

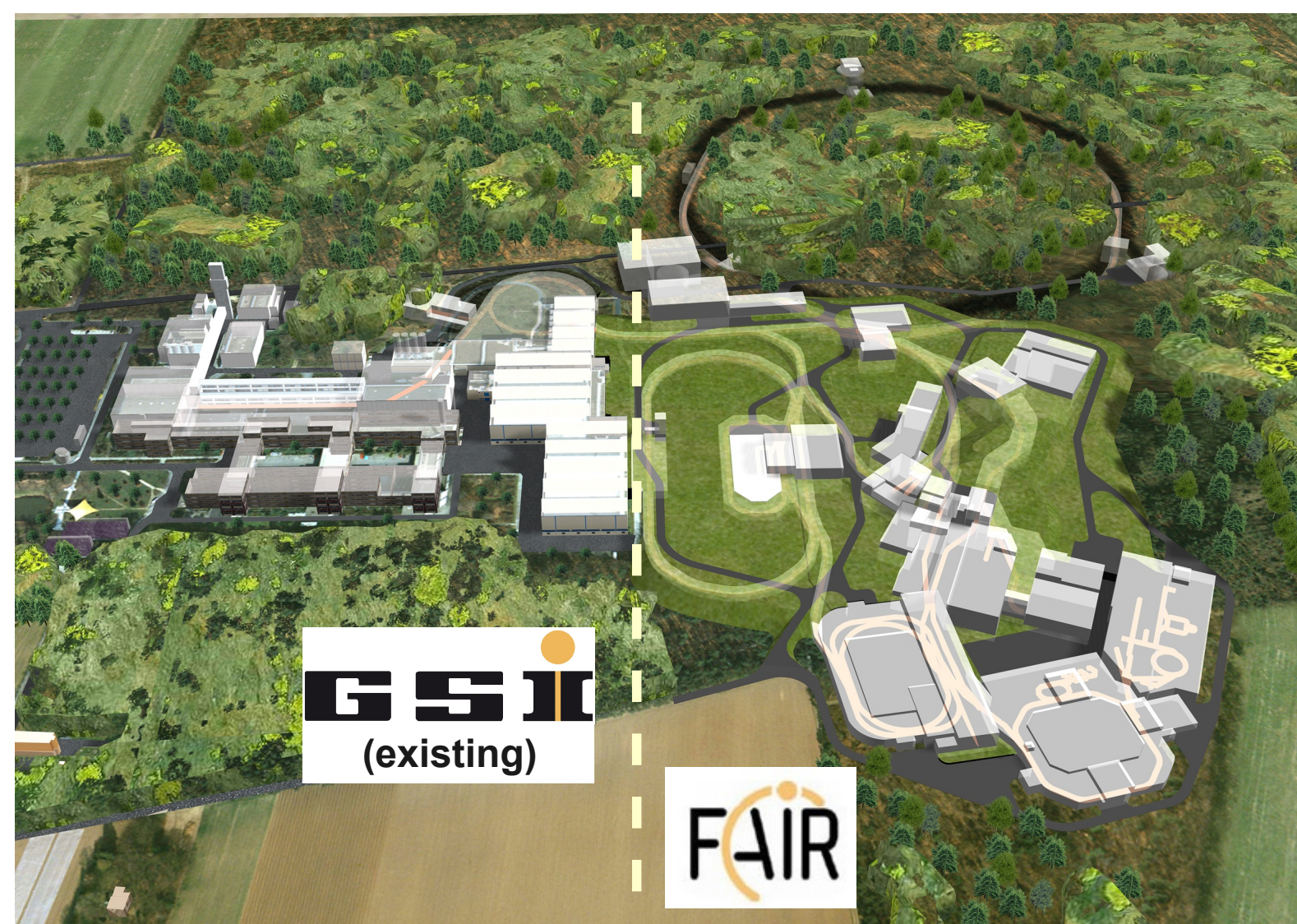
# The Silicon Tracking System of the CBM experiment at FAIR

## – overview and development progress –

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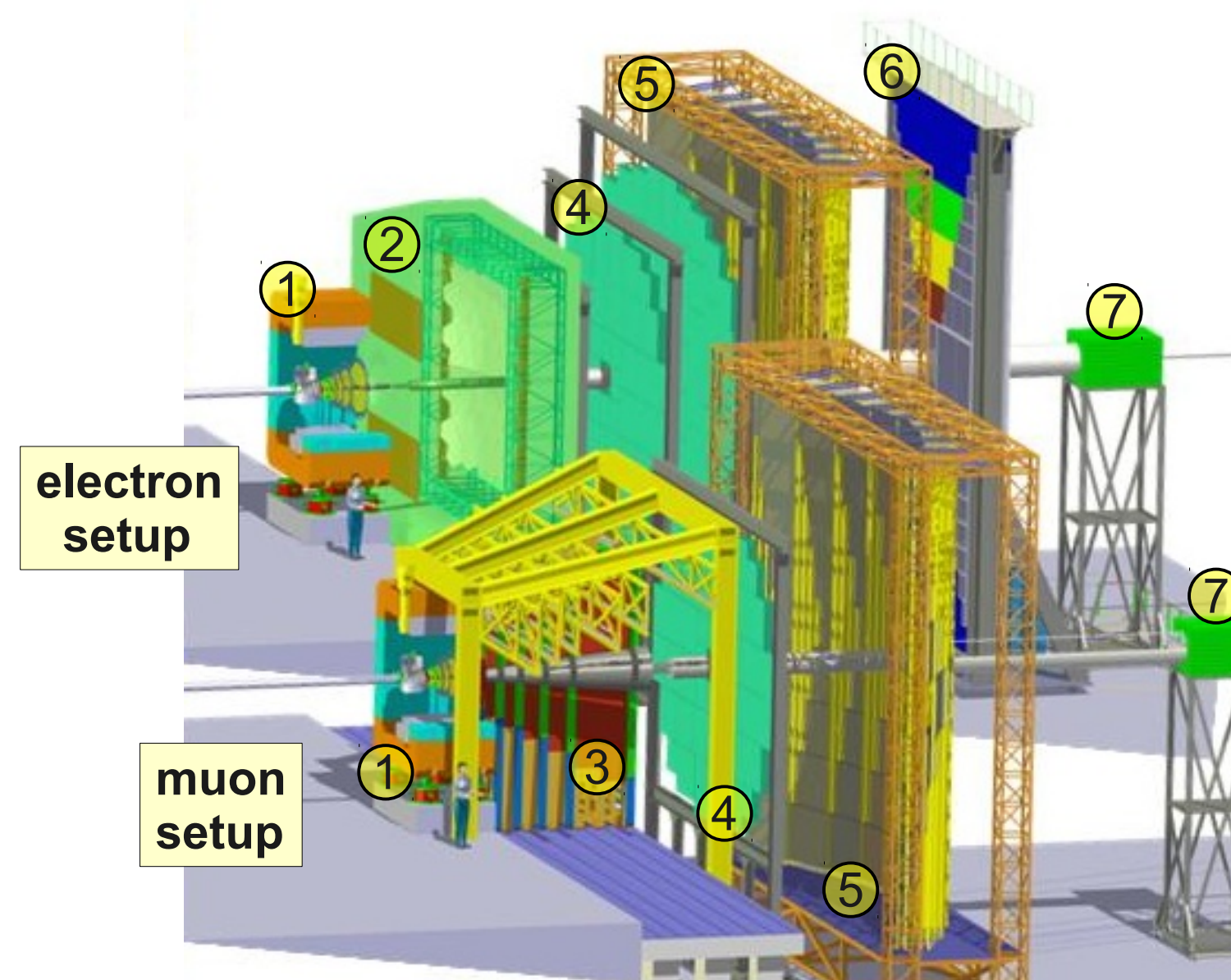
### The CBM experiment at FAIR

#### The FAIR facility



- Accelerators: SIS-100 and SIS-300
- Main experiments: APPA, CBM, NuSTAR, PANDA
- Proton, heavy ion, secondary and anti-matter beams
- Start version commissioning planned: 2018
- Construction cost about 1 billion Euro.
- Construction started in Dec 2011.

#### The CBM experiment



**CBM = Compressed Baryonic Matter.**  
Fixed target experiment. A-A, A-p and p-p collisions up to 45 AGeV (incident).  
**Goal:** explore the phase diagram of strongly-interacting matter at high baryonic densities:

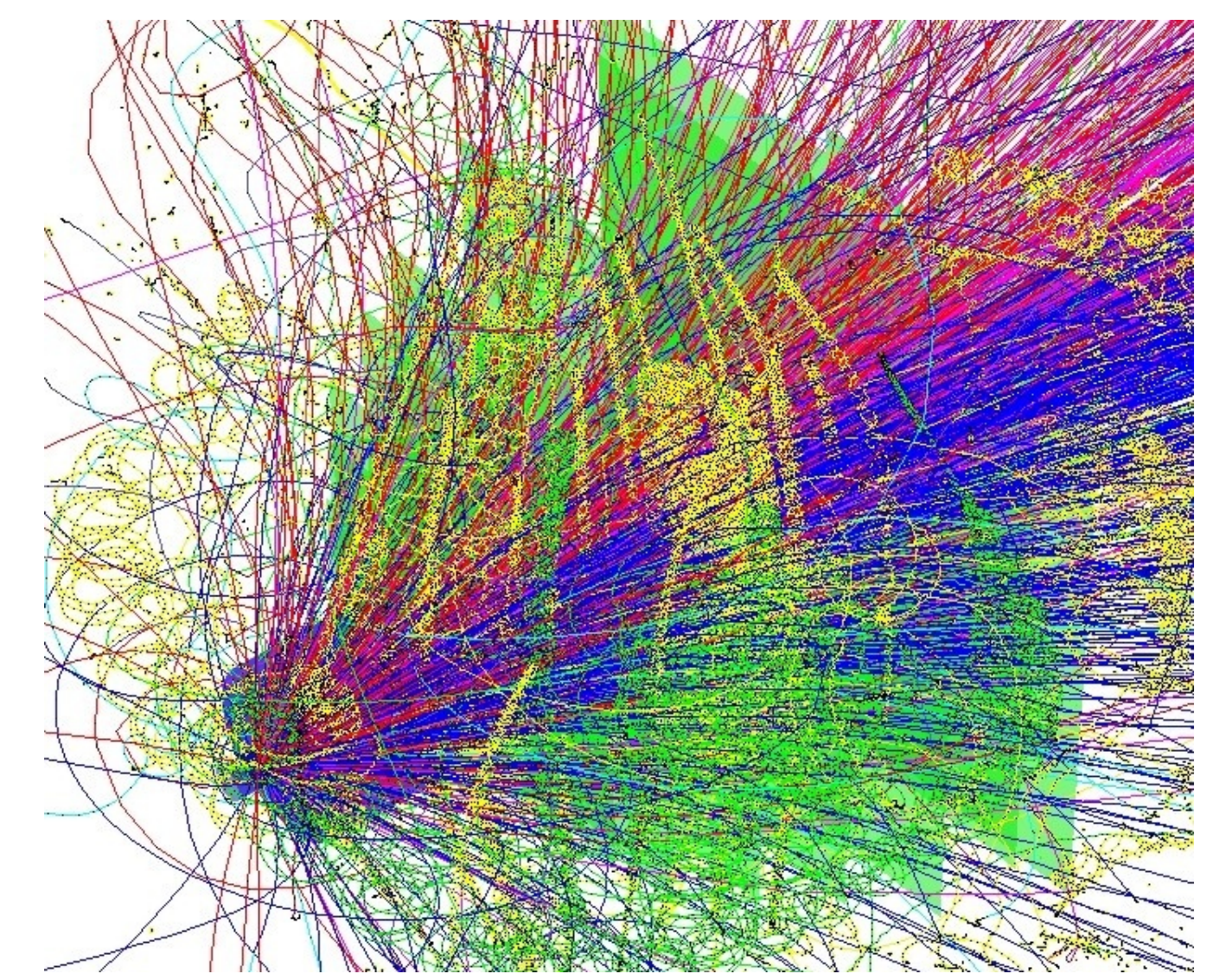
- deconfinement phase transition
- critical point
- chiral symmetry restoration

- (1) Target (solid)  
Micro-Vertex detector (MAPS)  
Silicon Tracking System (strips)  
Superconducting Magnet (1T)
- (2) Cherenkov detector
- (3) Muon detector and absorber
- (4) Transition Radiation detector
- (5) Time of Flight detector
- (6) Electromagnetic Calorimeter
- (7) Projectile Spectator detector

#### Main observables:

- low mass vector mesons
- D-mesons, charmonium
- strangeness production
- collective flow
- event-by-event fluctuations

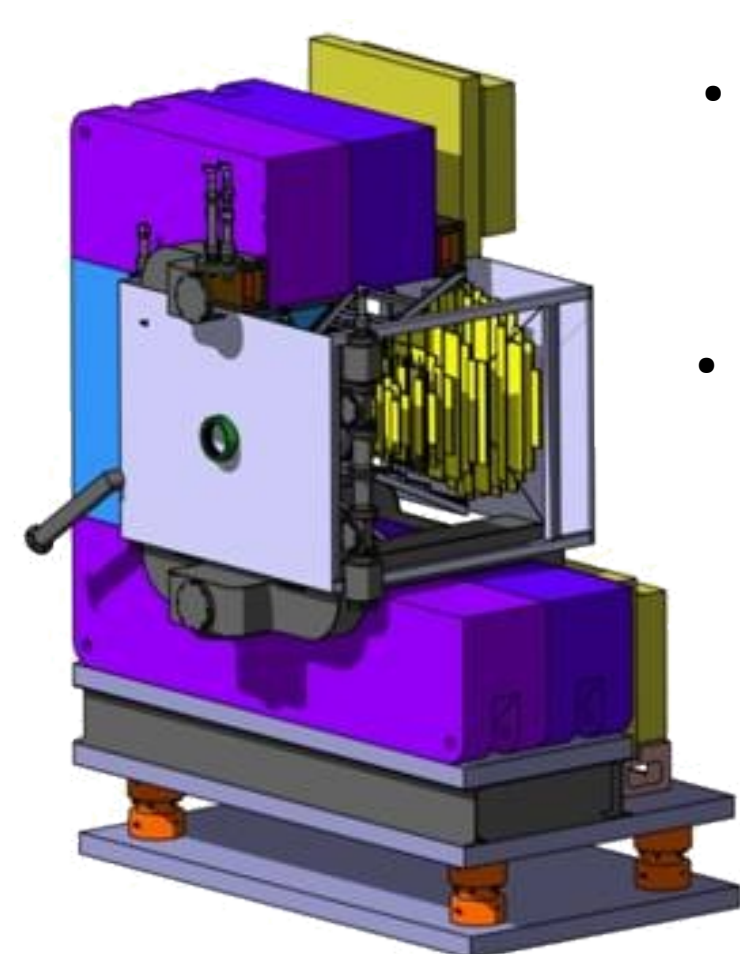
#### Experimental challenge



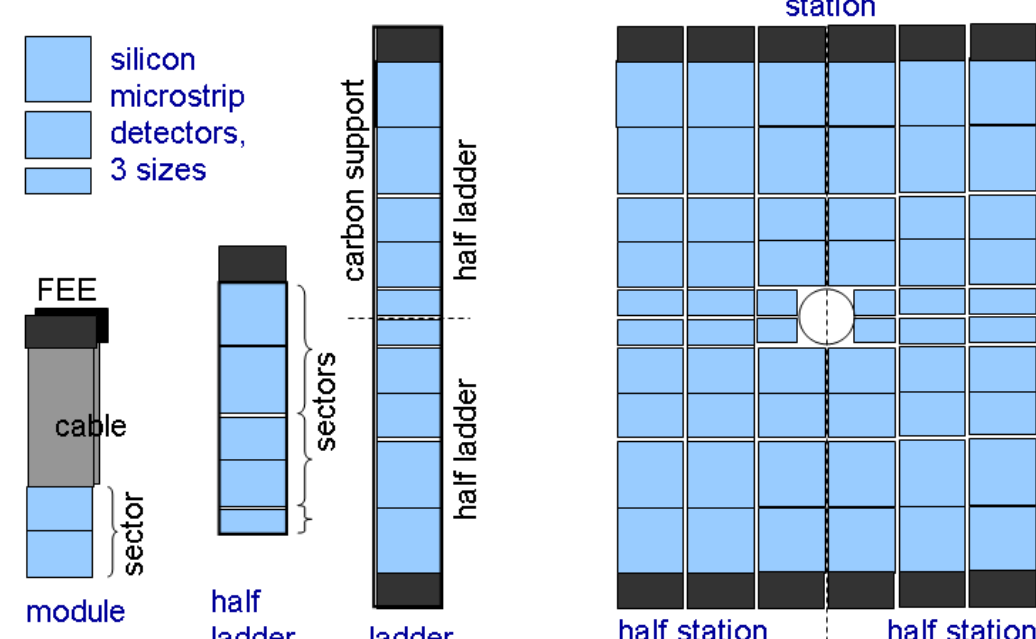
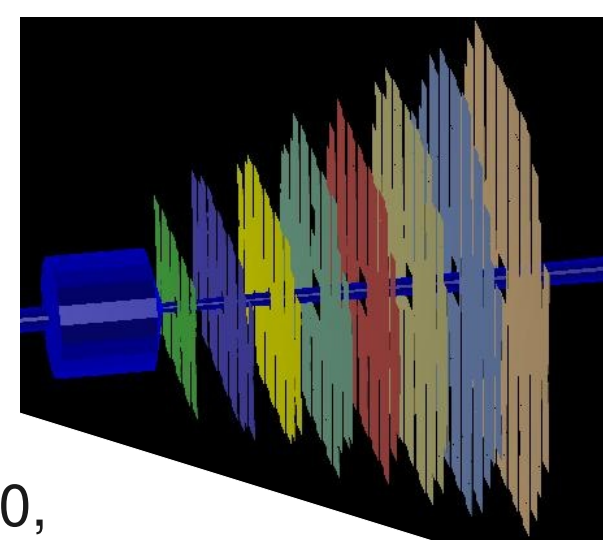
UrQMD simulation: central Au-Au @25AGeV

- 1000 charged products per central Au-Au collision
- up to  $10^6$  Au-Au or  $10^7$  p-p interactions
- momentum resolution about 1%
- time resolution about 5 ns
- radiation load:  $10^{12} - 10^{13}$  n.eq. (innermost:  $10^{14}$ )

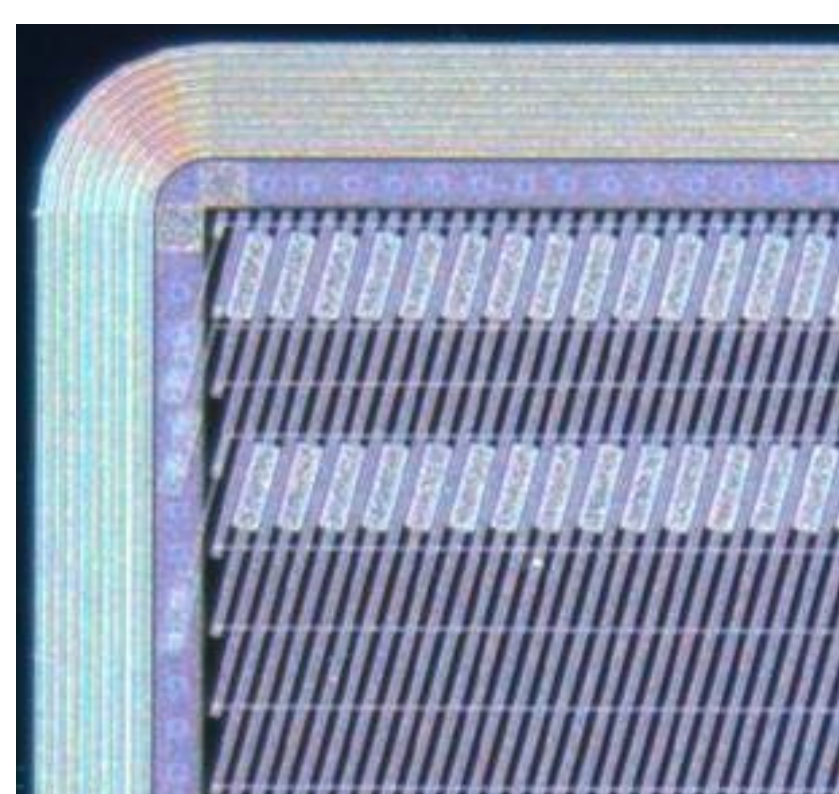
### Concept



- 8 stations in 1 T dipole magnet field
- distance from the target: 30, 40, 50, 60, 70, 80, 90, 100 cm
- self-triggering r/o electronics
- r/o electronics outside the acceptance



Number of integration components	
Ladders	106
Sectors	1040
Detectors	1292
R/O chips	16640
Channels	2133k

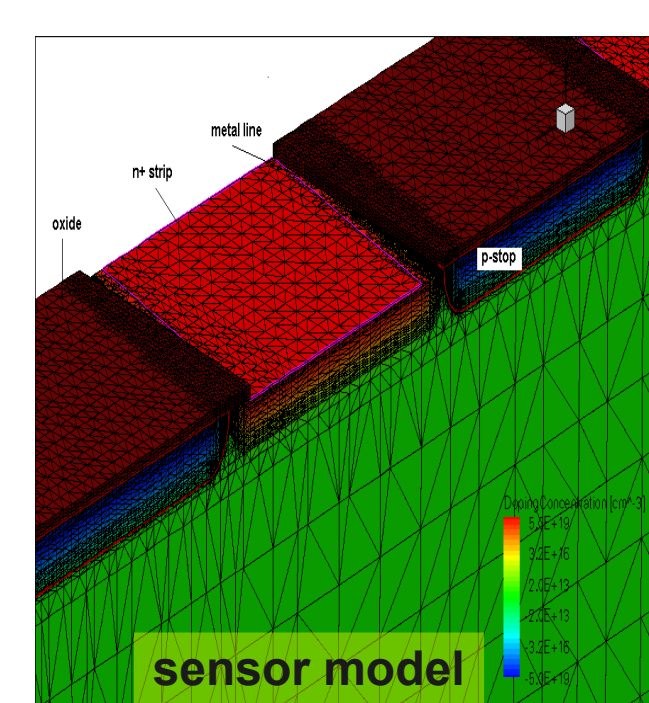


#### Sensors:

- double-sided silicon strip
- 300  $\mu$ m thickness
- 58  $\mu$ m pitch
- AC-coupled
- stereo-angle 8°(or other)
- double metalization (one side)

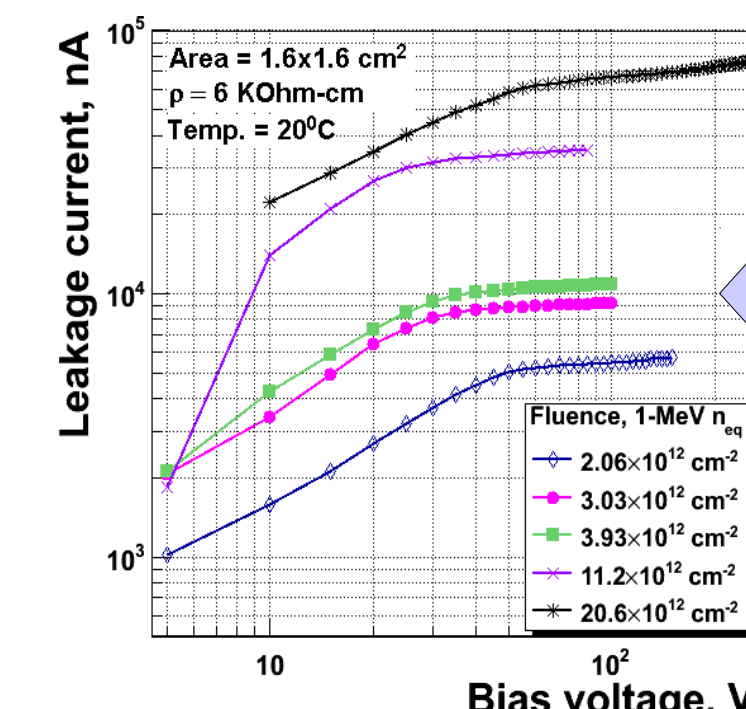
### Simulations

#### Sensor simulations



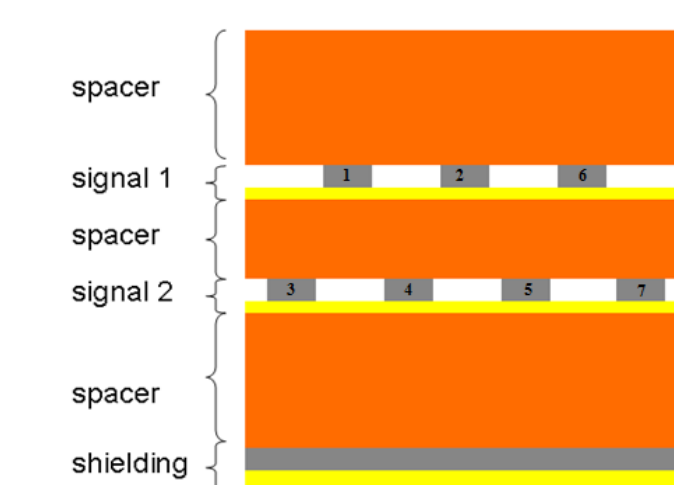
- Synopsys simulation package.
- I-V
  - C-V
  - MIP response
  - breakdown
  - radiation damage

#### Example results:



Reasonable agreement with the measurements!

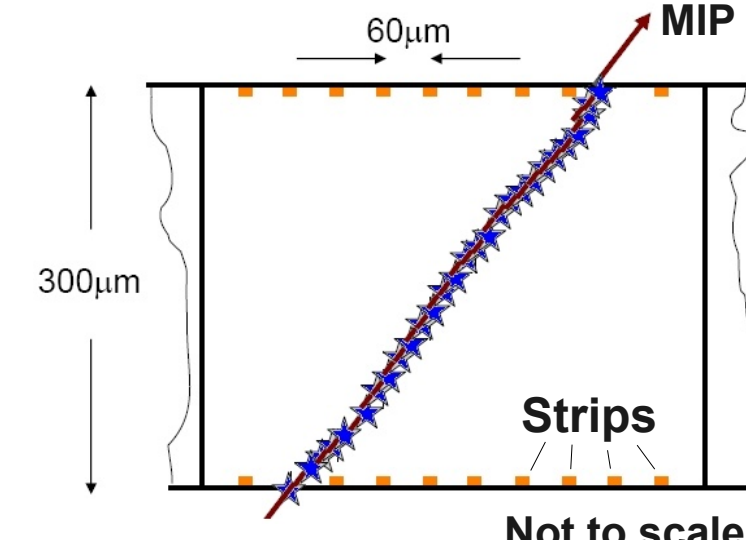
#### Cable simulations and optimization



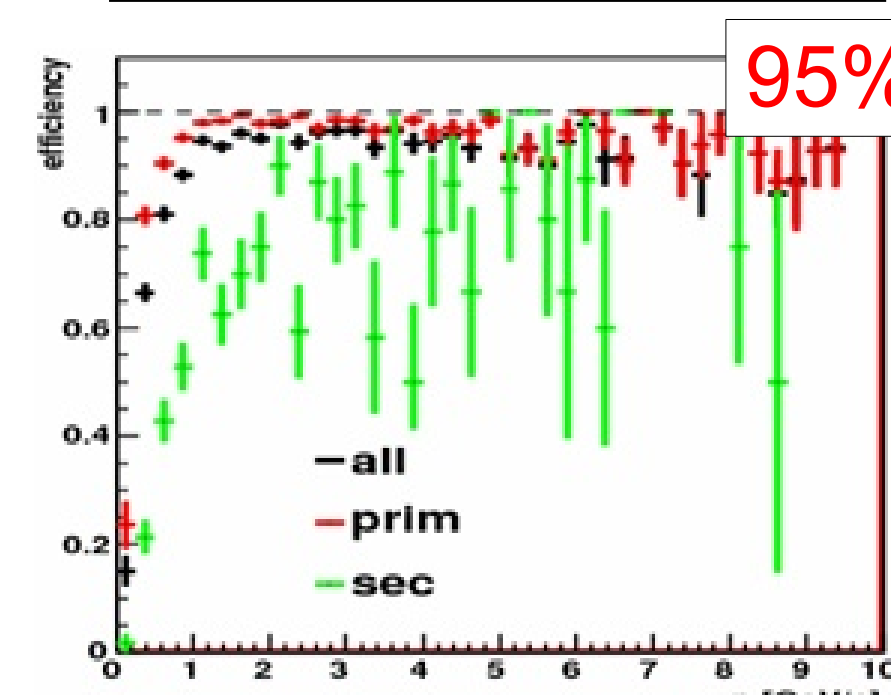
- RAPHAEL simulation package
- Capacitance and resistance
- simulation for noise estimate
- Optimization of geometry for minimal noise within limited material budget
- Cu and Al traces considered

#### Detector response for MC simulations

- charge sharing between strips
- charge collection inefficiency
- Lorenz shift
- channel dead time
- noise

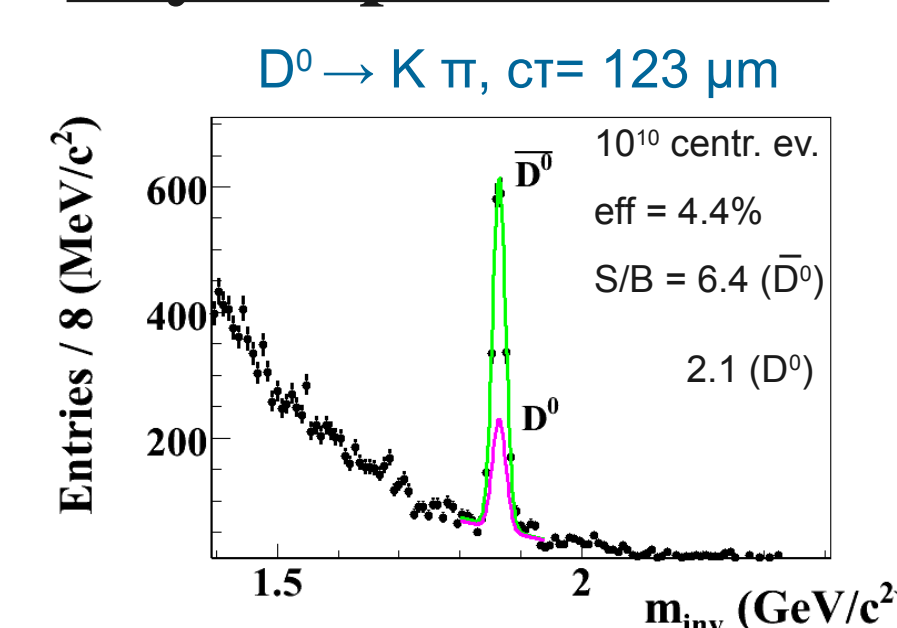


#### Track reconstruction



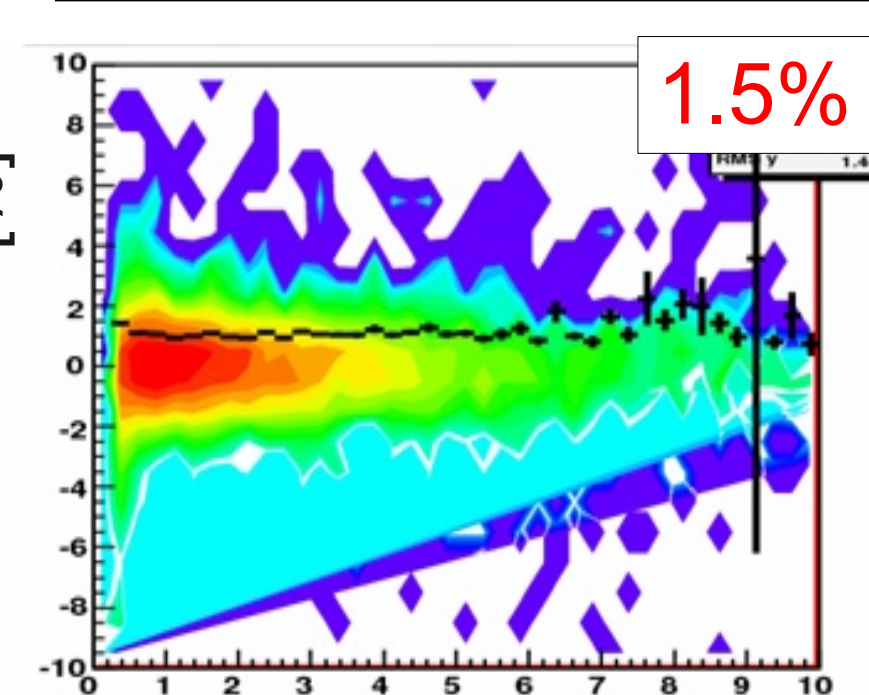
- Cellular automaton track finder + Kalman filter
- Idealistic detector model

#### Physics performance



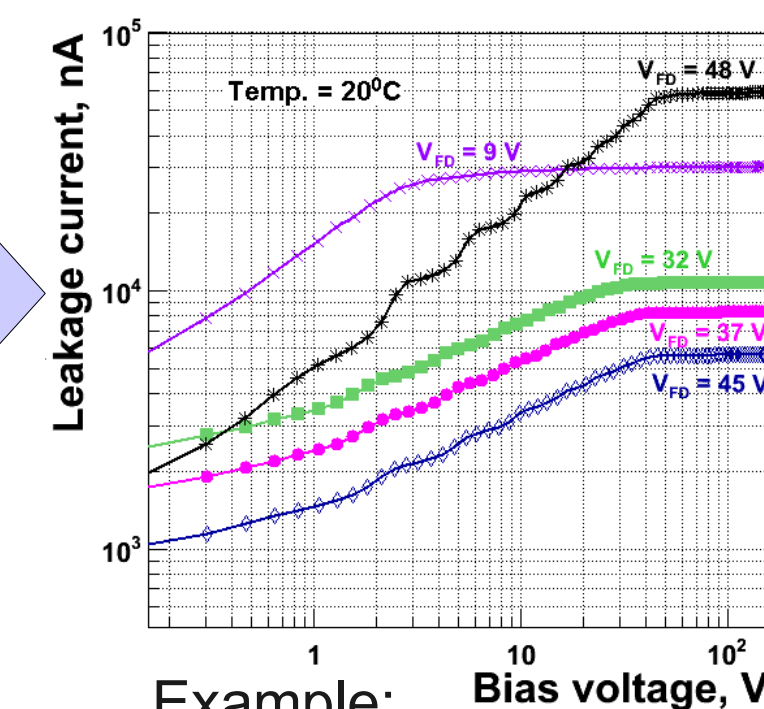
Au+Au@25AGeV. 2 weeks @ $10^6$  ev/s. HSD and SHM generators.

#### Momentum resolution



### Prototypes

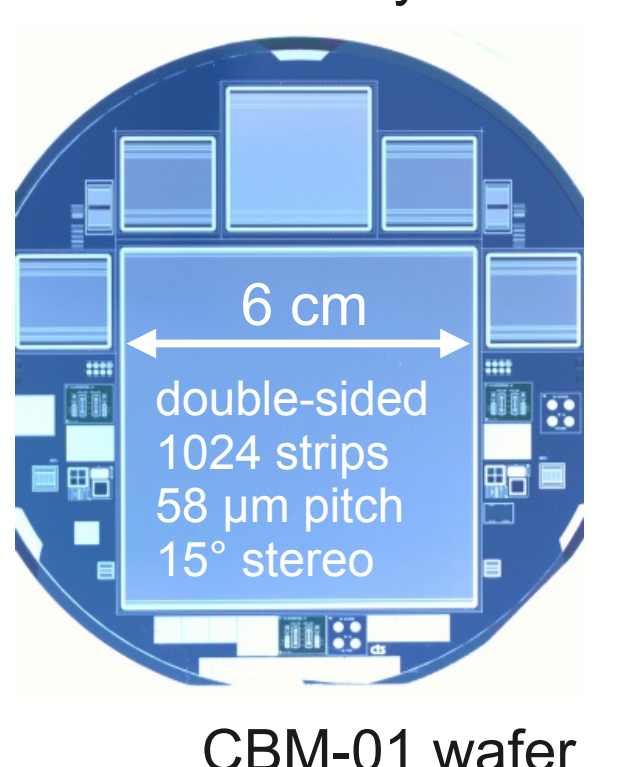
#### Sensors



Example: I-V characterization

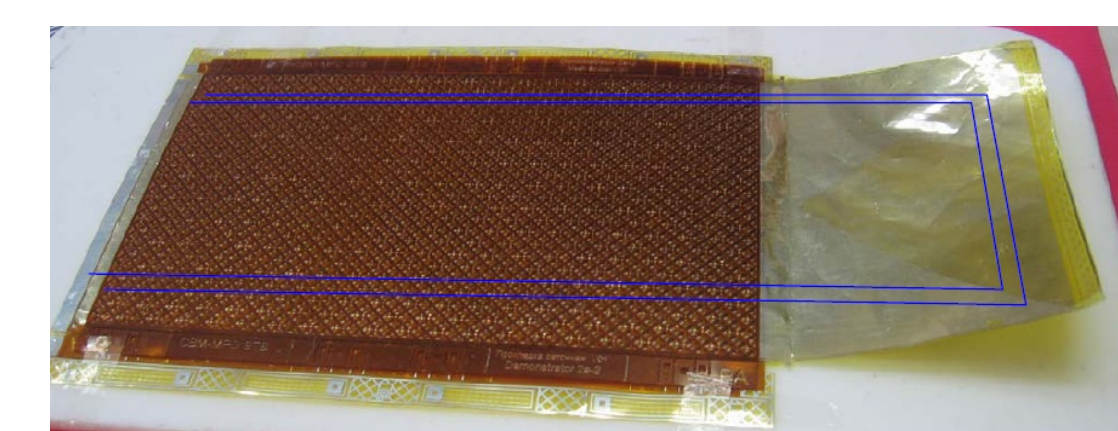
Main manufacturer: CiS, Erfurt, Germany

- Collaborative activities:
- R & D
  - characterization
  - quality assurance (being established)



CBM-01 wafer

#### Cables



Stacked cable layer



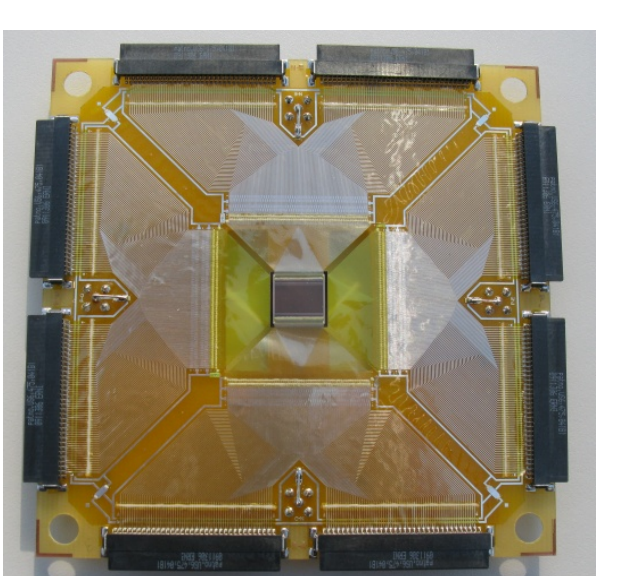
Al strips on polyimide  
Produced: SE SRTIIE, Ukraine

#### R/O electronics



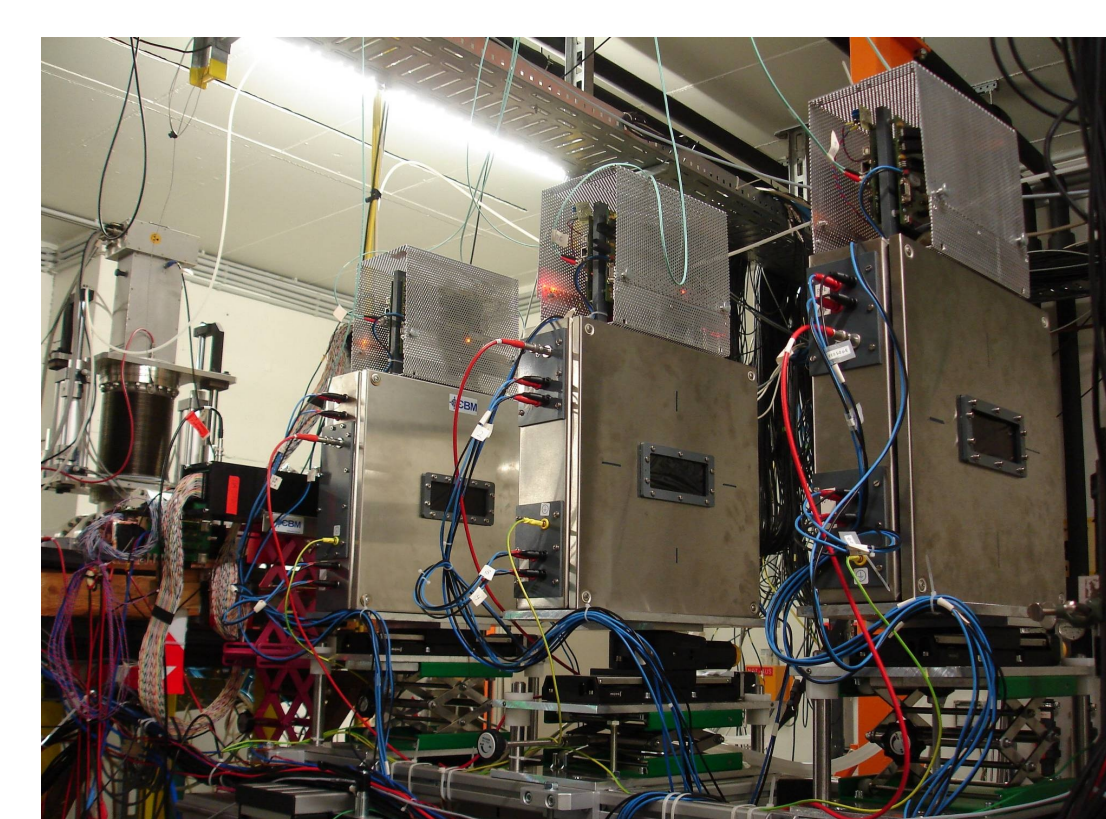
- n-XYTER chip – for early prototyping (DETNI project)
- Self-triggering
  - Time and amplitude measurement
  - 128 channels
  - dynamic range about 120ke<sup>-</sup>
  - 2 shapers per channel: slow, fast

#### Detector boards



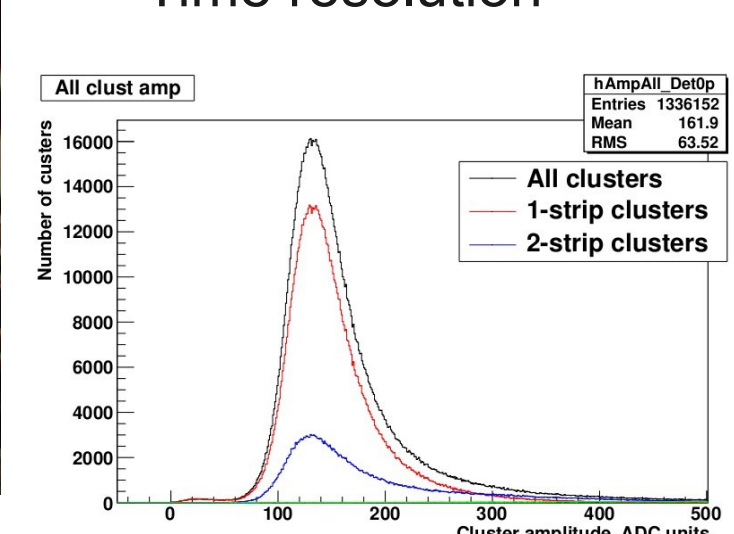
- detachable from r/o electr.
- baby sensor, 256 strips
- TAB bonded – durable

#### Beamtests



COSY, Jülich (Germany) – Jan 2012  
3 stations in a proton beam

- General system test
- Detector response
- Position resolution
- Tracking
- Time resolution



Example: amplitude response

This is only a tiny fraction of ongoing activities