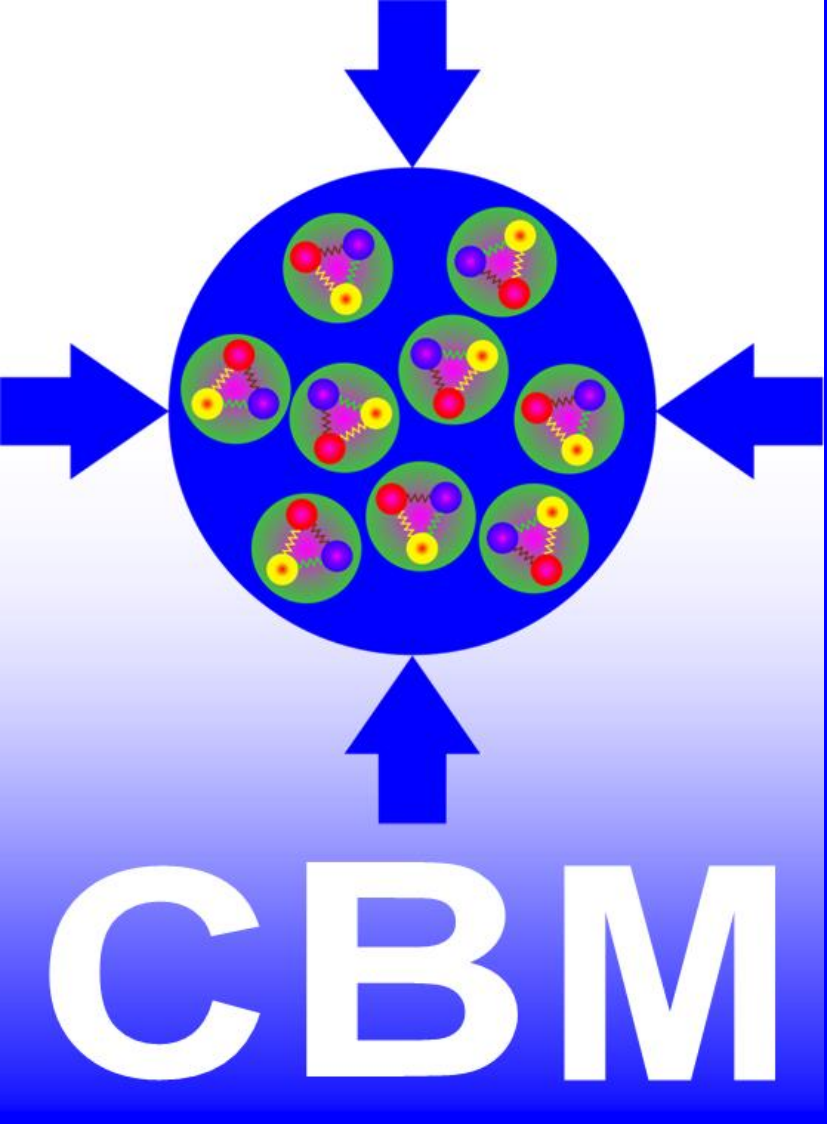




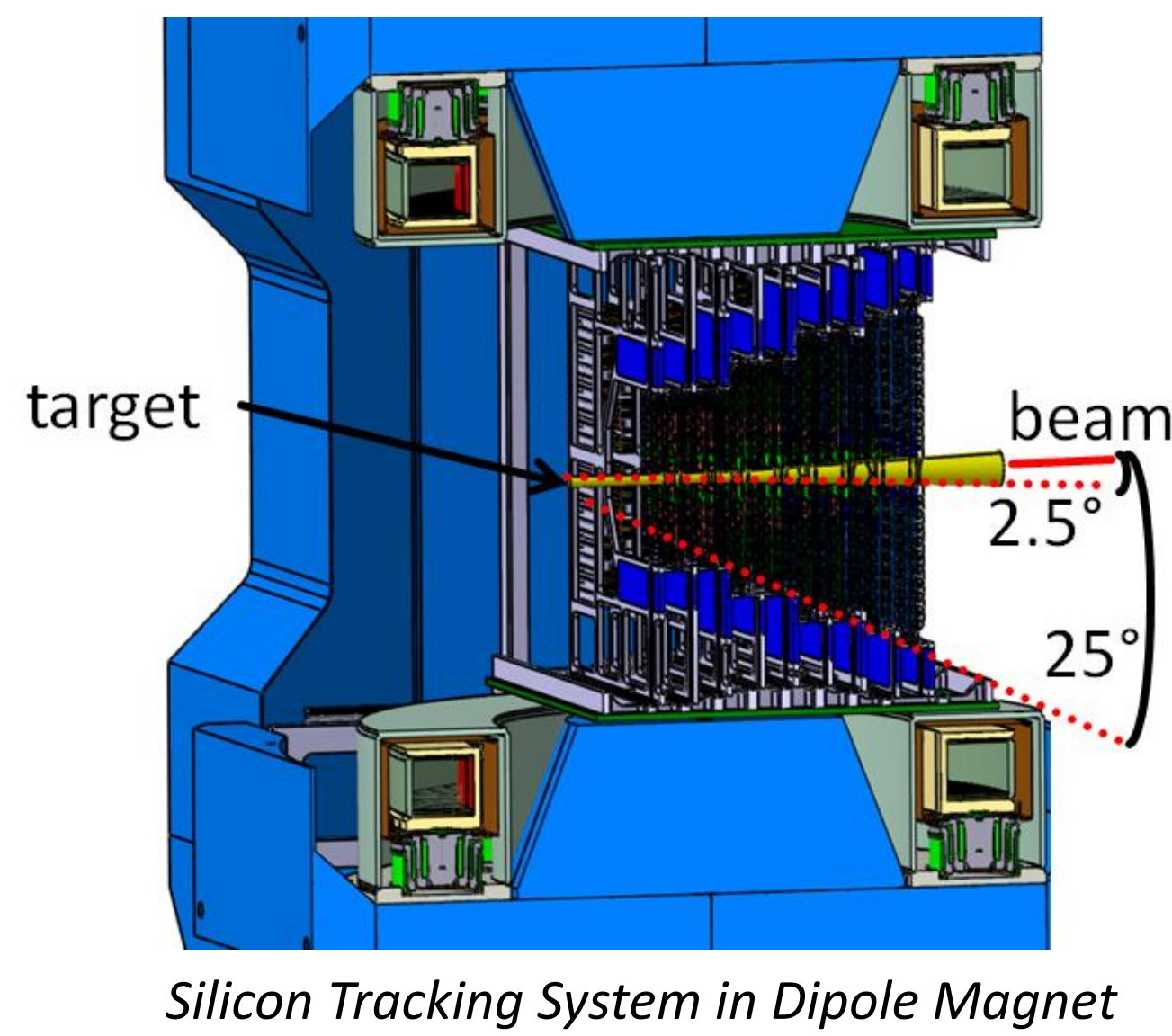
The Silicon Tracking System of the CBM experiment at FAIR

Johann M. Heuser, for the CBM Collaboration

GSI Helmholtz Center for Heavy Ion Research, Darmstadt, Germany

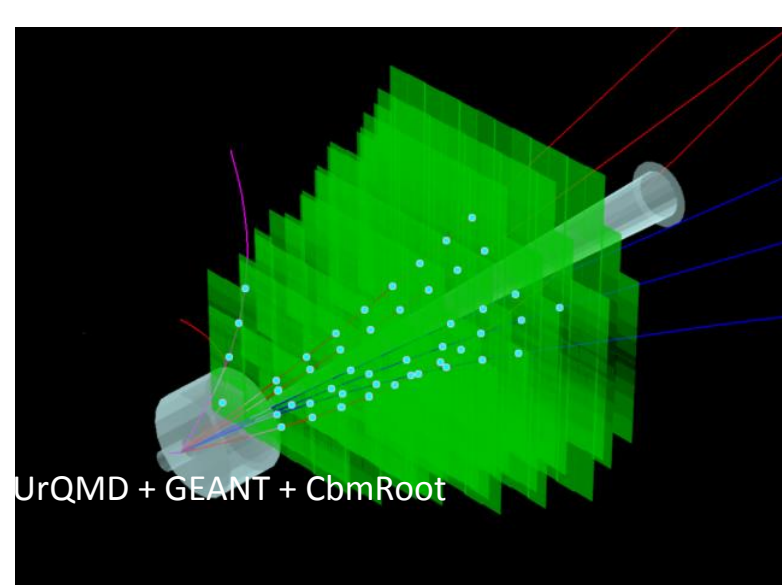
Compressed Baryonic Matter experiment at FAIR

Silicon Tracking System

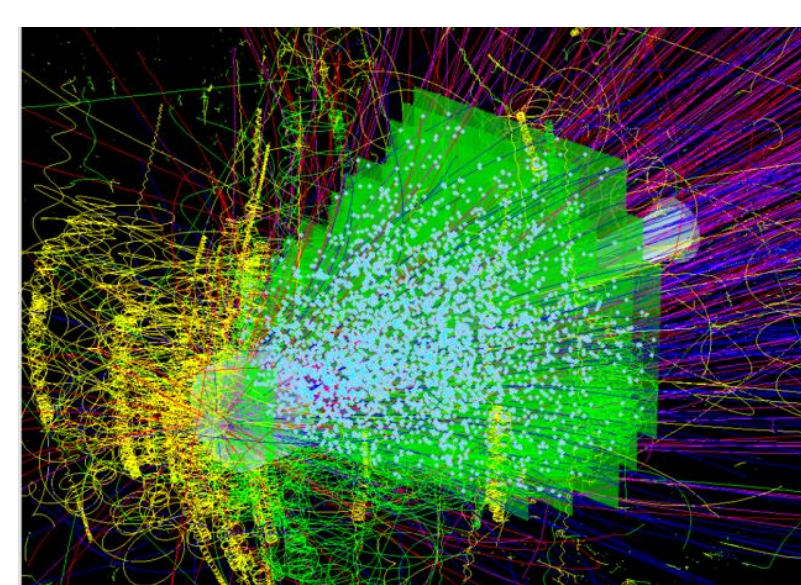


Silicon Tracking System in Dipole Magnet

- track point measurement in high-rate collision environment:
 $10^5 - 10^7/s$ (A+A), up to $10^9/s$ (p+A)
- physics aperture :
 $2.5^\circ \leq \theta \leq 25^\circ$, $0.3 \text{ m} \leq z \leq 1.0 \text{ m}$
- 8 tracking stations
- double-sided silicon microstrip sensors
- hit spatial resolution $\approx 25 \mu\text{m}$
- self-triggering front-end electronics
- time-stamp resolution $\approx 5 \text{ ns}$
- material : $\approx 0.3\% - 1.5\% X_0$ per station
- $\Delta p/p \approx 1.8\%$ ($p > 1 \text{ GeV}/c$, 1 Tm field)

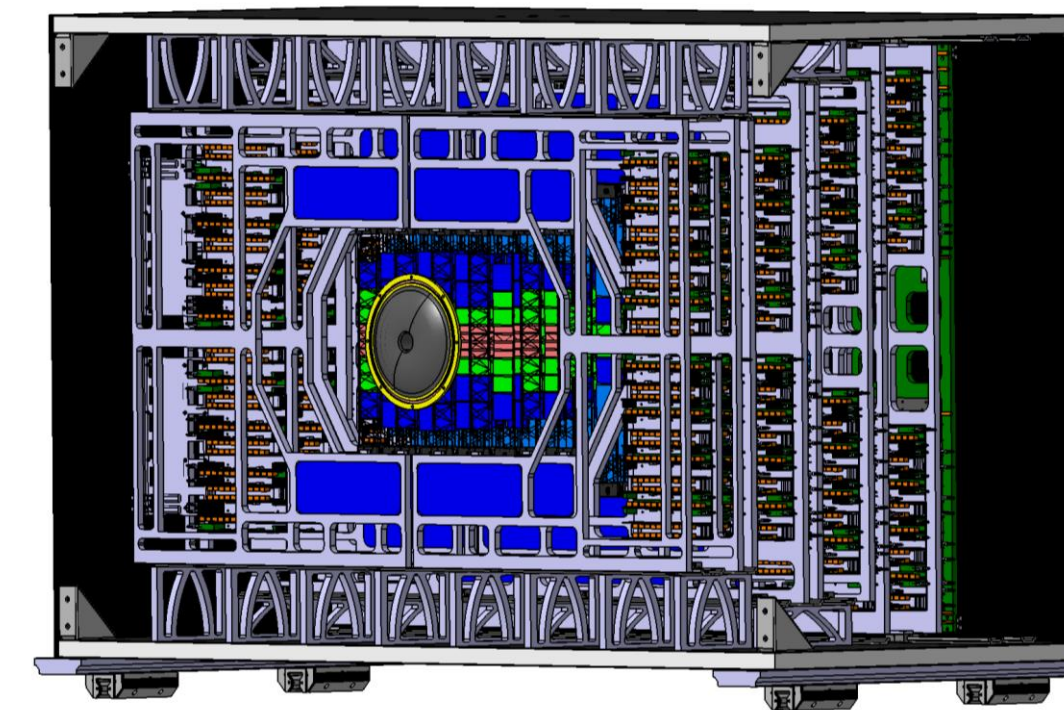


p+C,
29 GeV

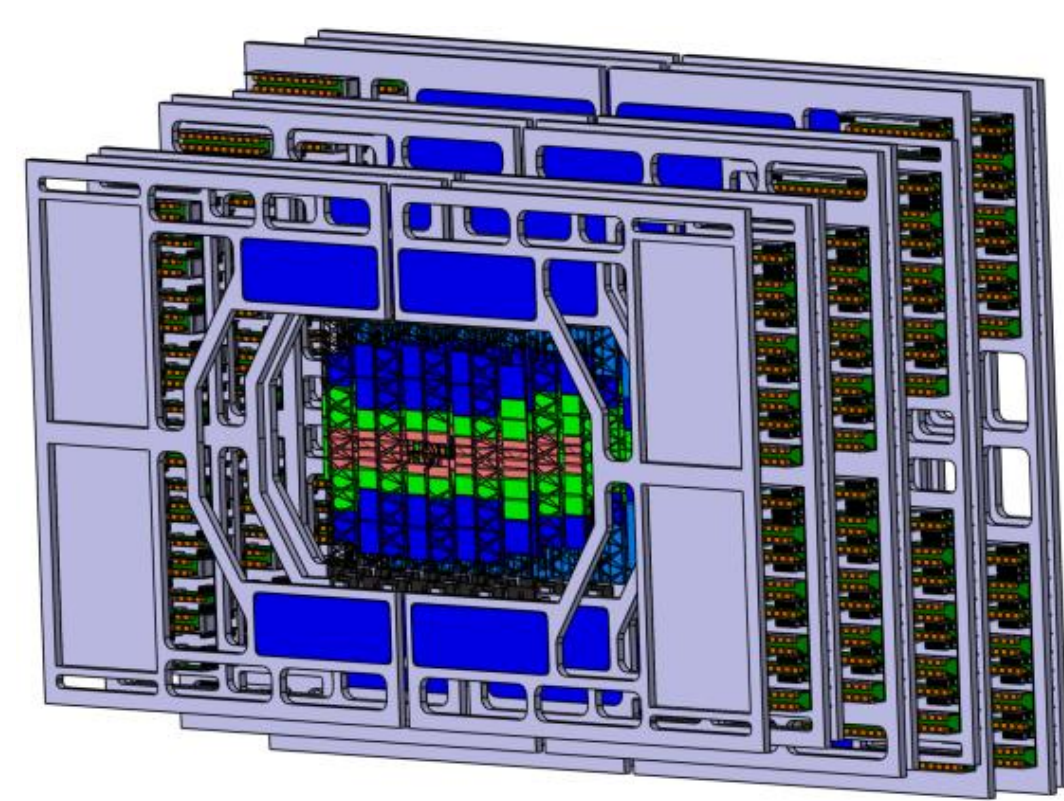
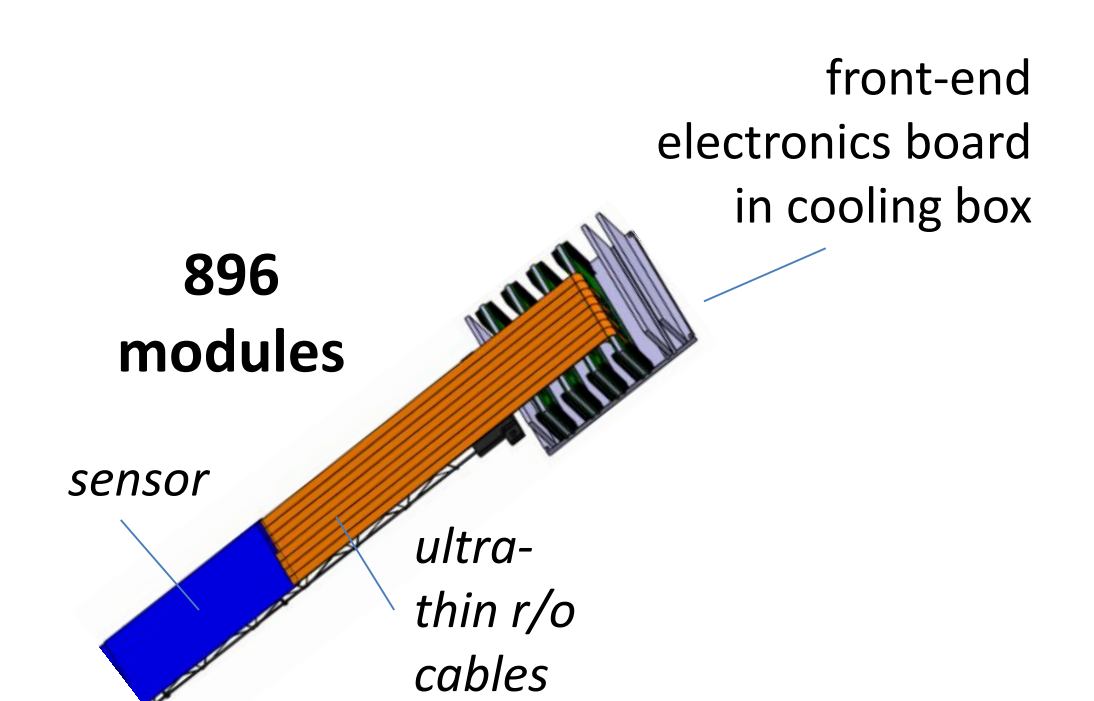


central Au+Au,
8 A GeV

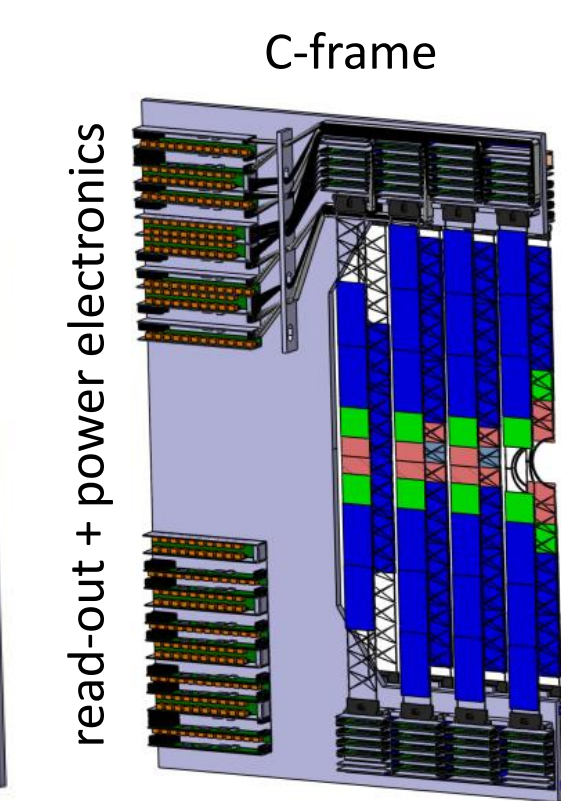
System Integration



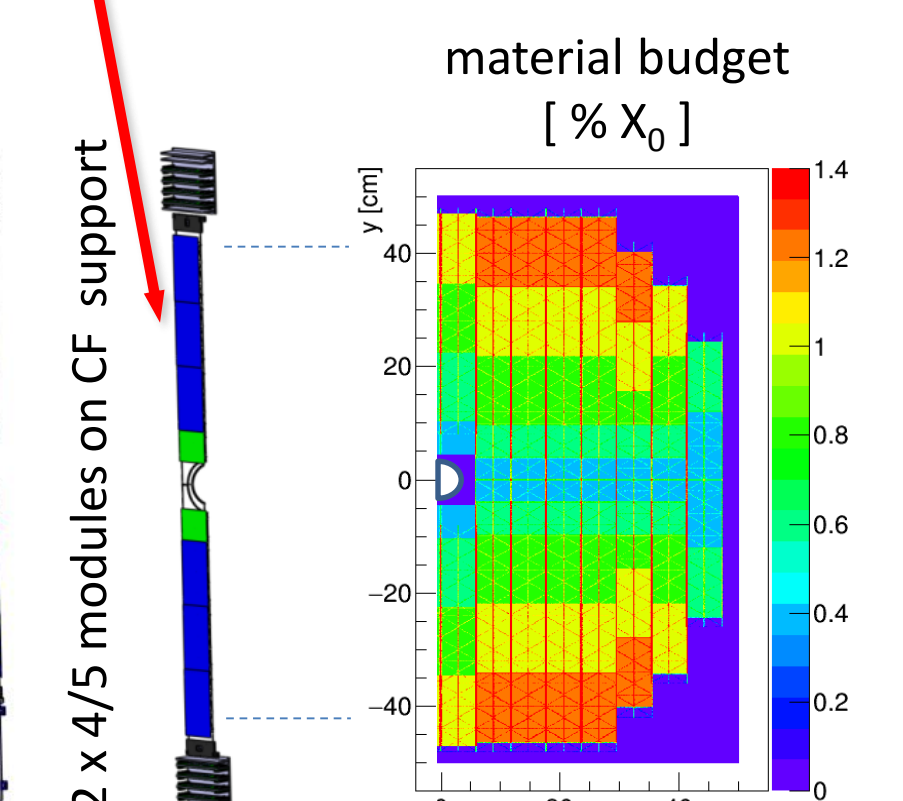
system in thermal enclosure
sensors at -5°C
cooling of electronics with bi-phase CO_2



8 tracking stations



18 mechanical half-units



106 ladders

Silicon Microstrip Sensors

- $285/320 \pm 15 \mu\text{m}$ thick
- n-type silicon
- double-sided segmentation
- 1024 strips of $58 \mu\text{m}$ pitch
- strip length 2/4/6/12 cm
- angle front/back: $7.5^\circ/0^\circ$
- read-out from top edge
- double-metal routing on p-side
- radiation tolerance
 $1 \times 10^{14} n_{\text{eq}} (1 \text{ MeV}) / \text{cm}^2$, 1 Mrad

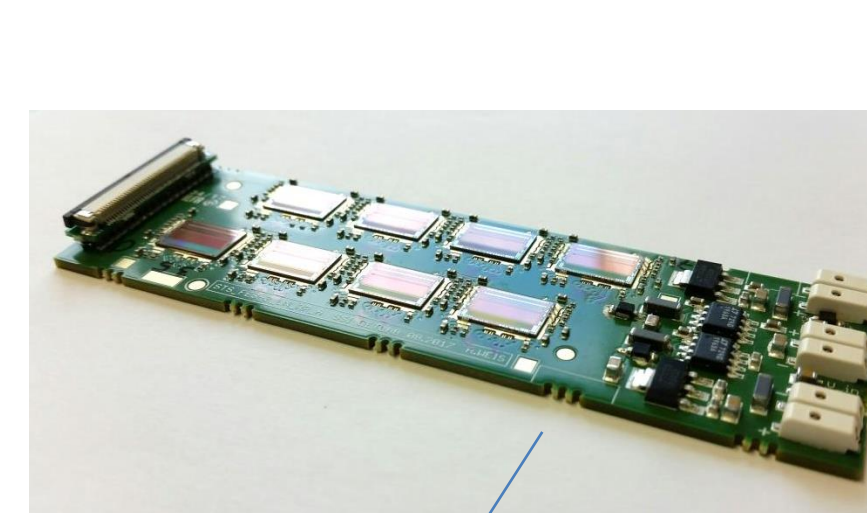
prototypes developed and produced:
CiS/ Germany, Hamamatsu/Japan

- $6.2 \times 2.2 \text{ cm}^2$
- $6.2 \times 4.2 \text{ cm}^2$
- $6.2 \times 6.2 \text{ cm}^2$
- $6.2 \times 12.4 \text{ cm}^2$

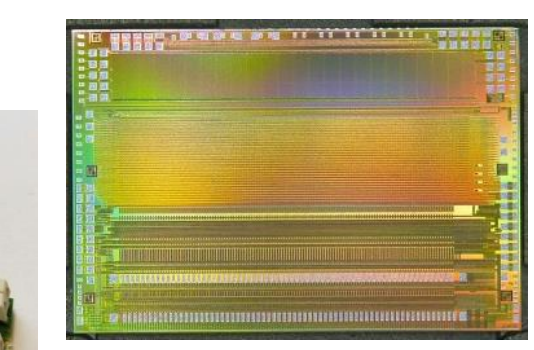
CBM06

0.5 mm/div

Read-out Electronics



STS modules



STS-XYTER v2.0 ASIC
 $8 \times$ on FEB-8

read-out chain for *miniSTS*

Common GBTx Readout Board

μTCA crate with AFCK boards

FLES input node with FLIB boards

copper link ($\sim 1 \text{ m}$)

optical link ($\sim 50 \text{ m}$)

optical link ($\sim 300 \text{ m}$)

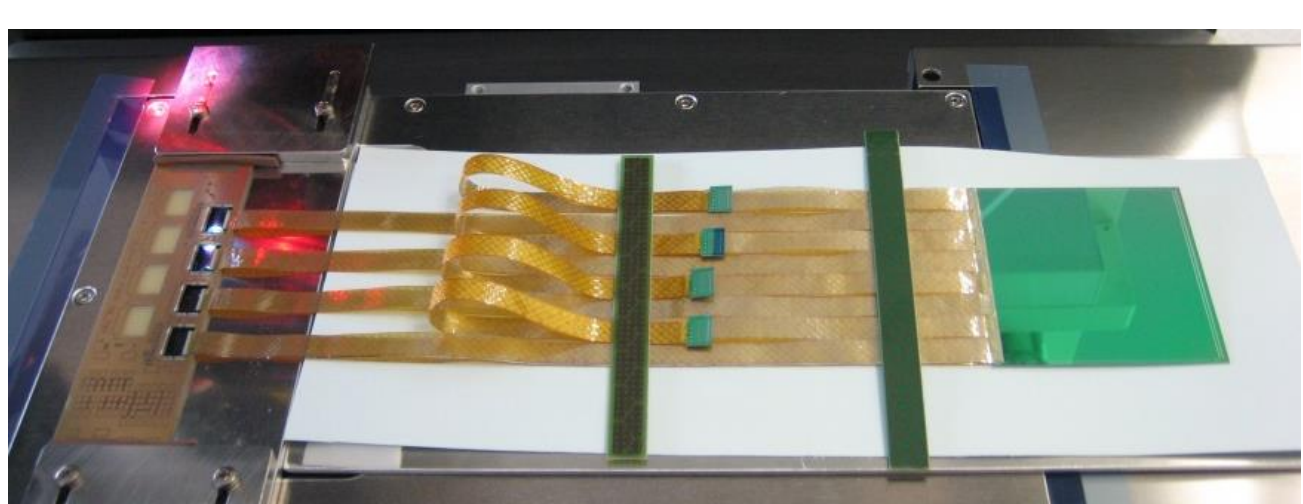
on detector

in DAQ room

in "Green Cube" computing center

Modules and Ladders

module assembly



tab-bonding of Al-polyimide cables between ASICs and sensor

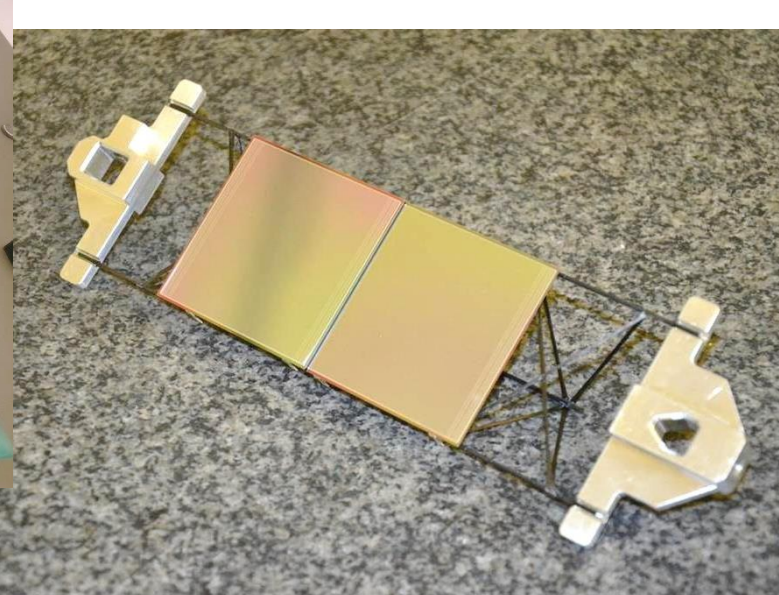


assembly procedure defined and tested on mechanical dummy modules

ladder assembly



mounting of modules onto low-mass carbon-fiber supports



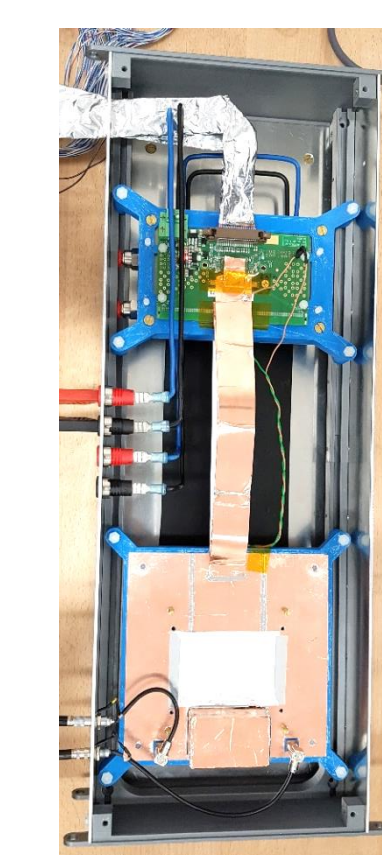
sensor position precision $\pm 40 \mu\text{m}$

Demonstrators

prototype modules

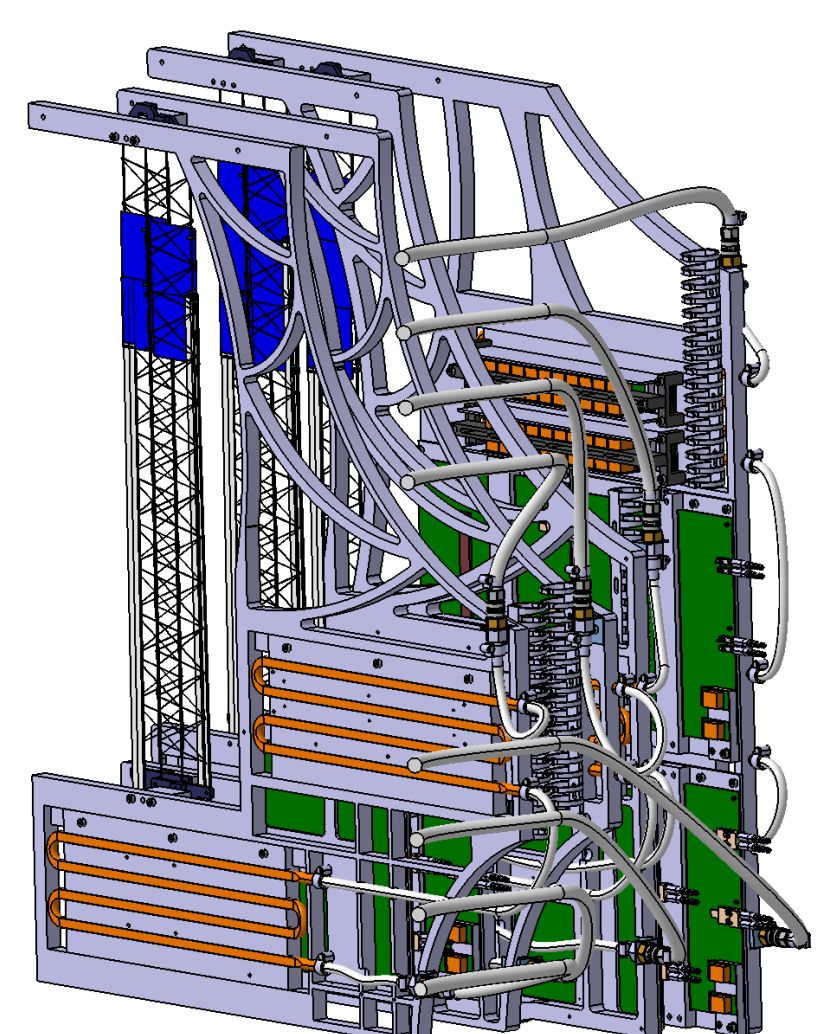
test at COSY, Feb. 2018

- proton beam, 1.7 GeV/c
- sensor $285 \mu\text{m}$ thick
- 128 channels /side read out
- microcable 25 cm long



performance:

- noise:
 $1090 \pm 150 \text{ e (n)}$
 $1350 \pm 200 \text{ e (p)}$
- r/o threshold:
7000 e
- signal mean:
 16720 e (n)
 20300 e (p)
- signal-to-noise: 15 ± 3
- hit detection eff.: $> 95\%$



miniSTS design

miniSTS

in demonstrator experiment *miniCBM* at GSI/SIS18

- operation 2018 - 2021
- 2 tracking stations
– 13 modules
– 5 half-ladders
- GBTx read-out
- FLESin DAQ node

verification of :

- ASIC under load
- system aspects
- data transport
- tracking

STS Project Timeline

- Production Readiness : Nov. 2018
- Detector construction 2019 – 2022

Detector ready for installation: 2023

Assembly Centers: GSI-FAIR, JINR-VBLHEP