MIMOSIS-3 ASIC PRR
Welcome

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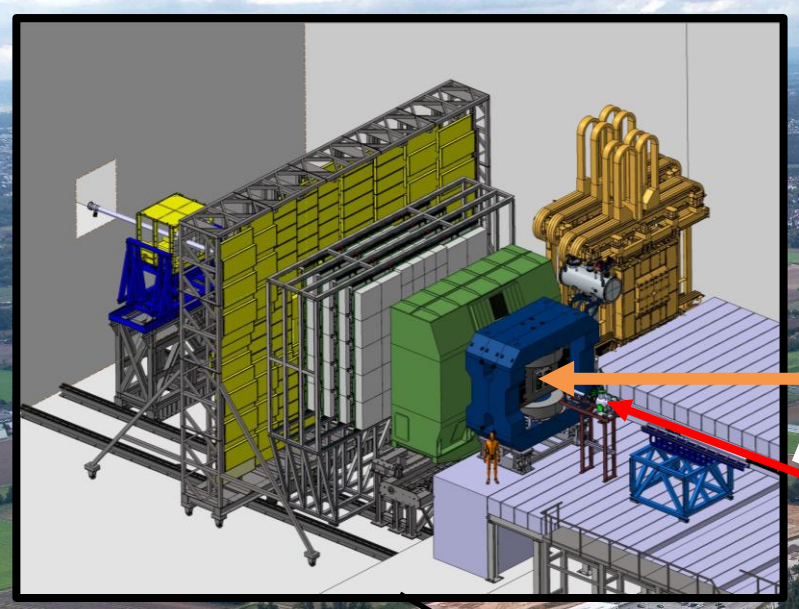
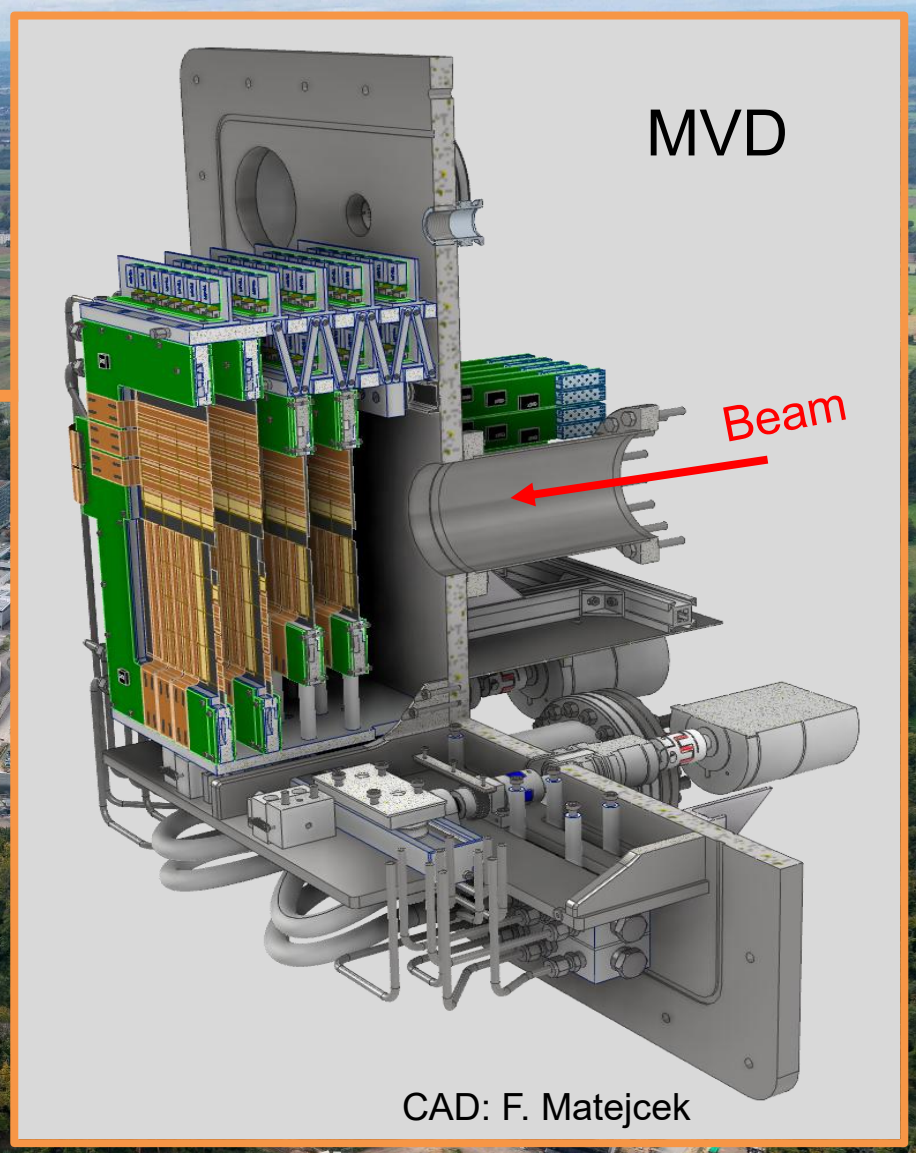
Compressed Baryonic Matter (CBM) experiment @ FAIR





CAD: F. Matejcek

Aim of the CBM Micro Vertex Detector (MVD):

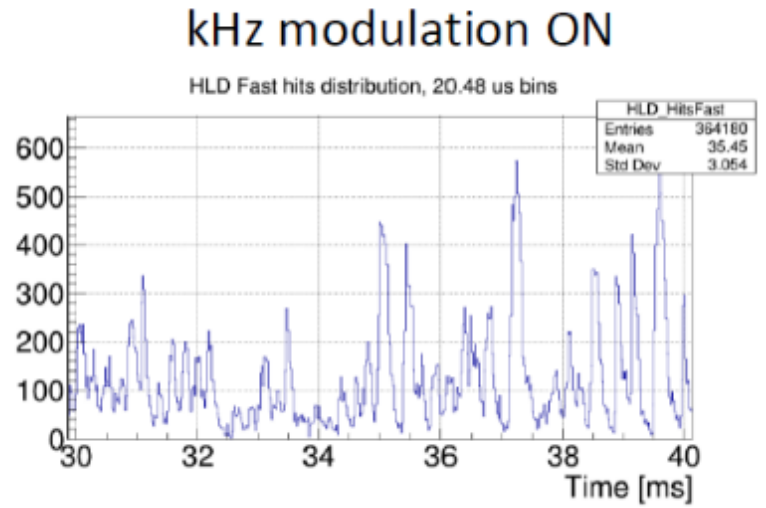
- Open charm reconstruction
- Low momentum tracking
- …

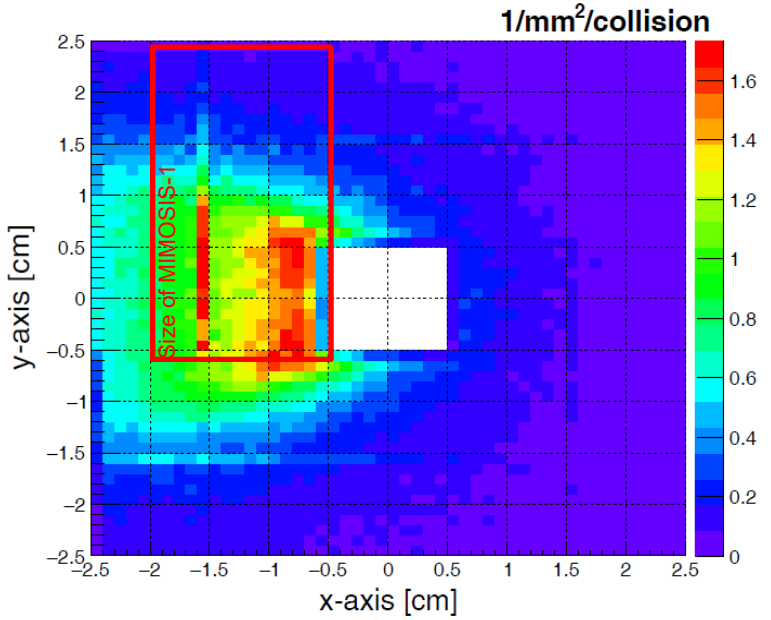
=> $\sigma = 5\ \mu m$ and <0.5% X_0/layer.

at 100 kHz ~10 AGeV Au+Au collisions.
10 MHz ~30 GeV p+Au collisions.

Requirements on the sensor

	Requirements
Spatial, time resolution	~5 µm, 5 µs
Sensor thickness	~ 50 µm
Power dissipation (in vacuum)	<100 mW/cm²
Radiation doses	7×10^{13} n_{eq}/cm² → ~10 x ALPIDE ~ 5 MRad
Radiation gradient over sensor	~ 100%
Heavy ion tolerance	1 kHz/cm²
Rate (average/ 35 µs peak)	20 / 80 MHz/cm² → ~20 x ALPIDE (internal)





Need to design customized sensor for CBM: MIMOSIS
(Minimum Ionizing MOs active pixel sensor for experiments at and beyond the SchwerIonen Synchrotron)

⇒ Derive from ALPIDE (priority encoder readout) in TJ180nm.
⇒ Add fully depleted sensing node.
⇒ Re-design digital front- and back end (higher bandwidth, elastic buffer…)

MIMOSIS R&D plan

MIMOSIS-0 (2018)
- Demonstrate pixel concept. ✓
- Demonstrate zero suppression. ✓
- Demonstrate readout concept. ✓

MIMOSIS-1 (2020)
- Full dimension sensor ✓
- Add buffer structure. ✓
- SEE hardening 1/2 ✓

MIMOSIS-2/2.1 (Q2/2023)
- On-chip pixel grouping. ✓
- Final pixels. ✓
- SEE hardening 2/2 ✓

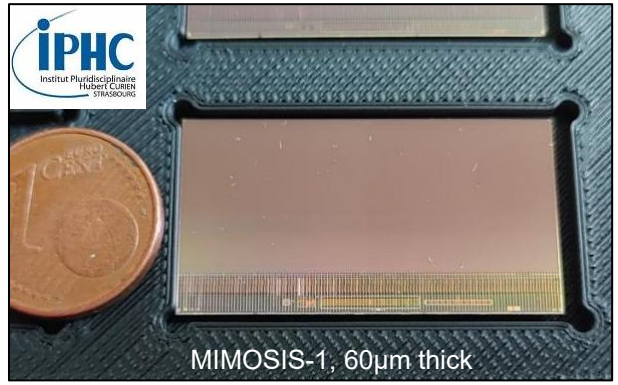
MIMOSIS-3
- Final sensor for mass production

Add features
Fix issues
Design optimization

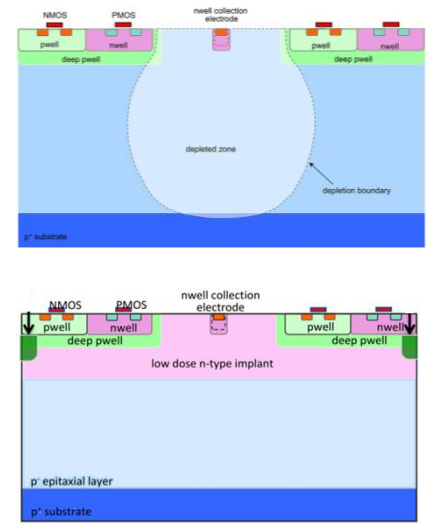
Add features
Fix issues
Design optimization

Final design choice
Fix issues

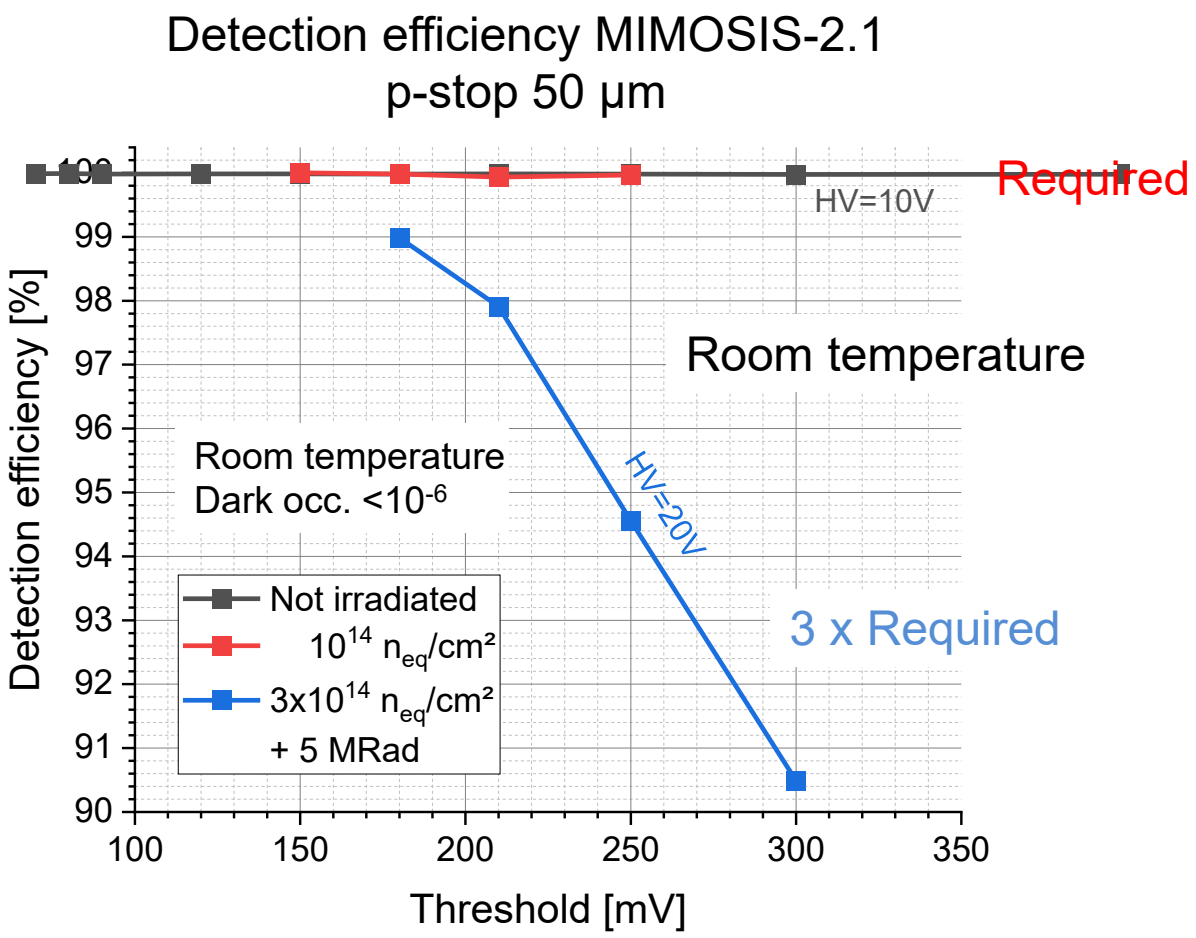
e.g. epi type



MIMOSIS-1



MIMOSIS 2.1 test results (produced 2025)



Response to beam ions (simulated beam impact)

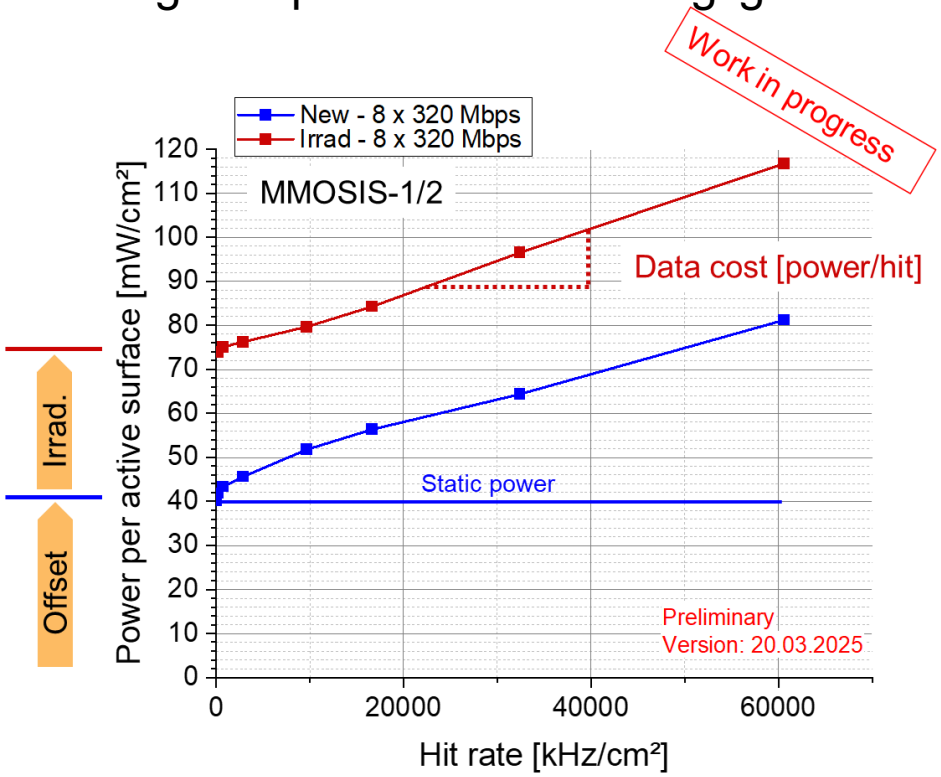
Non standard settings

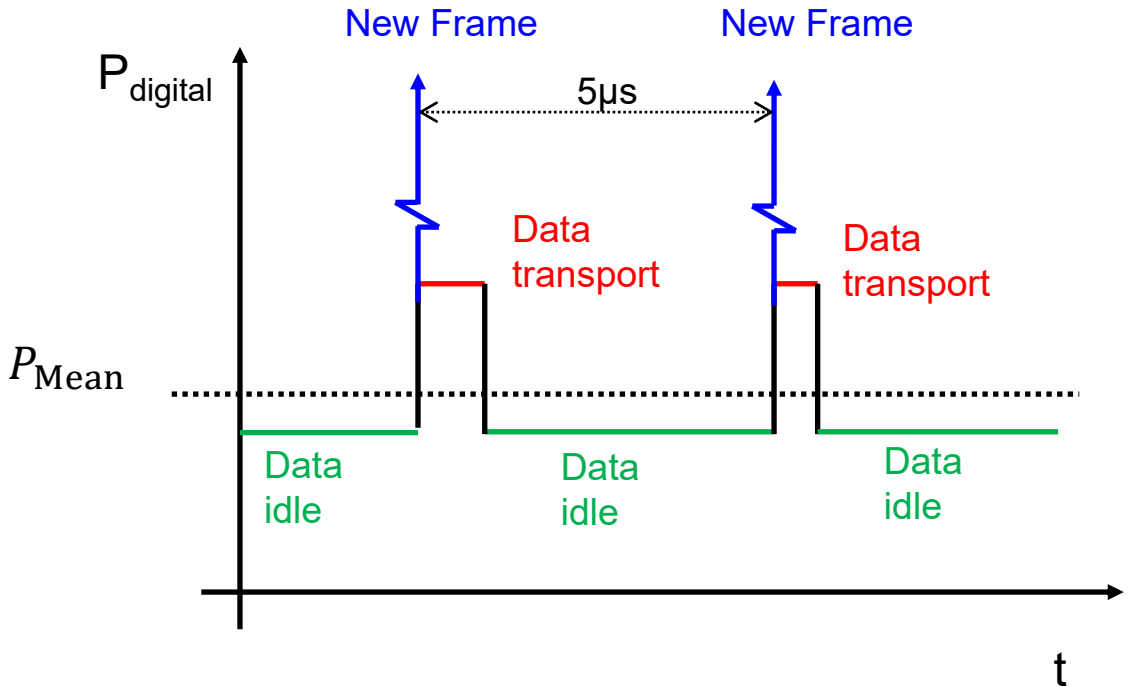
MIMOSIS-2.1 fulfills CBM requirements incl. spat. resolution and dark rate…
if operated in test system.

Operating MIMOSIS in experimental environment

MIMOSIS will be operated with single layer flex print cables.

- No nearby voltage regulators (rad. hardness issue).
- Voltage drops in cables not negligible





Voltage drops on all frequencies (few 10 ns to ~1s spill breaks) must be tolerated with realistic cables.
PLL & data links showed weakness => being reworked with help of reviewers.

Independently: Constraints from attempt to reduce traces on flex print cables.
Our conclusion (reported to ECE): MIMOSIS-3 is a high-risk submission.

The task of today

MIMOSIS-3 is designed as the final sensor for the CBM experiment:

- Limitations by time line and budget don't allow for re-submission.
- Must work the first attempt.
- PLL issue was spotted early, initial mitigation strategy remained insufficient.
- Sensitivity to powering voltage fluctuations only understood during system integration studies (delayed funding of system integration).
  - Addressed as soon as observed. Still:
    => need "last minute changes".
    => MIMOSIS-3 turned into a high-risk submission.

Intense work on the measurement side and on the ASIC side was performed to ensure success.

The purpose of this review: Minimize submission risks.

The question of this review:

"Are we ready (within few weeks) for sensor submission?"

1) Yes:
   - Please document this answer in a written form for the FAIR-ECE (CERN-LHCC equivalent).
   - Document will be considered in full PRR scheduled about Feb. 2025.

2) No: Please help to build a comprehensive check list on the steps required to arrive at 1)