Application for testing CBM detectors in beam at COSY in Q4/2019

- *Recent tests: (1) in mCBM (3/2019) (2) at COSY (4/2019)*
- *Beamtime application at COSY for Q4/2019*
- *Preview of medium-term plans at COSY 2020 – 2022*

Johann M. Heuser
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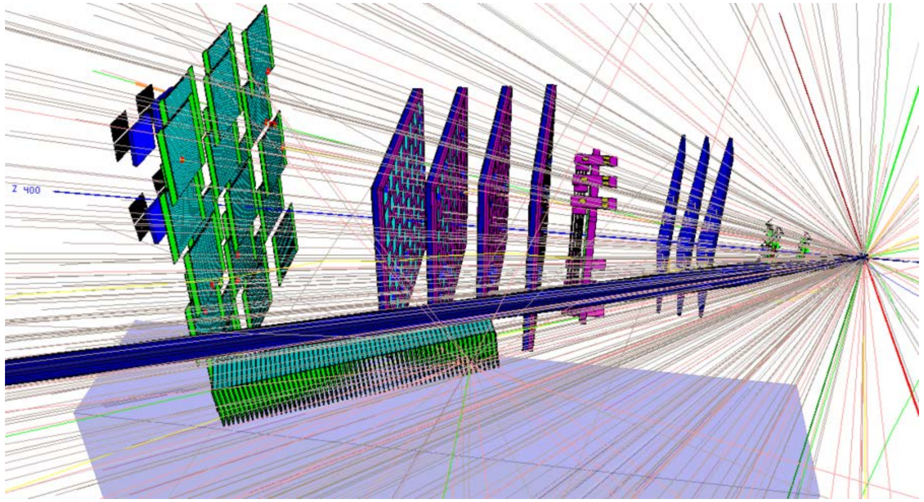
for the CBM Collaboration

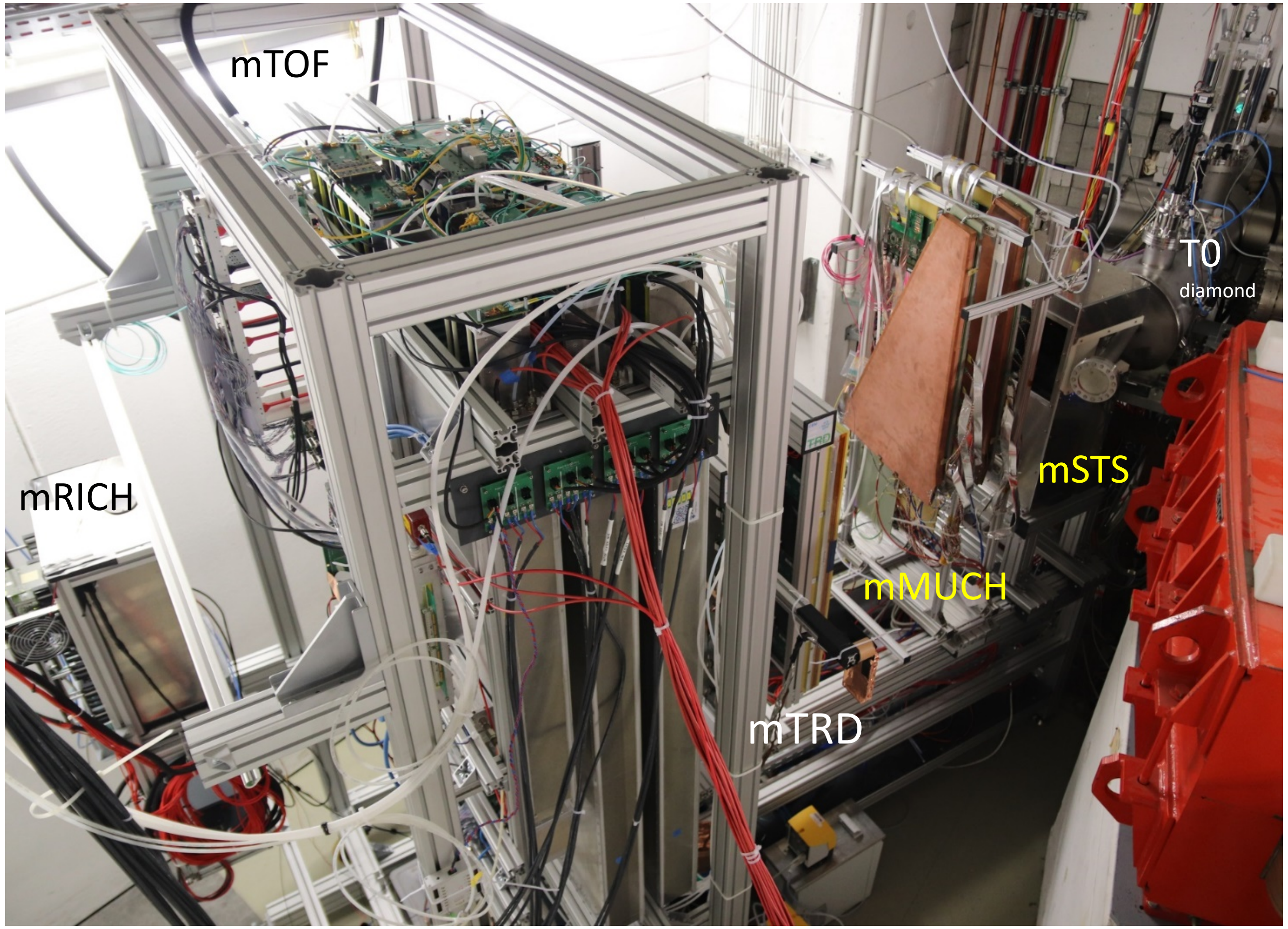
10th COSY Beamtime Advisory Committee Meeting,
IKP FZ Jülich, 1 July 2019

(1) Tests in mCBM@SIS18, 12/2018 and 3/2019

FAIR Phase 0 Research Program

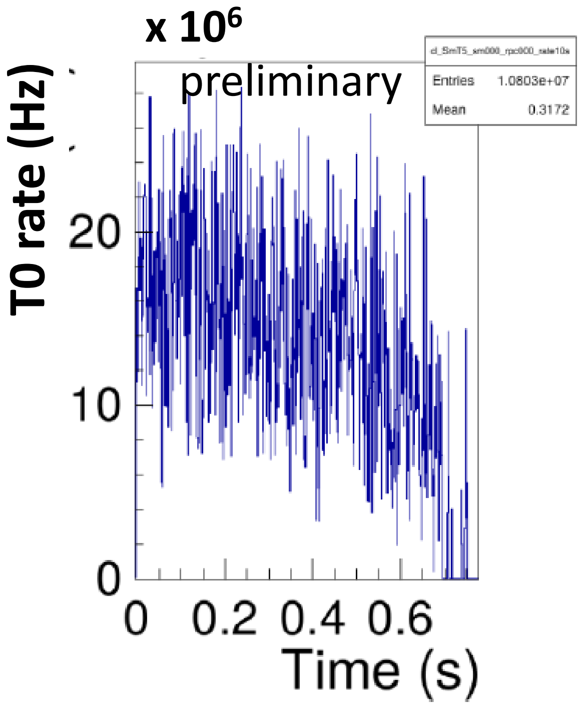
mCBM@SIS18 - a CBM full system test-setup
for high-rate nucleus-nucleus collisions at GSI/FAIR





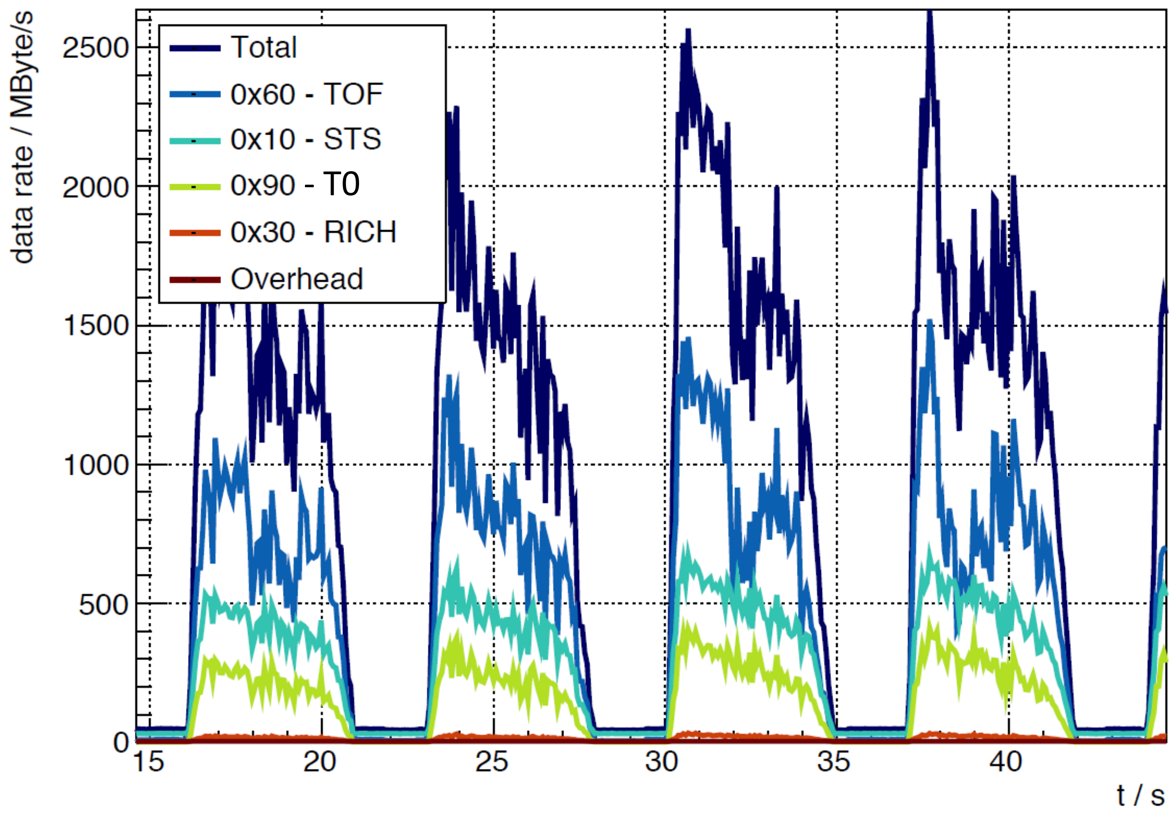
- first successful commissioning with beam 12/2018 and 3/2019
- CBM prototype detector systems
- free-streaming read-out and data transport to the mFLES
- up to 10 MHz collision rate
- online monitoring
- event reconstruction and selection – offline now, on-line next

mCBM@SIS18 – combined data taking



March 30, 2019:
beam intensity ≈ 10^8 Ag ions / s
interaction rates 10^6 … 10^7 / s (preliminary)

March 30, 2019 – run 175
(approx.) 10^8 Ag ions/s (1.58 GeV/u) + Au (2.5 mm)

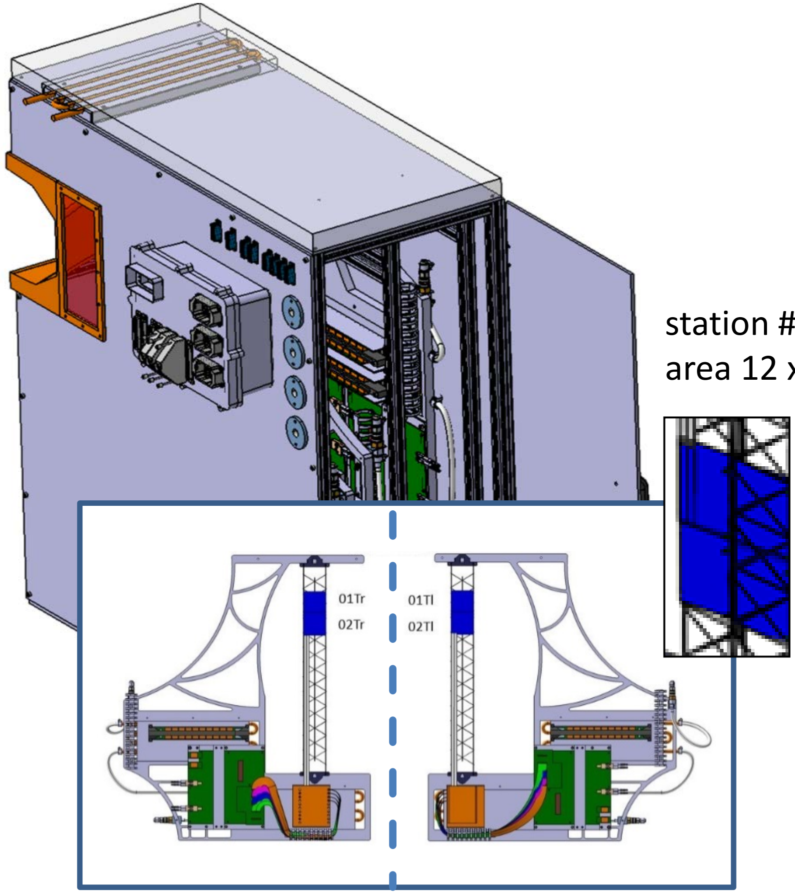


mSTS demonstrator

mSTS – demonstration of:

- C-frame and ladder mounting mechanics
- module and ladder assembly
- LV + HV powering
- liquid cooling of electronics (water)
- module performance, data streaming

no sensor cooling, operation at “room” temperature



station #0
area 12 x 12 cm^2

station #0: C-frames #0 and #1

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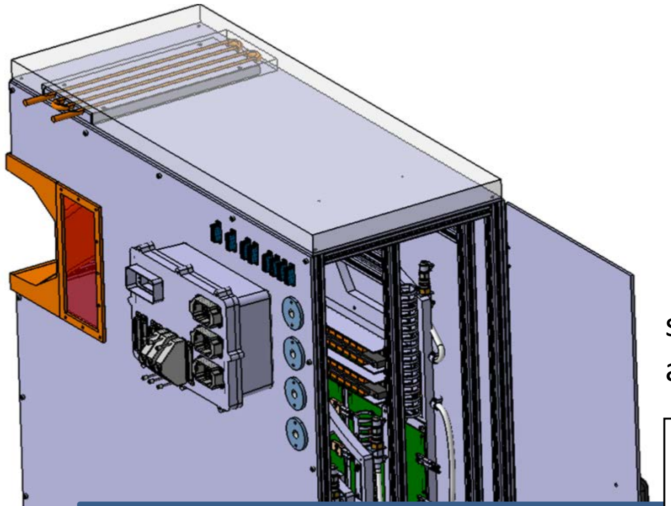

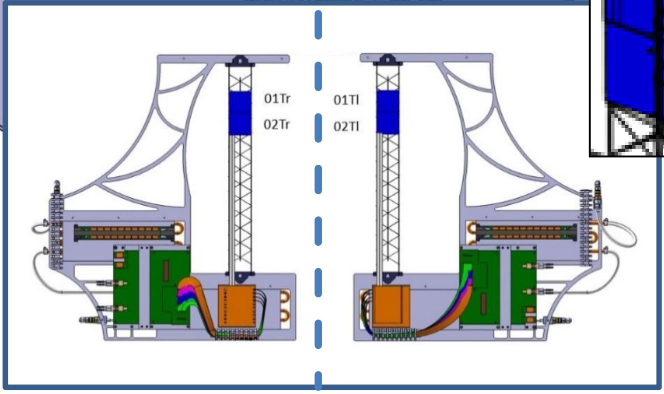

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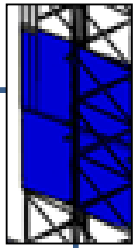
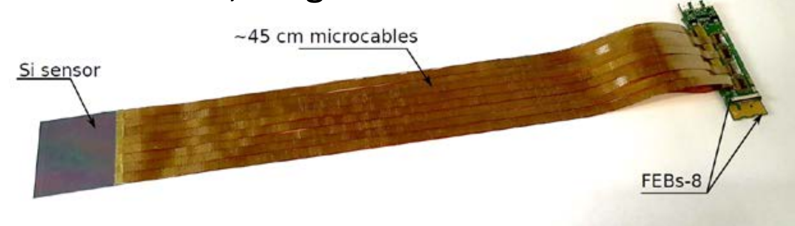
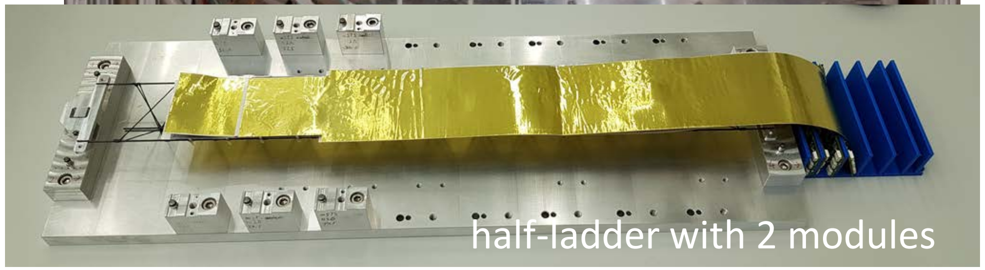


module, longest STS variant





half-ladder with 2 modules

mSTS achievements and findings

Achievements

module assembly

- first full-size modules assembled

ladder assembly

- first half-ladders assembled

system integration

- C-frame assembly
- cooling plates
- powering and read-out electronics
- ladder installation
- cabling
- power supplies in “final” cave location

read-out

- data links stable
- high-rate read-out achieved

Findings

module assembly yield

- all tested components used (sensors, microcables, ASICs)
- microcable attachment yield high
- FEB 8 assembly/operation yield
  too low on the first prototypes
- some modules fading away during (in-beam) operation
  – under systematic study
  – new FEB design, custom designed rad. tolerant LDO, …

noise in longest modules too high *(preliminary)*

- in test box: $\approx$ 1300 e OK
- in mSTS: $\approx$ 3000 e $\Rightarrow$ S/N $\approx$ 8-12
  threshold high
  - under systematic study
  - power supplies, filtering

mSTS achievements and findings

preparations ongoing

Achievements

module assembly
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ladder assembl
- first half-lad

system integra
- C-frame asse
- cooling plate
- powering ar
- ladder instal
- cabling
- power suppl

read-out
- data links sta
- high-rate read-out achieved

approach:
1) in-detail check of module components, FEB-8 v2 and assembly procedure
2) assembly of new modules
3) systematic test in the STS lab
4) if successful, carry out in-beam test at COSY: module in reference fiber hodoscope tracking telescope (Q4/2019)

Findings

module assembly yield
- all tested components used (sensors, microcables, ASICs)
- microcable attachment yield high
- FEB 8 assembly/operation yield

n
- in test box: ≈ 1300 e OK
- in mSTS: ≈ 3000 e ⇒ S/N ≈ 8-12 (preliminary)
  threshold high
  – under systematic study
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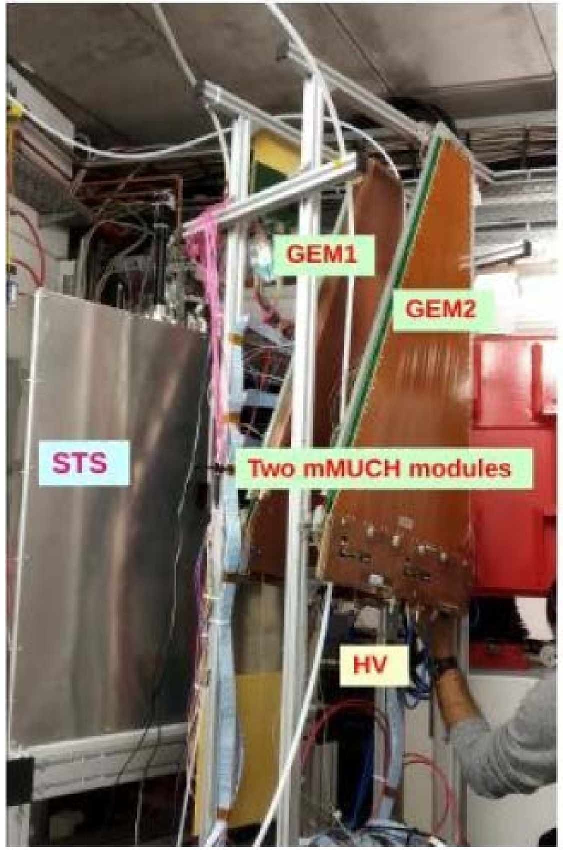
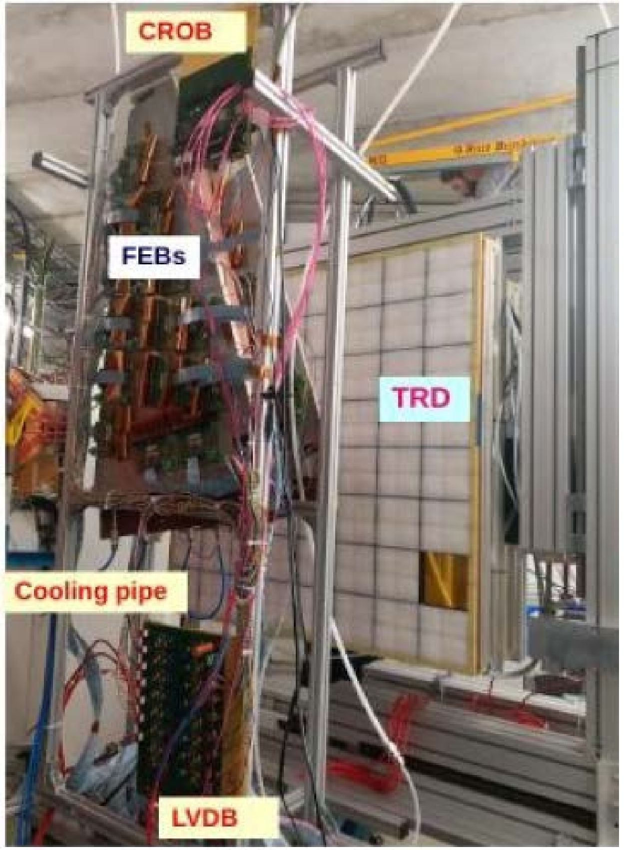
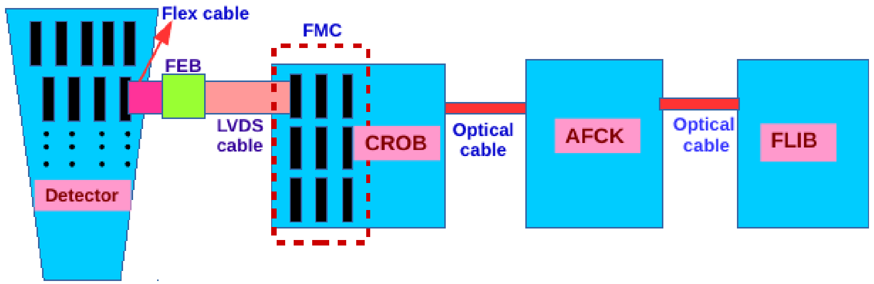
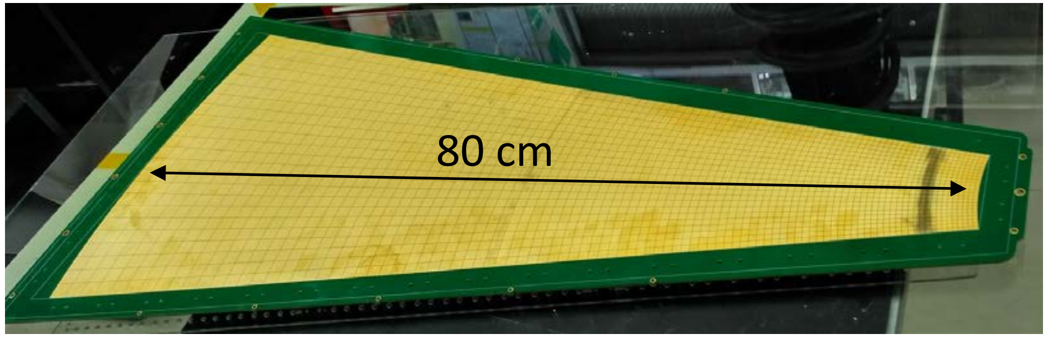
mMUCH demonstrator







~2200 pads, 18 FEBs per chamber



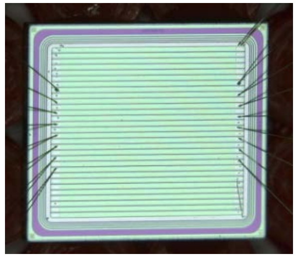
current issues:

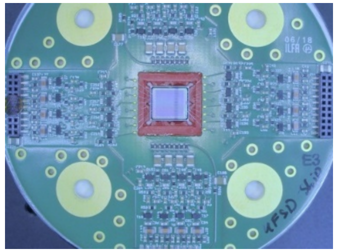
- noise in one chamber
- data synchronization in one chamber
- modification in LV system for upcoming mCBM running

(2) UFSDs tested at COSY (4/2019) for HADES + CBM@FAIR

Ultra Fast Silicon Detectors:
A novel technology based on low-gain avalanche diode:

- excellent timing properties, time precision below 100 ps
- well established, cheap, production process
- on-going R&D (ATLAS/CMS)





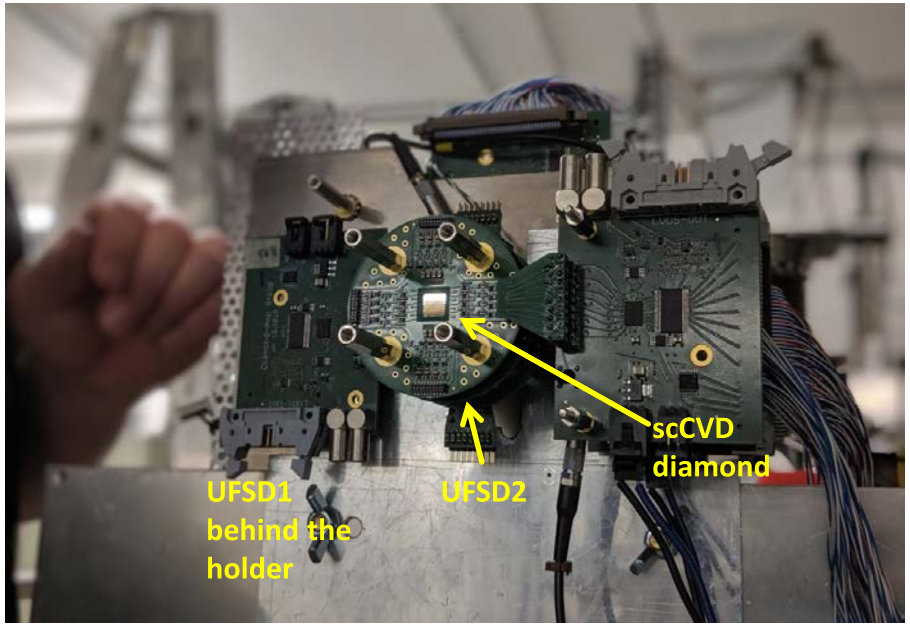
First FBK Production of 50μm Ultra-Fast Silicon Detectors

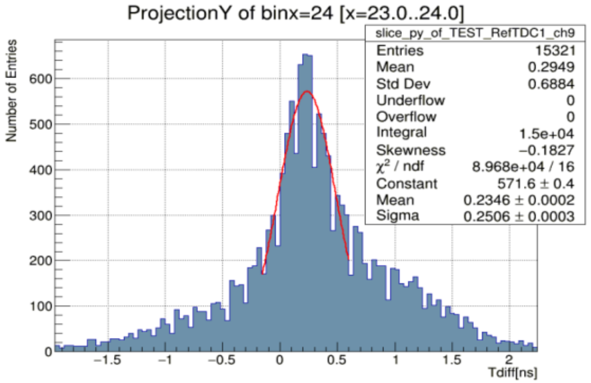
V. Sola[a,b,*], R. Arcidiacono[c,b], M. Boscardin[d,e], N. Cartiglia[b], G.-F. Dalla Betta[f,e], F. Ficorella[d,e], M. Ferrero[a,b], M. Mandurrino[b], L. Pancheri[f,e], G. Paternoster[d,e], A. Staiano[b]

Sensors delivered from INFN Torino and FBK Trento

NIM A924 (2019) 360-368

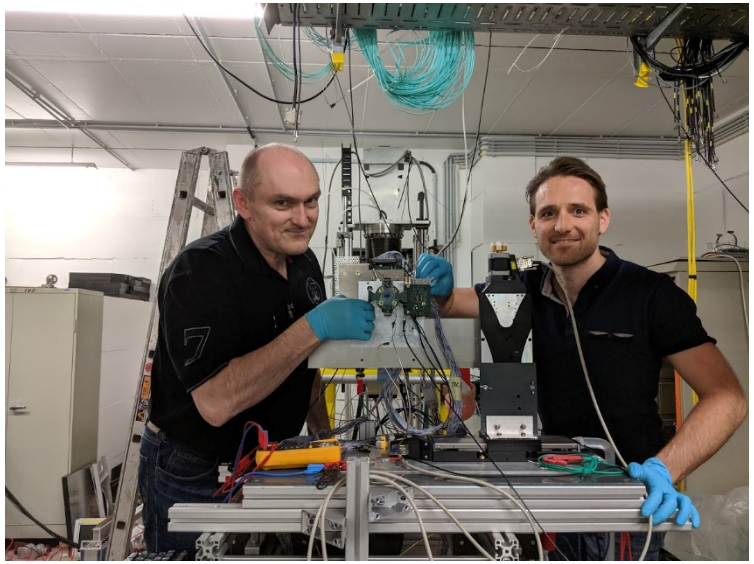
Jerzy Pietraszko (GSI) et al.



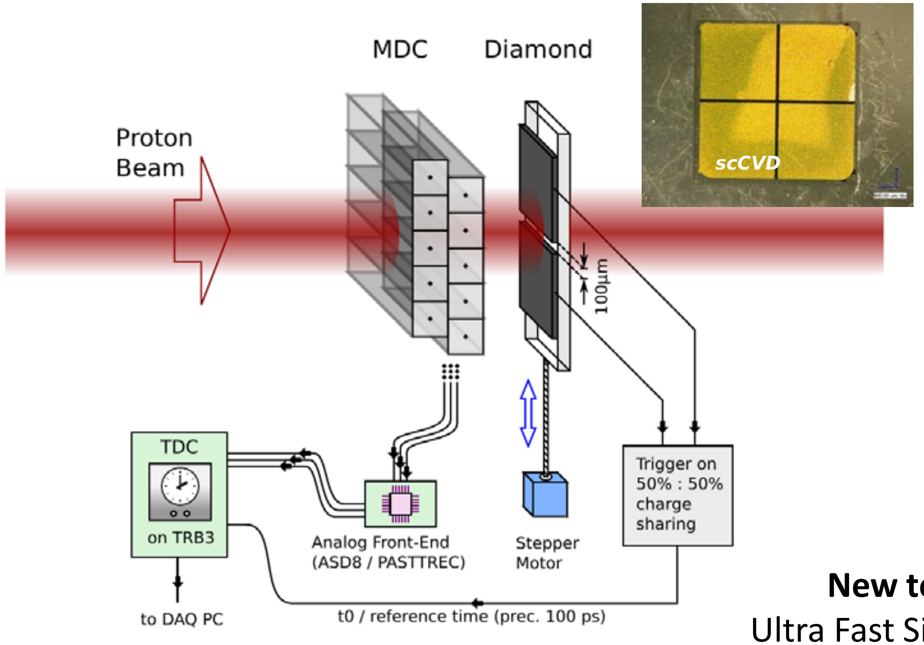


Online results:

- time precision 250 ps / 1.4 = 178 ps
- detailed analysis on-going
- further tests needed with improved detector stabilities



UFSDs: Further tests at COSY in Q4/2019

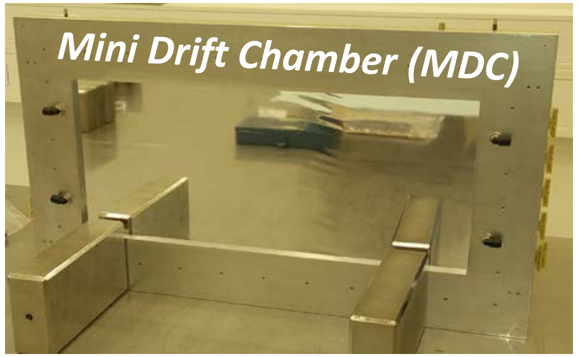


Goals:

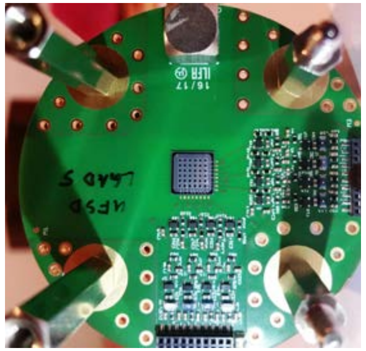
- Study drift velocity map inside drift cell, gas mixture dependency
- Measure spatial resolution of new drift cell geometry (2.5 x 5 mm²)

Setup:

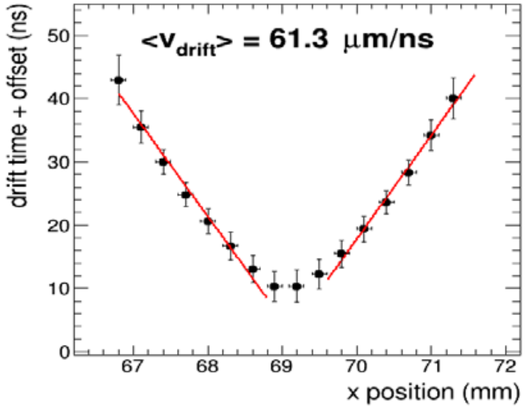
- HADES Mini Drift Chamber (MDC)
  - 50 x 20 cm² active area
  - 2 drift cell layers, each 80 cells
- reference / tracking by Silicon or Diamond detector:
  - 4 channels, 100 µm gap (diamond)
  - 36 pixels, active area: 4.5 x 4.5 mm²
  - time precision < 100 ps
  - movable (µm step precision)



New technology
Ultra Fast Silicon Detectors



set-up ready



drift time inside a MDC prototypeV1 (5 x 5mm²) drift cell as function of perpendicular distance to sense wire (measured by same setup 2017 @ COSY)

Fault Tolerant Local and Monitoring & Control

Reasons to develop FTLMC

- SEE’s are problematic and can result in serious malfunctions
- ARM produces intellectual property fault tolerant processors:
  - Safety and redundancy: arm7v4 **Cortex R5F**
  - Vendor that produces such a chip: **TI- TMS570**
  - Task: Build a control board based on that chip: **FTLMC**
- Robustness in detector environment

Goethe Universität Frankfurt

Test at COSY 2/2018:

Cortex-R chip (TI-TMS570)

- exposed directly to beam during 13 hours
- beam: 2 Gev Protons 10^5 per bunch
- total detected and corrected SEU’s:
  - in Bank A: 718, in Bank B: 686
- no unrecoverable errors
- failure registers continuously monitored
- database with error time-stamp
- no errors during beam off times detected

To be tested at COSY Q4/2019:

new FTLMC board

set-up ready

Beamtime application at COSY for Q4/2019

Aim: Test CBM detectors equipped with new STS-XYTER v2.1 ASIC – shifted from Q2/2019

In order to exclude any potential risk regarding the qualification of the front-end electronics towards STS-XYTER Production Readiness, carry out further, dedicated test of the detectors:

- STS module – in proton beam at COSY, allowing full characterization
- [MUCH GEM chamber – better placed in mCBM environment for the DAQ support, power supply study]

Further aim:

- refined tests of Ultra Fast Silicon Detectors
- SEE stability tests of Fault Tolerant Local and Monitoring & Control board

Prototypes of the detectors/boards either are ready or will be ready.

One week of beamtime in JESSICA Cave will be sufficient to operate and to test the detectors.

Beamtime application at COSY for Q4/2019

Total number of particles and type of beam (p,d,polarization)	Momentum range (MeV/c)	Intensity or internal reaction rate (particles per second)	
		minimum needed	maximum useful
p	**p ~ 3000**	**~ $10^4 - 10^6$**	**up to 10^8**
Experimental area	Safety aspects (if any)	Earliest date of installation	Total beam time (No.of shifts)
JESSICA Cave	**None**	**one week at turn of Oct./Nov. 2019 (e.g week #45)**	**7 days around the clock**

- Experimental set-up:
  - JESSICA cave
  - test beam table installed
  - additional space in rack room close to the JESSICA door
  - "Wasaquarium" as control room
- During the tests, access to the cave will be required in order to reconfigure the set-up, days and nights. The participating teams will be of moderate size in personnel.
- Delivery and installation of equipment during the week prior to the beam time could be helpful and efficient for the timely start of using the beam.

to be tested:

(1) STS module, (2) MDC-UFS detector, (3) FTLMC board

Preview of medium term plans for in-beam tests at COSY

- First (parasitic) heavy-ion beam was delivered to mCBM in March 2019.
- A first production run will take place in Spring 2020.
  - technical tests in November 2019.
- It is planned to extend running of mCBM further.
  - Depending on how future beamtimes beyond 2020 may be realized within the FAIR-Phase 0 activity, CBM subsystem studies before series production of components and modules/sectors might need additional testing places, including COSY, in the foreseeable time 2020 – 2022.
- Independent of the ongoing preparations for CBM, small test systems comprising new detector developments may be studied at COSY using the close-to-minimum ionizing protons in well focused beam.