

# Development of Radiation Hard Silicon Sensors for the CBM Silicon Tracking System Using Simulation Approach



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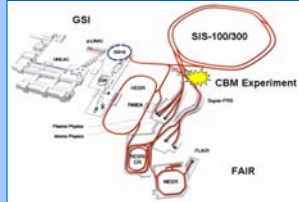


## Study of Super-Dense Baryonic Matter with Heavy-Ion Collisions at FAIR/SIS-300

Facility for Anti-proton and Ion Research,  
Darmstadt, Germany

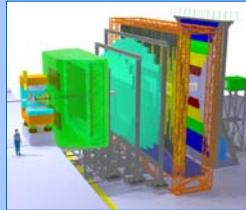
Compressed Baryonic Matter Experiment

High-rate, high-multiplicity environment

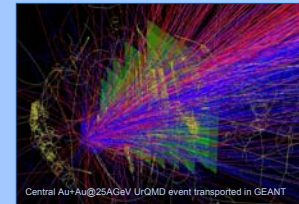


**Heavy-Ion Synchrotron SIS-300:**

- magnets: 300 Tm bend
- high-intensity DC beam  $10^9$  ions/s at CBM
- max. beam energies:
  - heavy ions: 45 GeV/u
  - protons: 90 GeV



- Micro-Vertex Detector
- Silicon Tracking System in dipole magnet
- RICH or MUCH
- Transition Radiation Detectors
- Time-Of-Flight
- Electromagnetic Calorimeter
- Projectile Spectator Detector



- Au+Au interactions at 10 MHz rate
- Up to 700 charged particles/event
- Detection of rare probes (e.g. open charm)
- Radiation hard detectors
- Neutron fluence  $10^{13}$ - $10^{15}$  cm<sup>-2</sup>

## Detector R&D

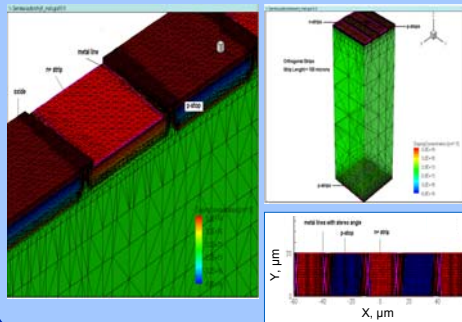


Double-sided micro-strip detectors  
GSI-CIS Erfurt,  
MSU-RIMST, Moscow.

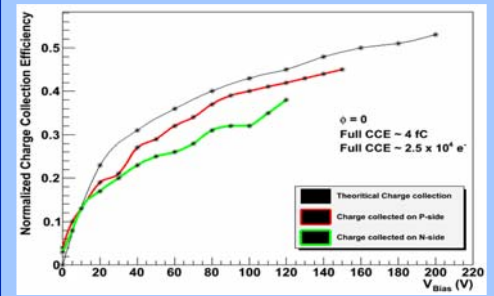


Detector module demonstrators  
GSI - SE RTIIE (Kharkiv, Ukraine)

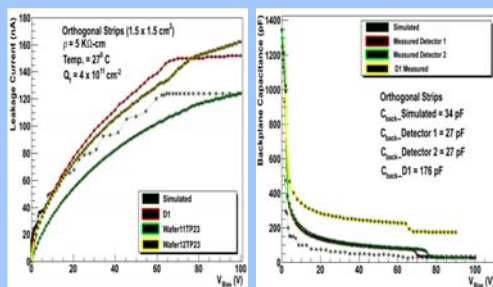
## SYNOPSIS TCAD 3D simulation grid



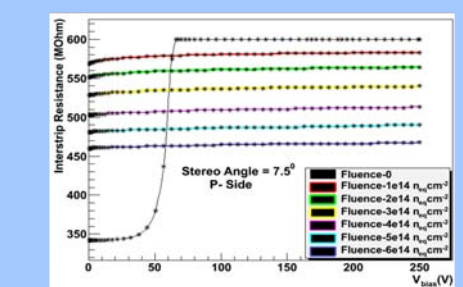
## Charge collection efficiency in double-sided sensors



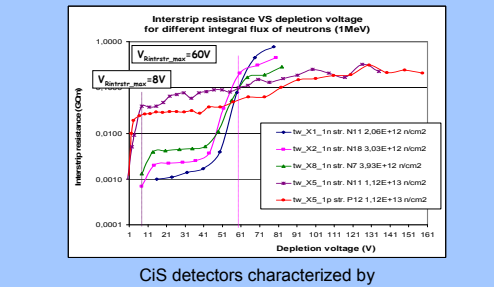
## Simulated IV/CV behavior



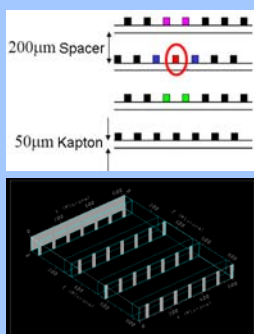
## Interstrip parameters simulation



## Measurements with prototypes

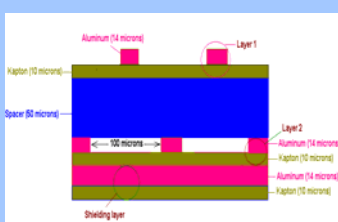


## Simulation of signal transmission through low-mass micro-line cables

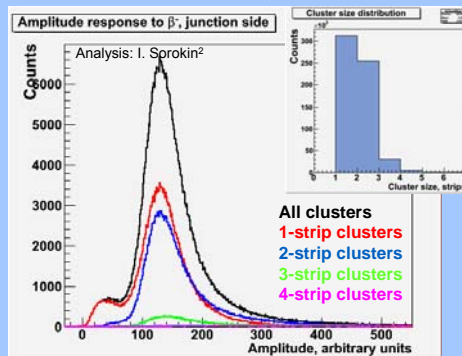


Multi-line microcable model for simulation validation

Structure of analog microcable used in CBM module demonstrators



- 2 signal layers of 14  $\mu$ m Al, 10  $\mu$ m Kapton
  - Spacer 50  $\mu$ m Kapton mesh
  - Shielding layer
- GSI-SE SRTIIE Kharkiv, Ukraine



Strip clusters due to charge sharing of signals (<sup>90</sup>Sr  $\beta^-$ -particles)

## Summary and Outlook

- Silicon Tracking System of the CBM experiment is the central detector for track reconstruction and momentum determination.
- Challenges are: high track densities, high collision rates, low material budget, radiation hardness.
- Detector module R&D program:
  - Radiation tolerant detectors.
  - Module prototypes include: double-sided microstrip sensors, multilayer analog cable, self-triggering front-end electronics.
  - Microcable electrical simulations using RAPAEEL package
  - 3D simulations of double-sided sensors with stereo angle using SYNOPSIS TCAD.
  - Characterization of irradiated sensors.