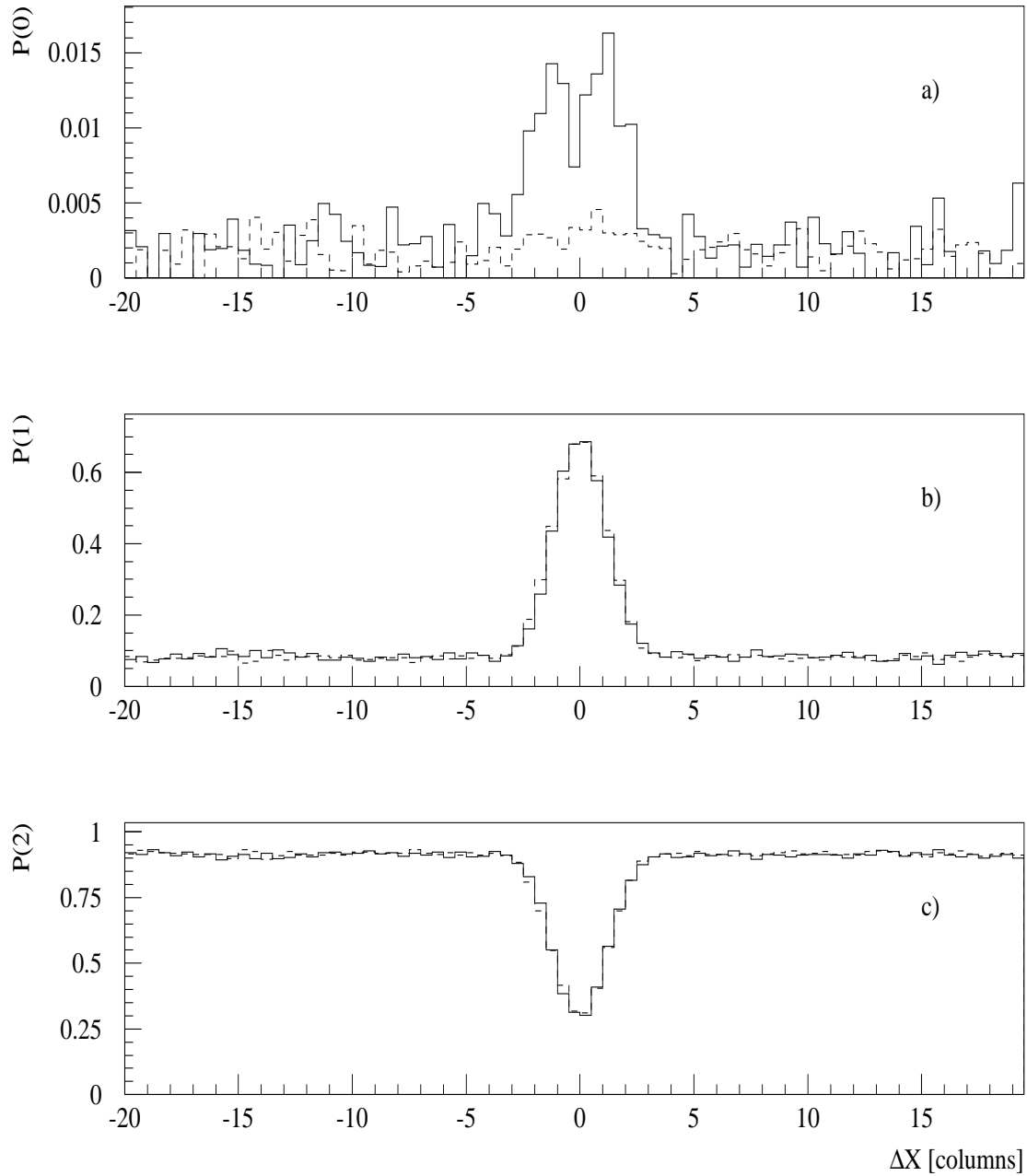


Figure 2: Probability to find 0 (a), 1 (b) or 2 (c) hits in the region where two tracks point out to the X-plane of fiber detector. Probabilities are shown as function of estimated coordinate difference of pair at the X-plane by solid line for experimental data and dashed line for simulation.

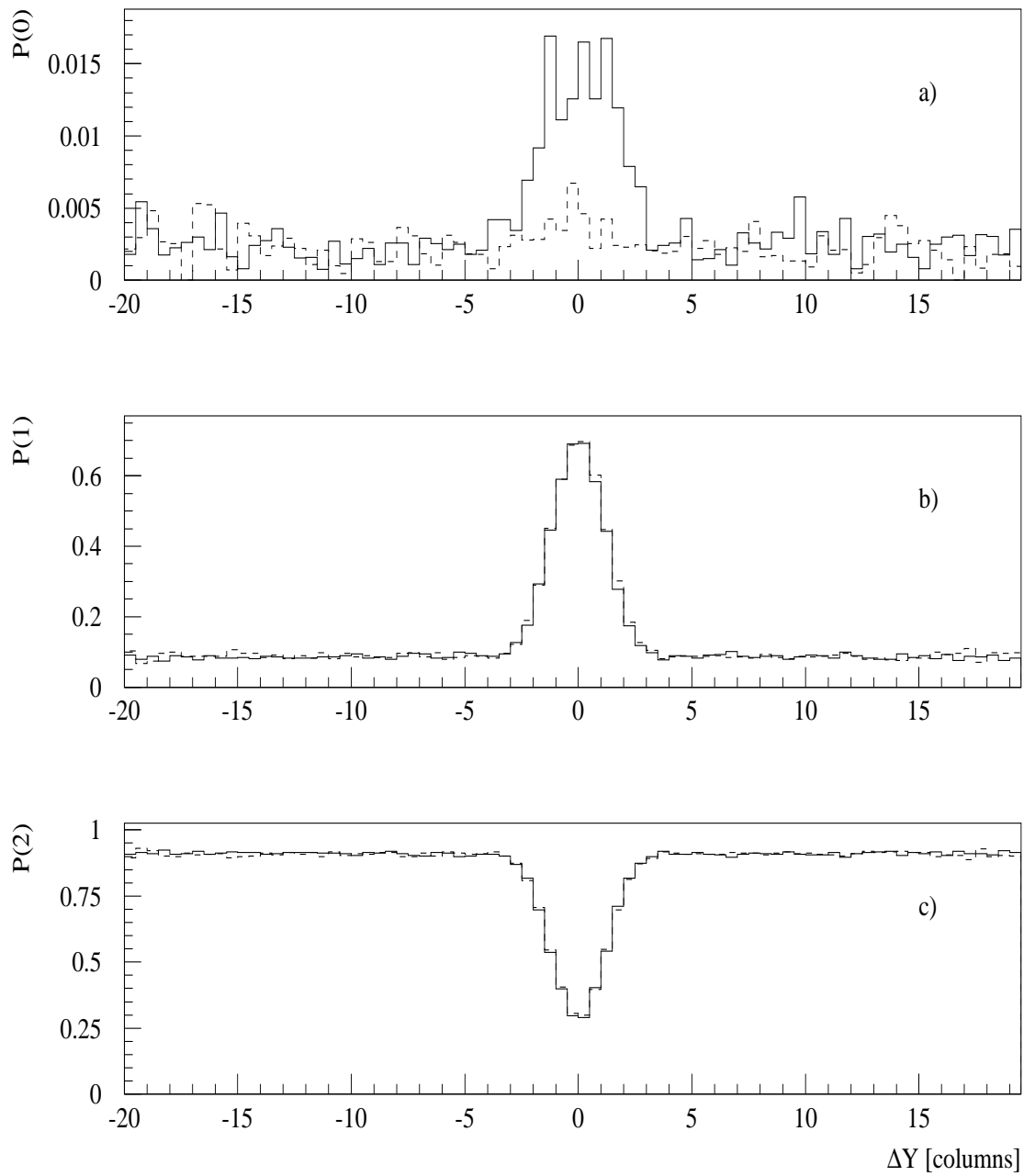


Figure 3: Probability to find 0 (a), 1 (b) or 2 (c) hits in the region where two tracks point out for Y-plane of fiber detector. Probabilities are shown as function of estimated coordinate difference of pair at the Y-plane by solid line for experimental data and dashed line for simulation.

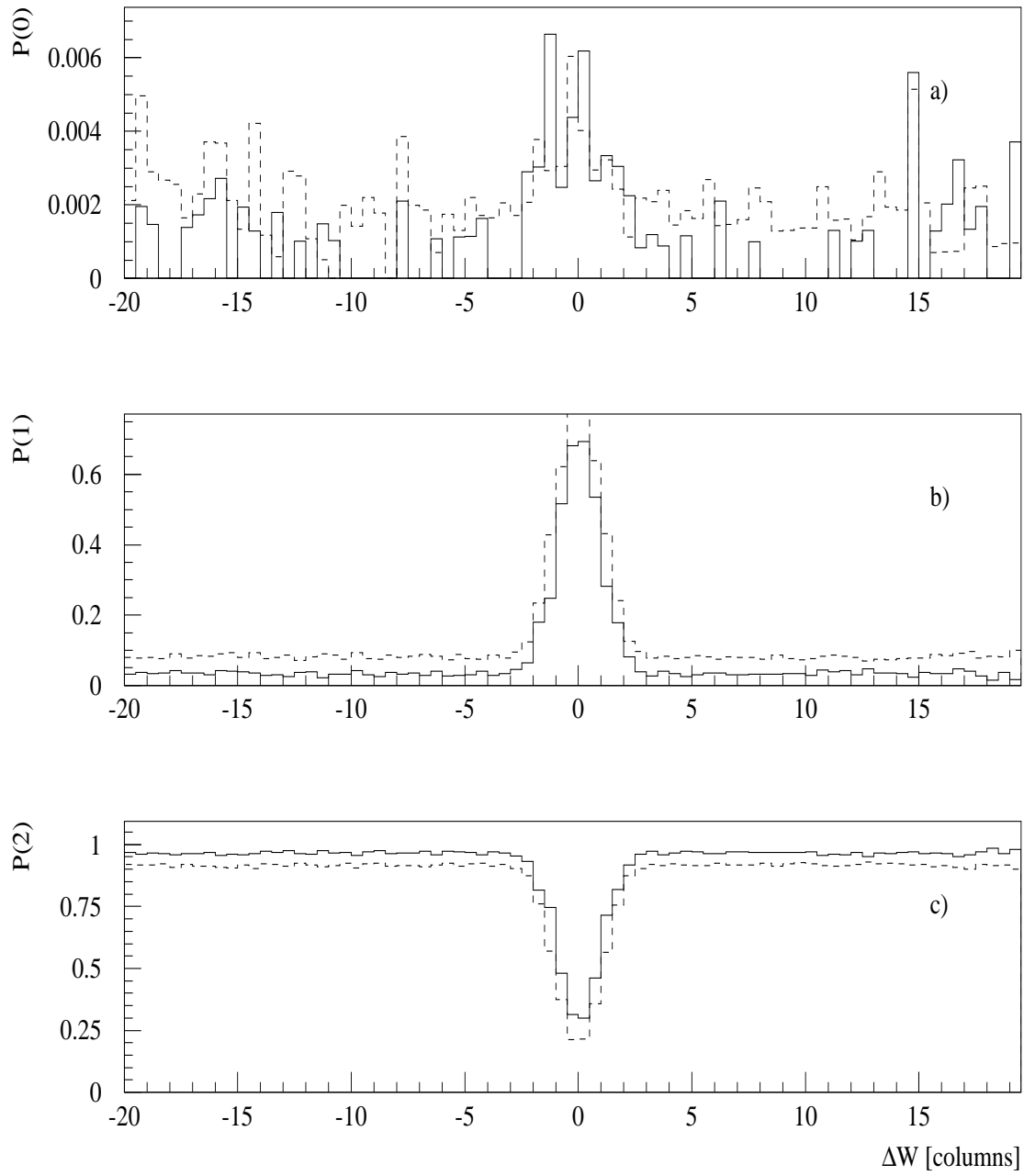


Figure 4: Probability to find 0 (a), 1 (b) or 2 (c) hits in the region where two tracks point out for W-plane of fiber detector. Probabilities are shown as function of estimated coordinate difference of pair at the W-plane by solid line for experimental data and dashed line for simulation.