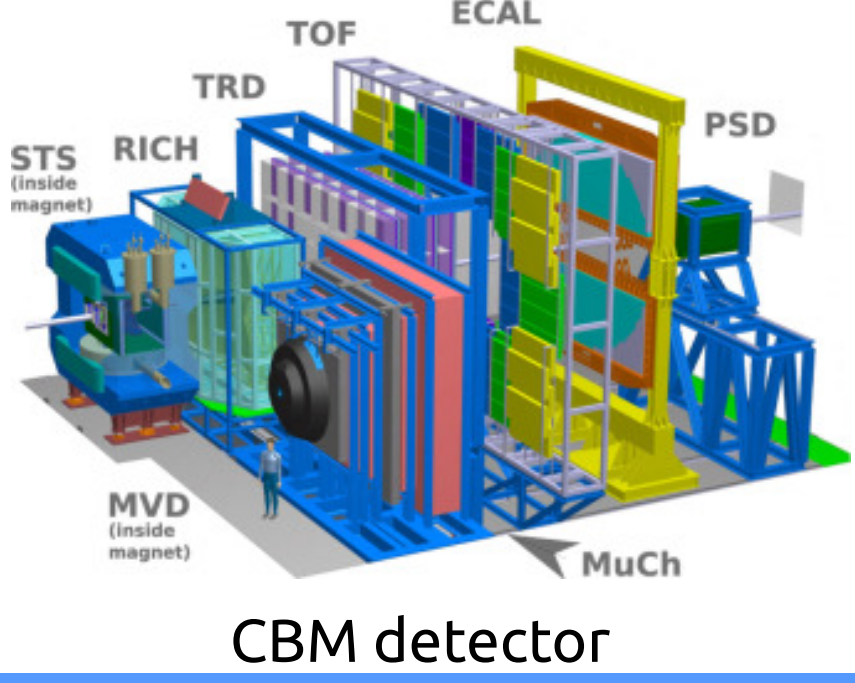
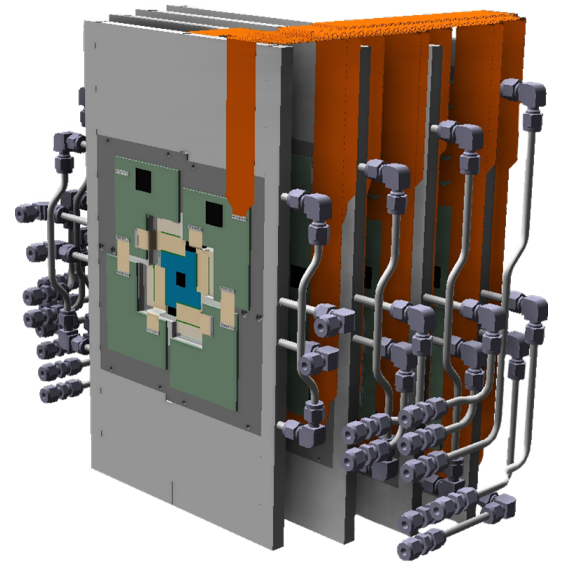


Motivation: The MVD of the CBM experiment



CBM is designed to explore the phase diagram of nuclear matter in the region of high baryon densities. Reconstructing rare particles is a key point to reach the CBM physics goals.

The **Micro Vertex Detector (MVD)** is designed to be the first sub-detector downstream of the fixed target. The MVD will rely on 50 μm thin **CMOS Monolithic Active Pixel Sensors** named **MIMOSIS** that will operate in vacuum.



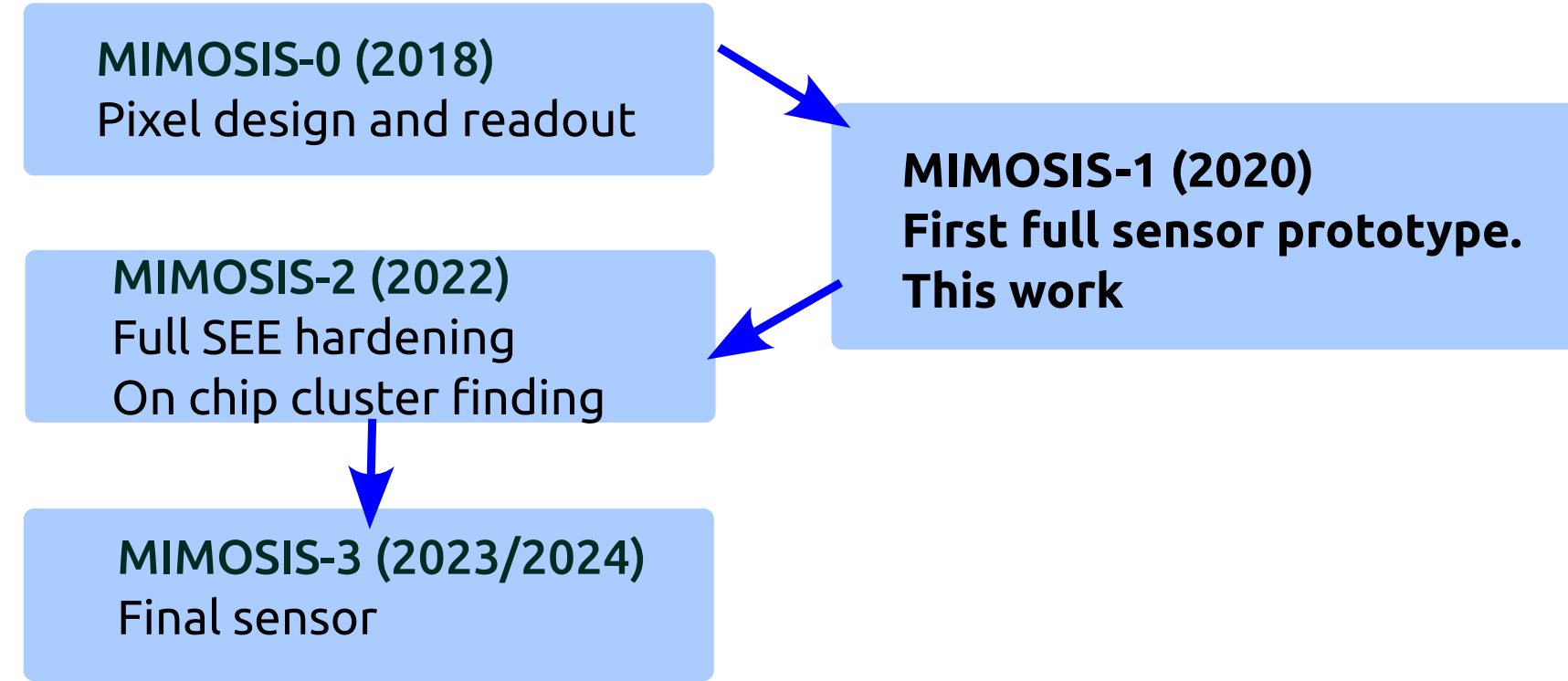
MVD detector

MIMOSIS Monolithic Active Pixel Sensor

Requirements:

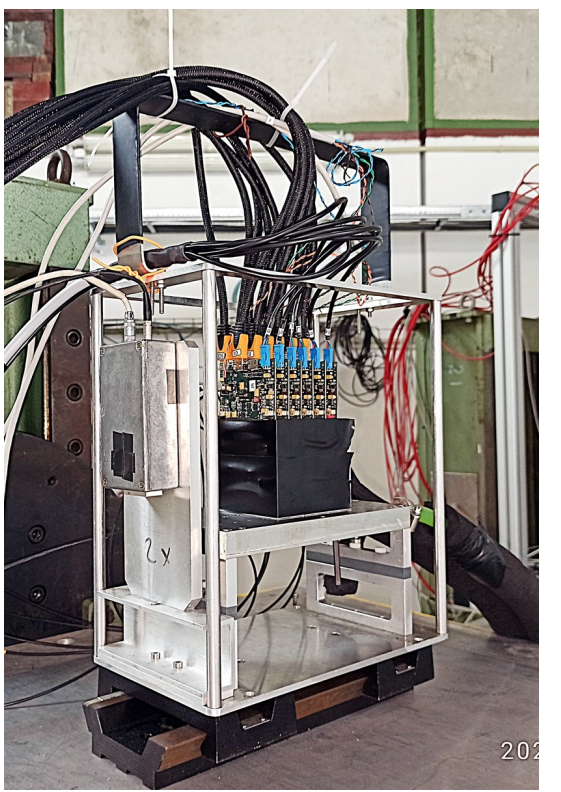
spatial & time resolutions	$\sim 5 \mu\text{m}$ & $\sim 5 \mu\text{s}$
sensor thickness	50 μm Si (0.05% X_0)
power dissipation (full hit density)	$< 100 \text{ mW}/\text{cm}^2$
operation temperature	-40°C to $+30^\circ\text{C}$
Radiation tolerance (non-ionizing)	$\sim 7 \times 10^{13} n_{\text{eq}}/\text{cm}^2$
Radiation tolerance (ionizing)	$\sim 5 \text{ MRad}$
radiation gradient on chip	100%
Rate (average/peak)	20/80 MHz/cm^2

R&D program:



Test program:

place	date	beam	Aim
GSI	03/21	Pb	SEE
GSI	05/21	Xe	SEE
DESY	06/21	e^-	performance, non irradiated (non-irr here after)
DESY	09/21	e^-	performance, X-ray irradiated
CERN	10/21	pion	performance, neutron irradiated
DESY	02/22	e^-	performance, combined irradiated
COSY	03/22	deuterium	performance, dE/dx
GSI	05/22	Ca	SEE

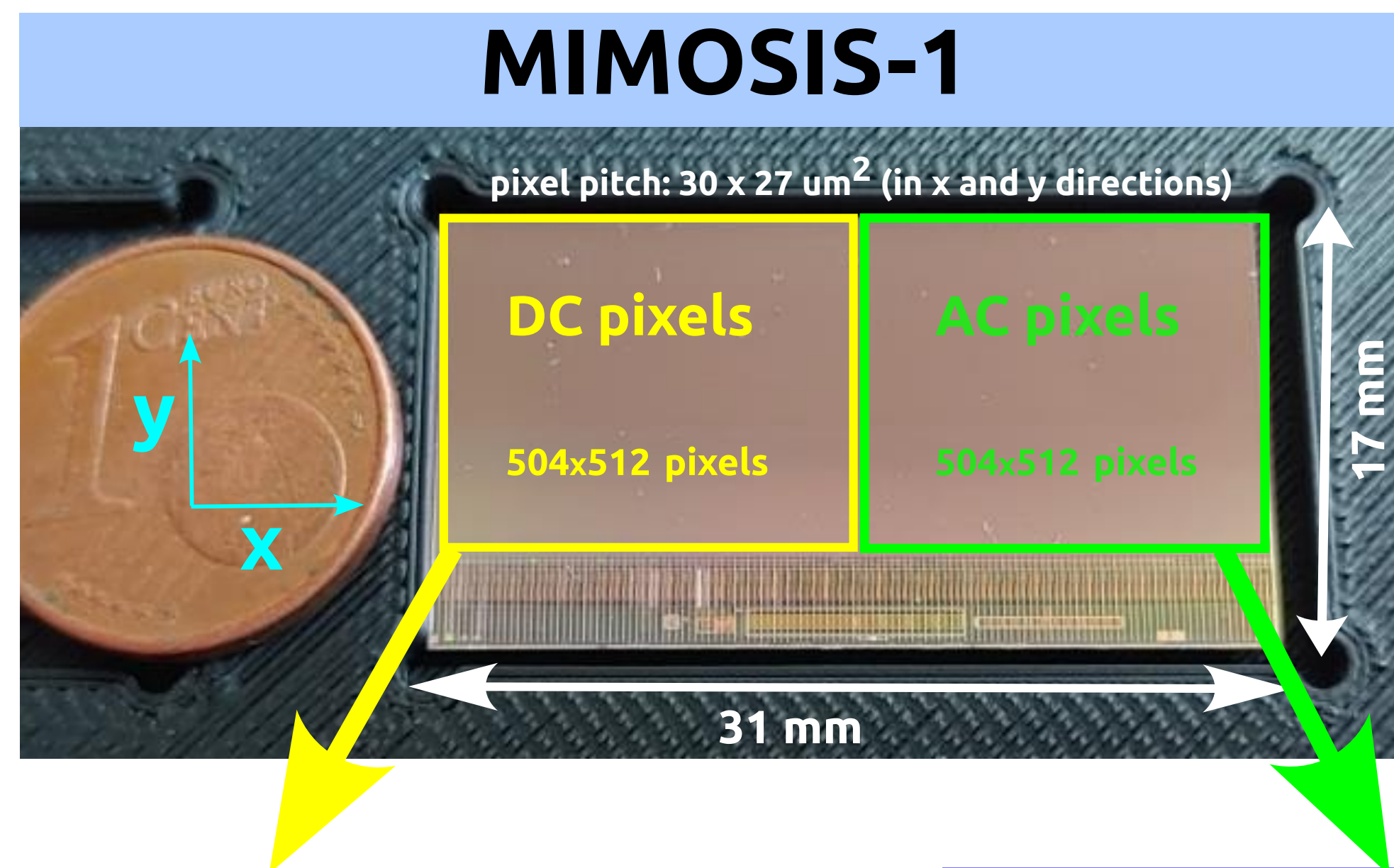


The MIMOSIS-1 Telescope

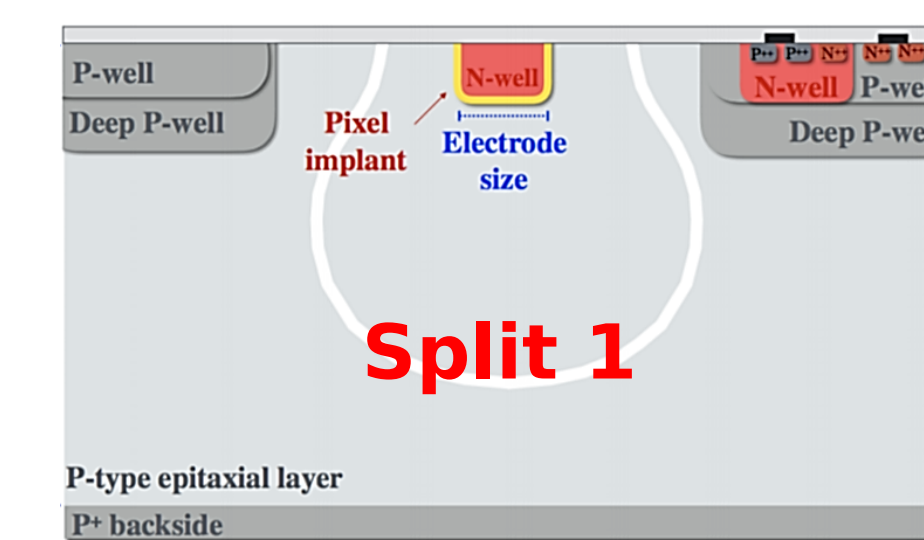
MIMOSIS-1 features and performance

Technical information:

Technology: TowerJazz CIS 180 nm
pixel pitch: 30 x 27 μm^2 (in x and y directions)
chip size: 31 x 17 mm^2
 504 x 1024 pixels
 25 μm thick epitaxial layer
Readout: continuous readout, global shutter
Time resolution: 5 μs
Data link: 8 x 320 Mbps
 Up to 3V back bias

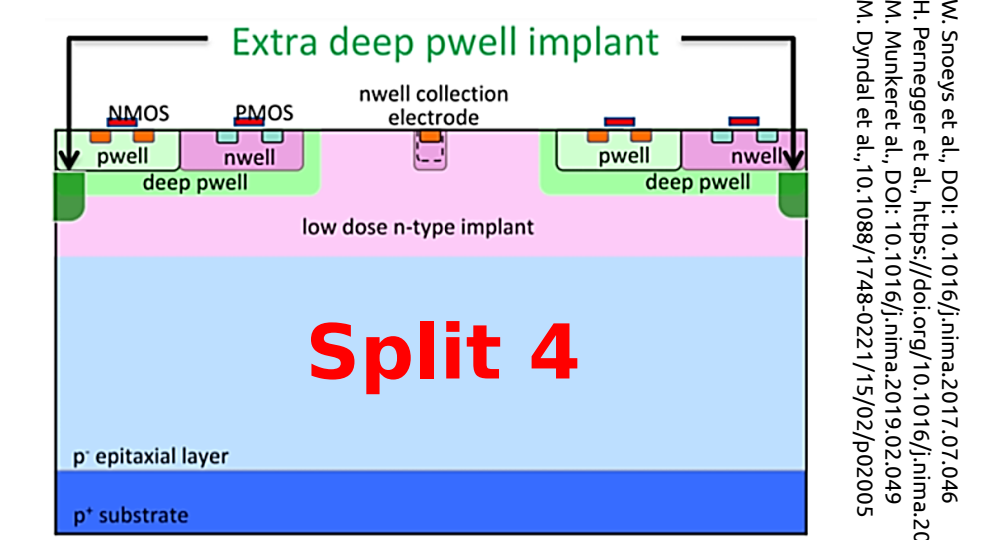


Sensing node options (2 out of 6)



Standard pixel:

- Partially depleted.
- Best spatial resolution expected.
- Restricted radiation tolerance expected.

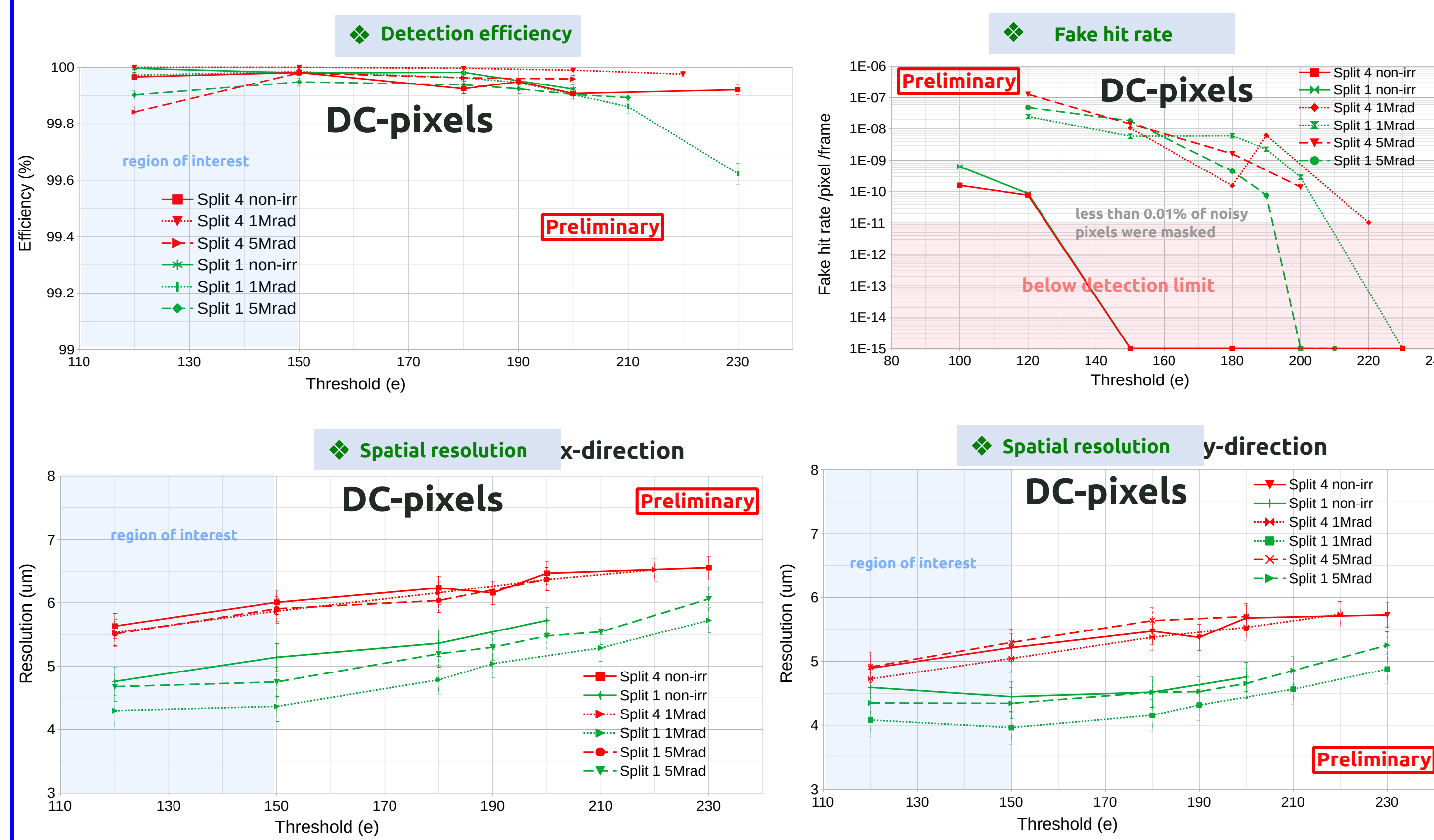
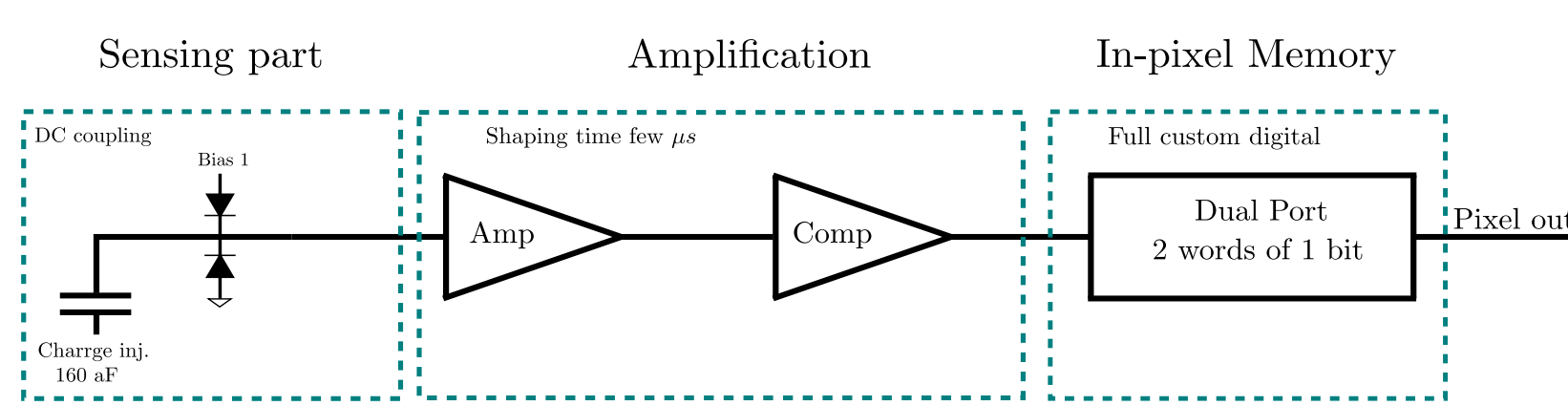


P-stop at pixel edge:

- Fully depleted.
- Spatial resolution?
- Improved radiation tolerance expected.

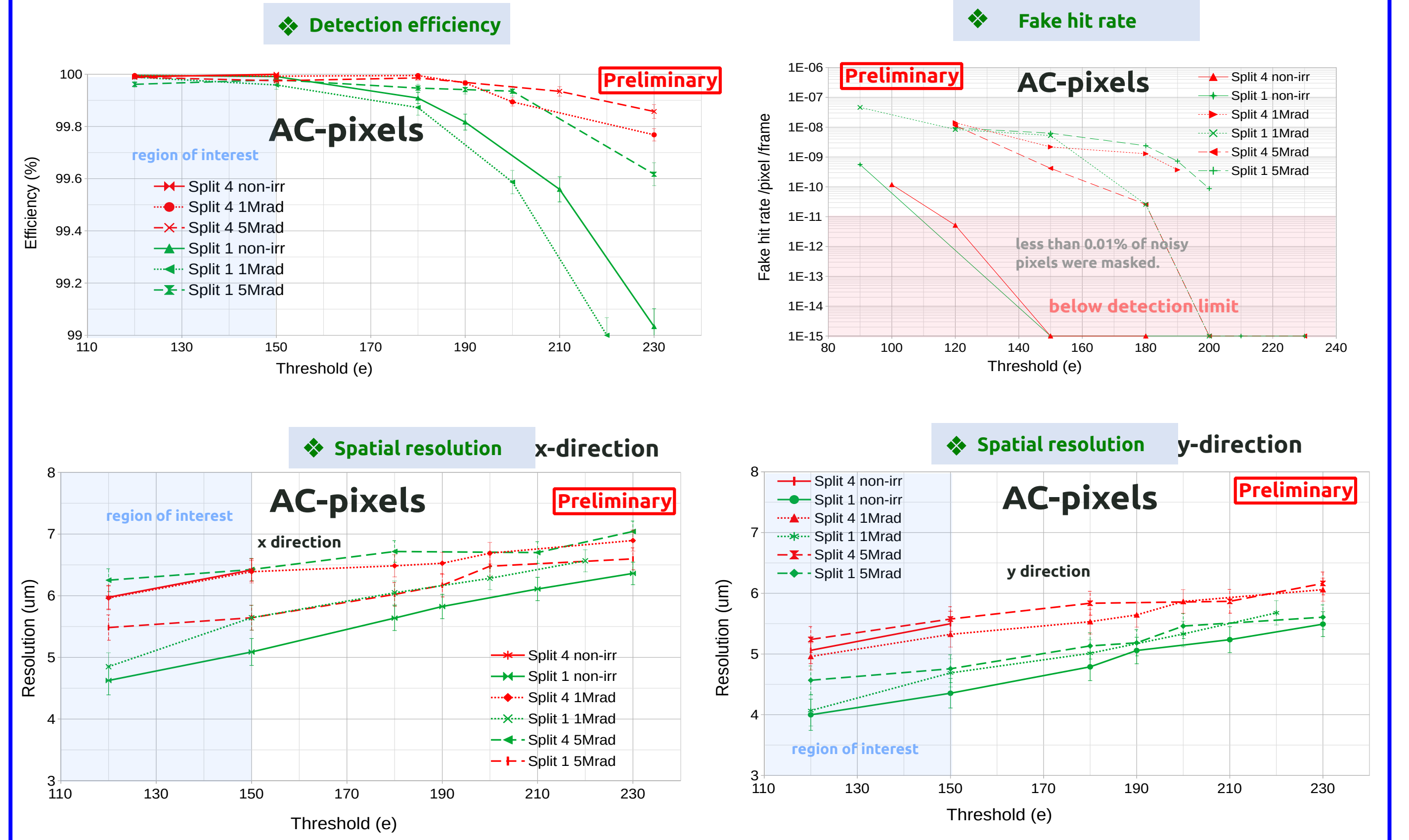
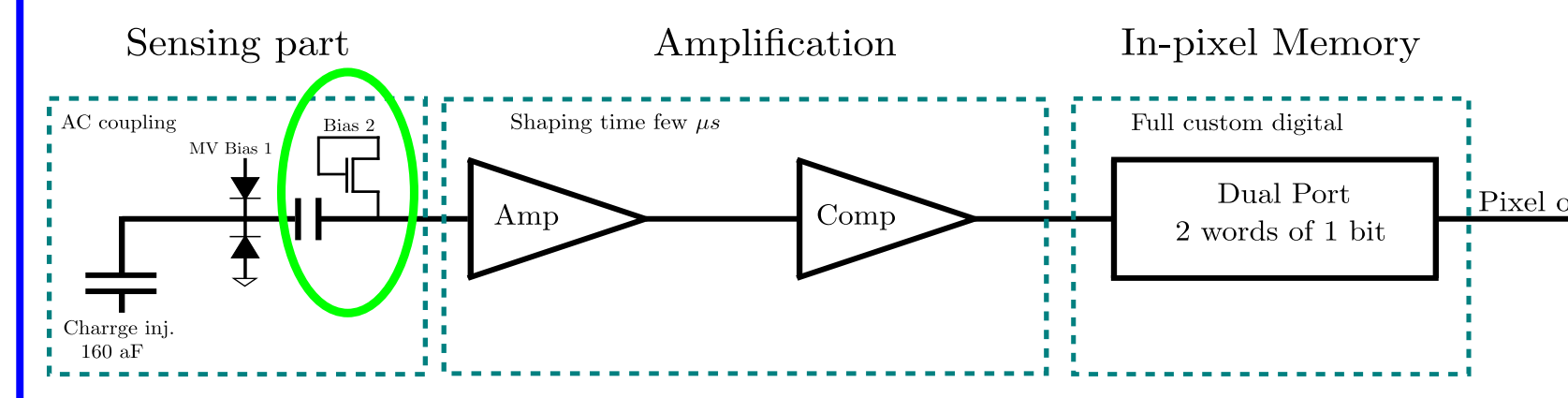
DC pixel option

- Proven design (ALPIDE)
- Lowest pixel capacitance
- Partial depletion



AC pixel option

- Up to 40V depletion voltage
- Top bias, no post-processing
- Full depletion possible



at 150e- and ~18°C:

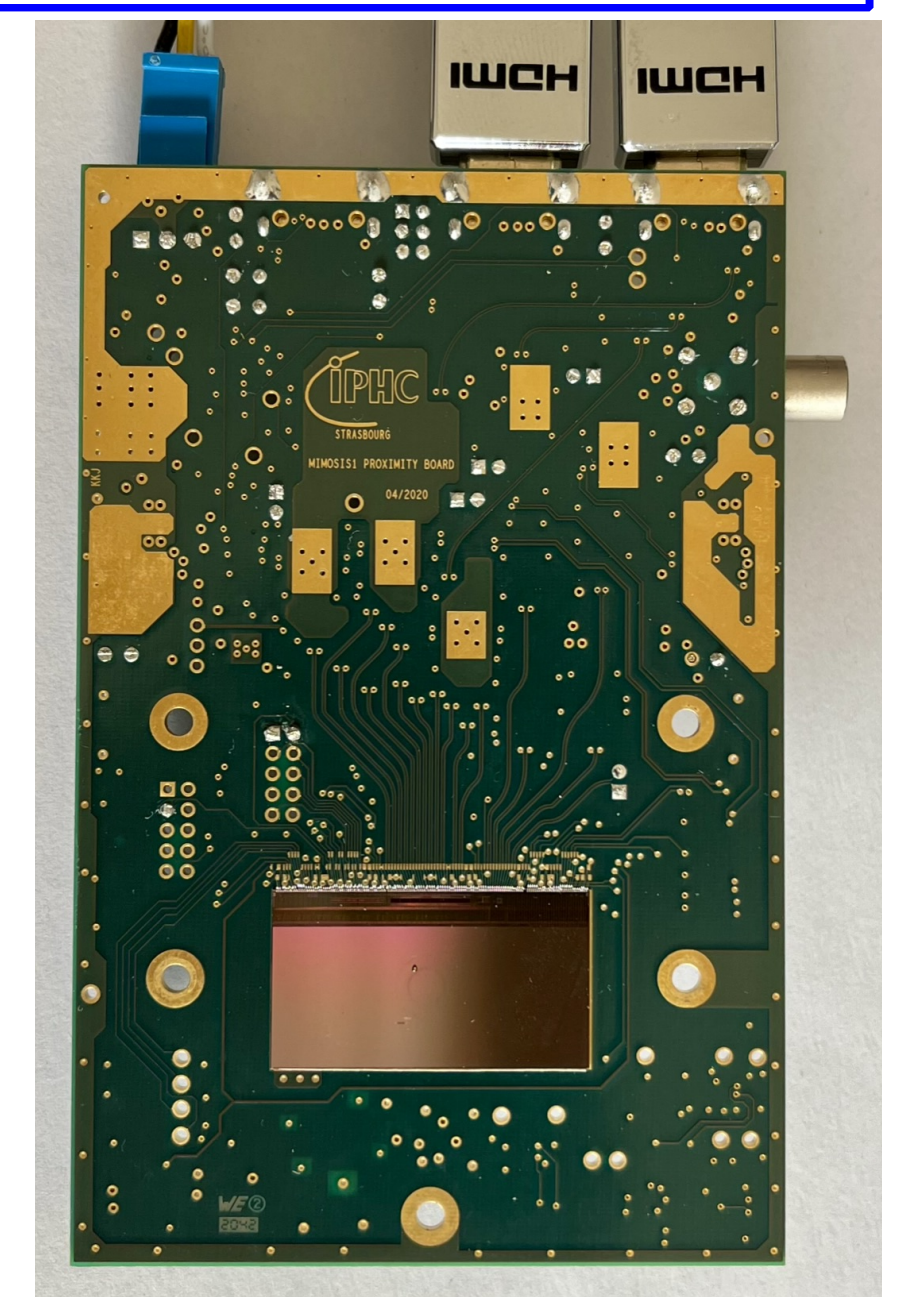
Before irradiation:
 FPN: 6-8 e^-
 Thermal noise: 3-5 e^-
 After irradiation (5MRad):
 FPN: 10-13 e^-
 Thermal noise: 5-8 e^-

Chips were irradiated with X-ray tube at KIT in Karlsruhe, Germany. Around 18 hours were needed to reach the 5MRad dose expected to be reached in one year CBM run.

-3V back bias and 10V HV top bias (in the case of the AC pixels) were used.

Summary & conclusion

- ✓ MIMOSIS is the CMOS Monolithic Active Pixel Sensor designed for the CBM-MVD.
- ✓ The results from the first tests on MIMOSIS-1, the first full dimension sensor, comply well with the sensor requirements.
- ✓ MIMOSIS showed tolerance to the 5 MRad ionizing radiation dose expected during one CBM year run.
- ✓ More chips have to be tested to check for chip-to-chip variations.
- ✓ MIMOSIS will be made available for interested users beyond CBM.



MIMOSIS-1 sensor on a PCB