Estimation of the ANKE STT tracking efficiency from experimental data*

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During the last decade two Silicon Tracking Telescopes (STT) designed for the detection of low energetic particles have been successfully exploited as a polarimeter in several experiments carried out by the ANKE and the PAX collaborations. In contrast to this application, the use of STTs as the detector of "spectator" protons in experiments aimed to study a process in the quasi-free kinematics requires more accurate quantitative understanding of the STT acceptance.

Results presented below were obtained from experimental data taken at ANKE using the proton beam and the deuterium cluster target. Two STTs were installed at 3cm distance to the left and to the right from the beam axis. The self-trigger from STT detectors was used to record the data. Since each STT consists of 3 position-sensitive (segmented) detectors, the self-triggering option allows to reconstruct the track in one STT using information from 2 detectors only, one of which must be the detector generating the self-trigger signal. This one was recognized from the time information recorded in the TDC. Finally, events with 1 track reconstructed per one pair of detectors were selected and used in further analysis.

Now, the efficiency of detector which was not involved into the track reconstruction can be investigated if one makes sure that the reconstructed track hits this detector. The last requirement is automatically fulfilled when the track is produced by a particle stopped in the last 3d (5mm thick) detector of STT. Moreover, in this case the expected energy loss in the 1st (70 μm thick) or in the 2nd (300 μm thick) detectors can be calculated as well as the expected position of the track intersection point. However, to be sure that the selected track hits the 3d detector, energy losses in the 1st and in the 2nd detectors have to be limited within such intervals where the particle identification is not possible.

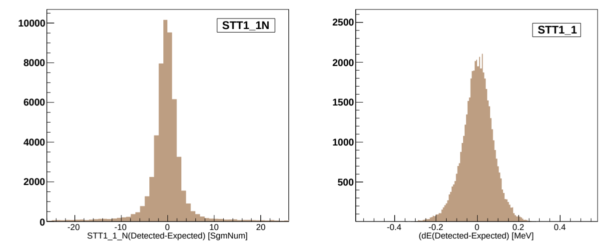

Fig. 1: Distributions of positions (left panel) and energy losses (right panel) of clusters found in the 1st detector of STT1 with respect to the intersection position and expected energy loss calculated for tracks reconstructed using the 2nd and the 3d detectors.

The accuracy of calculated intersection point position and the expected energy loss was verified by the comparison with positions and energy losses of clusters found in the detector under test in the same event. All distributions of differences between calculated and corresponding measured values were found to be similar to ones presented in Fig. 1. The uncertainty of intersection point calculation in other detectors is smaller because the distance between the 2nd and the 3d detectors is about 10mm while it is about 20mm between the 1st and the 2nd ones. However, the FWHM of similar position difference distributions were not less than 2.5 segments, anyway. Therefore, the detector under test was considered to be effective when the appropriate cluster was found within some area in vicinity of the calculated intersection point. This area have been chosen for each detector from distributions similar to ones shown in Fig. 1.

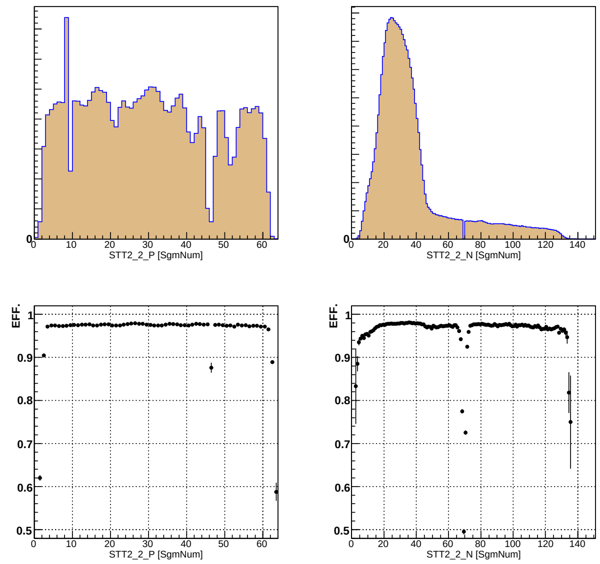

Fig. 2: Distributions of clusters found in the 2nd detector of STT2 along segments on different surfaces are shown in upper panels. Segments on the N-side are vertical while on the P-side they goes along the beam direction. Efficiency distributions along the detector surfaces are presented in lower panels. Note that the efficiency determined for one segment in the P-side (or in the N-side) is integrated over all segments on the opposite detector surface. In addition, the efficiency is integrated over total available energy loss range.

Despite the efficiency defined in such manner is convoluted over several neighboring segments, it is not crucial for the analysis of a process measured in quasi-free kinematics when the efficiency is smoothly changing over detector acceptance. As one can see from Fig. 2, the efficiency of properly operating detector remains nearly constant even when the count rate is strongly varying across the acceptance. However, near detector edges and in vicinity of broken segments the efficiency turns to be underestimated. In the simple case when one broken segment is surrounded by fully operating ones (see, for example, the segment 69 in the right column of Fig. 2) the efficiency of neighboring segments can be partially corrected taking into account that the broken segment must not respond. Excluding segments near detector edges and non-working segments, average efficiencies of 2nd and 3d detectors in both the STTs were found to be about 97%. However, efficiencies of the 1st (70 μm thick) detectors, where the dE-range below 1 MeV could be only tested with particles stopped in the 3d detector, did not exceed 87%.

In summary, the procedure which can be used as an effective tool for an estimation of the STT acceptance performance was developed though some improvement is still required to investigate the efficiency of the 1st detectors.

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