Charge sharing in micro-strip sensors: experiment and simulation*

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In December 2013 [1] and December 2014 [2] a prototype setup of the Silicon Tracking Systerm (STS) for the CBM Experiment was tested in a 2.4 GeV/c proton beam at the COSY synchrotron (Jülich, Germany). In the middle station, which could be rotated around its vertical axis, CBM05 prototype sensors (n-side with 0^0 stereo-angle, p-side with 7.5^0, 285 ± 15 μm thick) were under a test aiming at studying charge sharing. The n-XYTER read-out chips were triggered by a hodoscope. The equivalent noise charge of about 8 ADC promoted adapting the threshold of 20 ADC in the cluster finder to cut off the noise.

Charge sharing between two fired strips is described by $\eta = S_R/(S_R + S_L)$ with $S_{R(L)}$ being the signals on the right (left) strip of the cluster [3]. The left panel in Fig. 1 shows the measured distribution of η. Positions and widths of the peaks depend on characteristics of the sensor and the readout electronics (e.g. strip pitch, signal-to-noise ratio, coupling capacitance, threshold, etc.). For inclined tracks the η-distribution is essentially asymmetric. The position of the cluster with respect to the left strip can be calculated as $x_\eta = p\left(\int_0^\eta \frac{dN}{d\eta'}d\eta'\right)\left(\int_0^1 \frac{dN}{d\eta'}d\eta'\right)^{-1} = pf(\eta)$, where p is the strip pitch and $f(\eta)$ is obtained from measurements (see the right panel of Fig. 1).

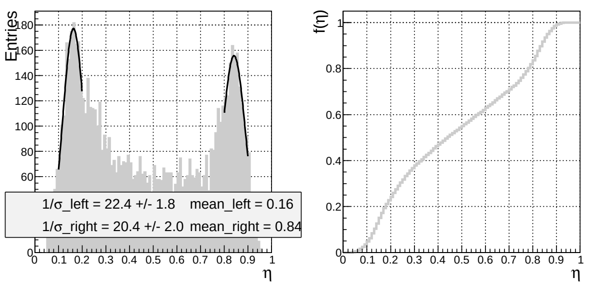

Figure 1: *Left:* η measured for p-side of CBM05 with Gaussians fitting the peaks. *Right:* $f(\eta)$. Perpendicular tracks.

Investigating cluster size distribution at different beam incidence angles is a good tool to verify the simulations of charge sharing in a silicon strip detector (implemented in the advanced model of the digitizer in CbmRoot). Figure 2 presents a typical distribution at one angle. Assuming the n-XYTER calibration [4] to be accurate, we get the reconstructed charge (Fig. 3) smaller than the one modelled. This indicates additional effects. Imposing 20% less charge from the sensor than expected from its thickness alone (on top of the 5% loss due to the trigger signal delay affecting the signal sampling in the ASIC) yields a better agreement. This is still to be explained.

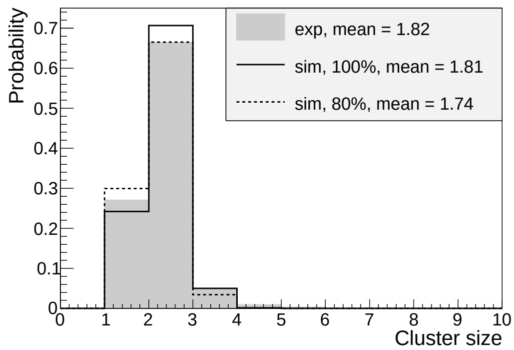

Figure 2: Cluster size distribution for slightly inclined tracks (10^0). Experimental data for n-side (the gray filled histogram), simulations with no (the solid line) and 20% (dashed) additional charge loosing.

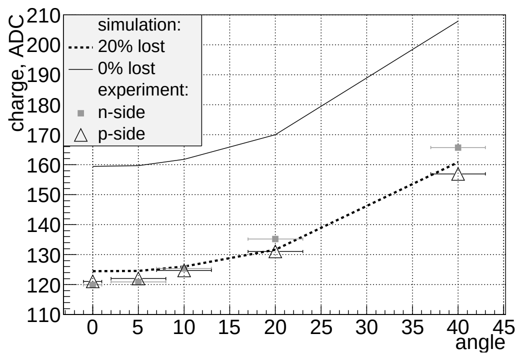

Figure 3: Most probable registered charge in dependence of track angles. The points show the experimental data from beamtime 2013 (the open triangles – p-side, the filled squares – n-side, the uncertainties in the angle measurements are drawn with bars) and the modelled data are represented by the lines (the solid line – no charge losses in the sensor, the dashed – 20% losses).

References

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