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

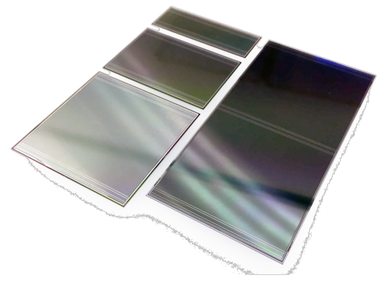
Evgeny Lavrik, for the CBM Collaboration
Facility for Antiproton and Ion Research, Darmstadt, Germany

CBM at FAIR

Compressed Baryonic Matter experiment

Silicon Tracking System facts

- Free-streaming read-out
- 10 MHz HIC interaction rate
- 10 MHits/cm^2 hit rates
- Ultra-low material budget ≤ 1% X_0
- Event multiplicities up to 1000 charged particles / collision
- ~25 µm spatial resolution
- ~10 ns time resolution
- 2.5°< θ <25° acceptance
- 300 µm DSSD thick sensors
- Δp/p ≈ 1 – 2%
- 2, 4, 6, 12 cm long strips

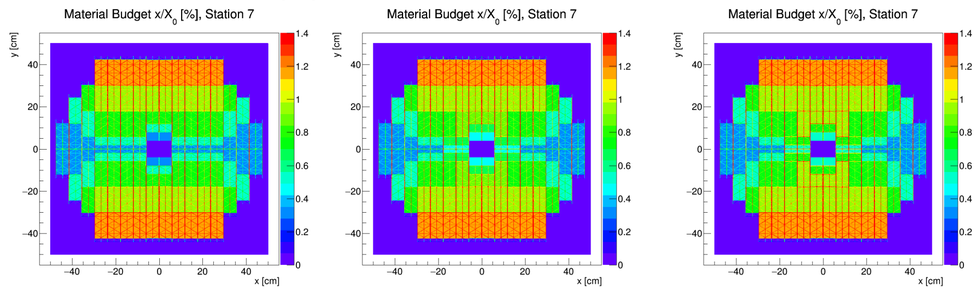


Double-sided Silicon microstrip sensors

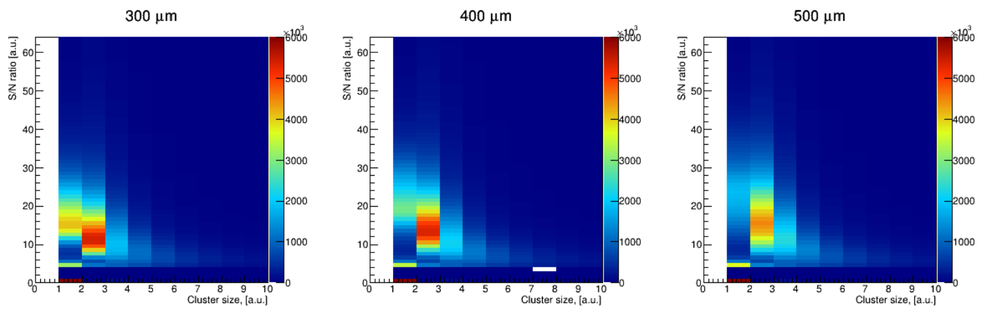
STS performance simulations are shown for three major study cases:

Sensor thickness

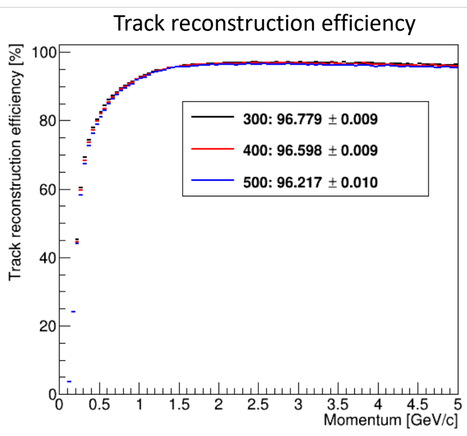
Influence of increased sensor thickness (300→400→500 µm) around the beam-pipe was studied.

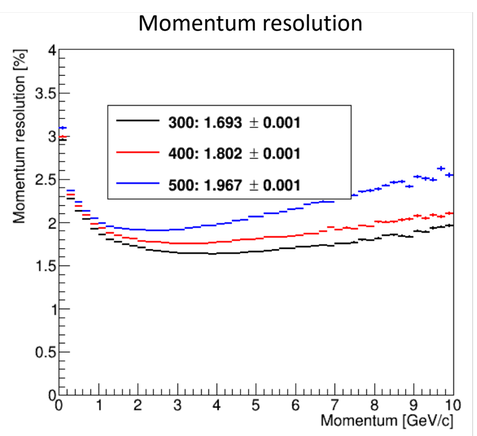


Increase of material budget of the 7th station

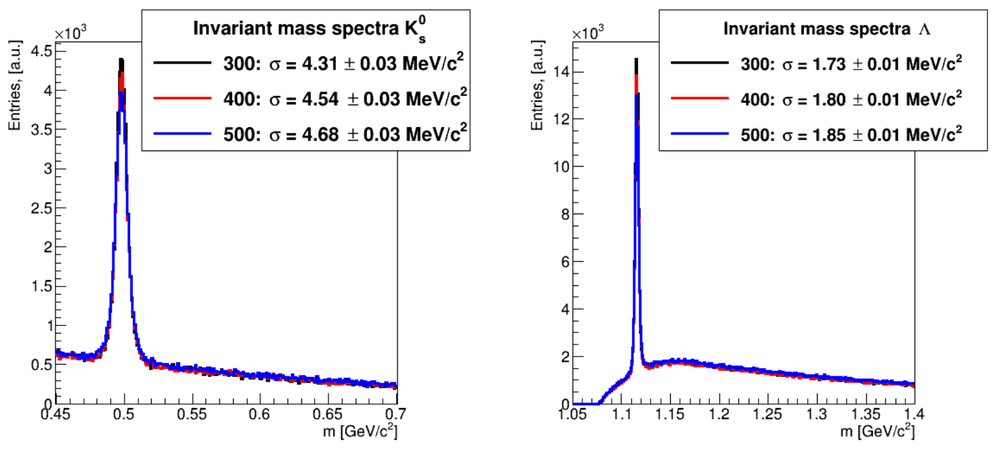


Increase of the signal to noise ratio w.r.t. cluster size.





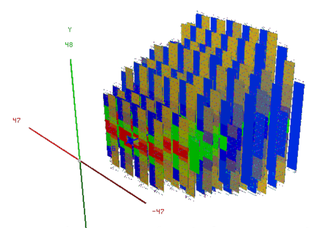
Minor decrease of track reconstruction efficiency (left panel).
Deterioration of track momentum resolution (right panel).

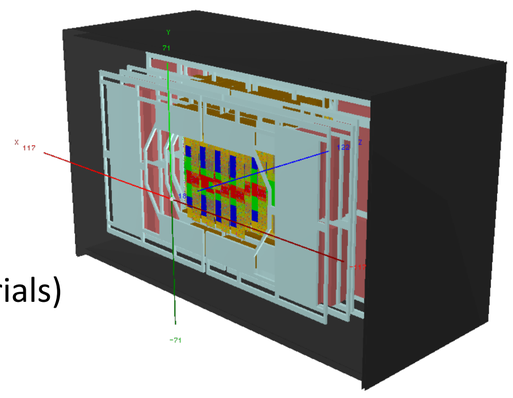


Reconstructed invariant mass spectra for short-lived particles K^0_S (left panel) and Λ (right panel). Widths of the distributions broaden due to momentum resolution.

Delta electrons

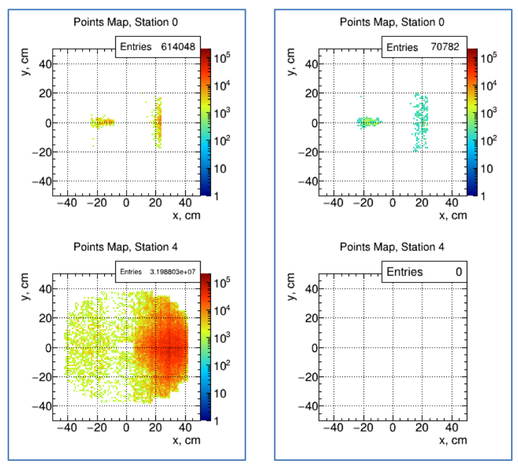
Delta electrons originate from beam-target interactions. Energetic (≳ 10 MeV) can reach the STS detector stations introducing background and impeding tracking.
Have to be shielded:





Old and new (with passive materials) simulation geometries

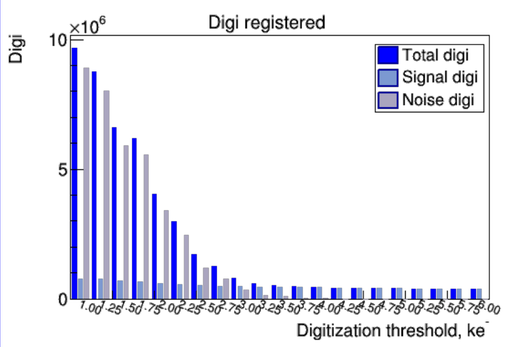
Monte Carlo hits distribution for charged particles in the STS detector planes number 0 and 4 for current (left panel) and updated (right panel) geometries. A significant clean-up is achieved with effect to tracking.

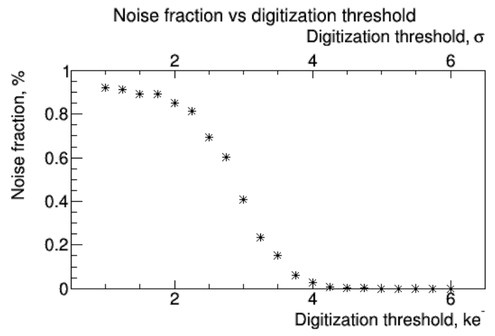


Noise performance

Detector response (digitization):

- Converts Monte Carlo transport to simulated read-out signal
- Time-based generation of noise similar to real read-out
- Accounts for:
  - ➢ Charge diffusion
  - ➢ Cross-talk
  - ➢ Lorentz shift
  - ➢ Energy loss models





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.

HELMHOLTZ SPITZENFORSCHUNG FÜR GROSSE HERAUSFORDERUNGEN

GSI FAIR