Performance simulations of the Silicon Tracking System of the CBM Experiment at FAIR

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Silicon Tracking System facts

- Free-streaming read-out
- 10 MHz HIC interaction rate
- 10 MHits/cm² hit rates
- Ultra-low material budget ≤ 1% $X_0$
- Event multiplicities up to 1000 charged particles / collision
- \(~25\,\mu m\) spatial resolution
- \(~10\,ns\) time resolution
- \(2.5^\circ < \theta < 25^\circ\) acceptance
- 300 \(\mu m\) DSSD thick sensors
- $\Delta p/p \approx 1 - 2\%$
- 2, 4, 6, 12 cm long strips

STS performance simulations are shown for three major study cases:

Sensor thickness

Influence of increased sensor thickness (300\(\rightarrow\)400\(\rightarrow\)500 \(\mu m\)) around the beam-pipe was studied.

Increase of material budget of the 7\(^{th}\) station

Increase of the signal to noise ratio w.r.t. cluster size.

Track reconstruction efficiency

Momentum resolution

Minor decrease of track reconstruction efficiency (left panel). Deterioration of track momentum resolution (right panel).

Delta electrons

Delta electrons originate from beam-target interactions. Energetic \(\geq 10\,MeV\) can reach the STS detector stations introducing background and impeding tracking. Have to be shielded:

Monte Carlo hits distribution for charged particles in the STS detector planes number 0 and 4 for current (left panel) and updated (right panel) geometries. A significant clean-up is achieved with effect to tracking.

Noise performance

Detector response (digitization):
- Converts Monte Carlo transport to simulated read-out signal
- Time-based generation of noise similar to real read-out

Different signal digitization thresholds investigated w.r.t. noise RMS level. The noise is suppressed substantially while almost no signal from charged particles is cut.

Double-sided Silicon microstrip sensors

Sensor thickness

Delta electrons

Noise performance