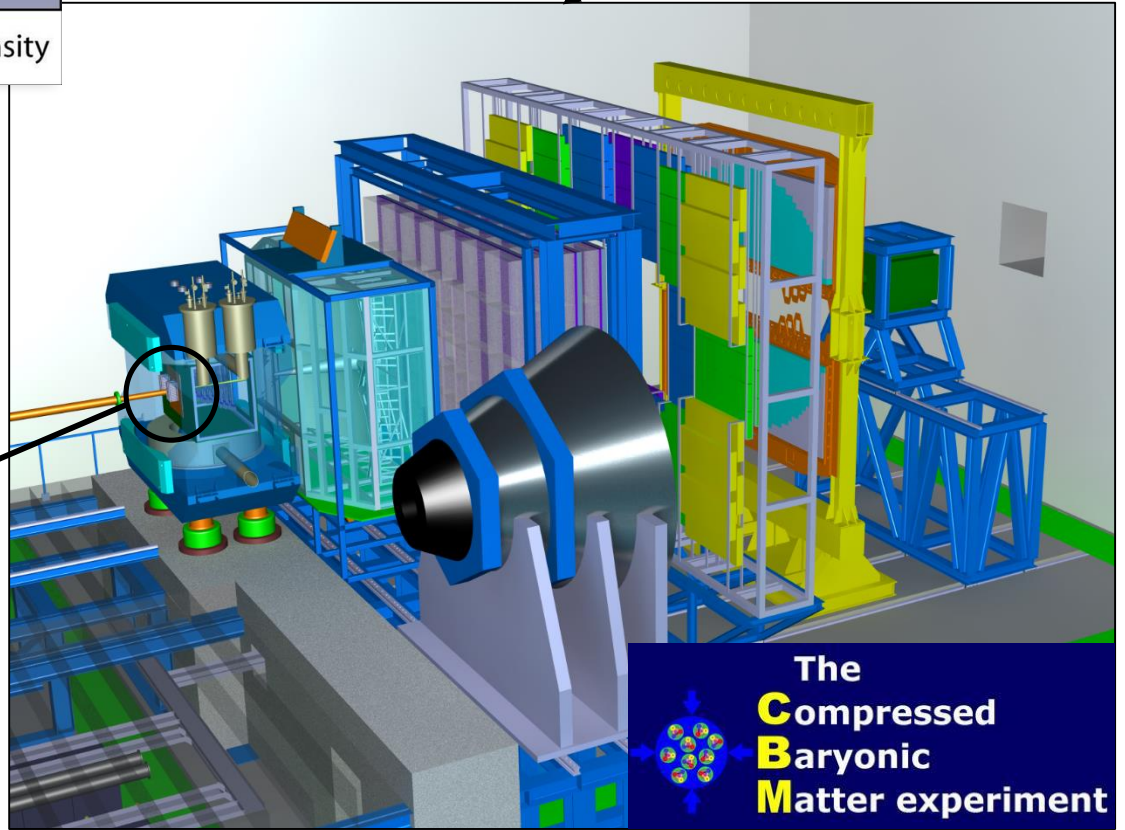
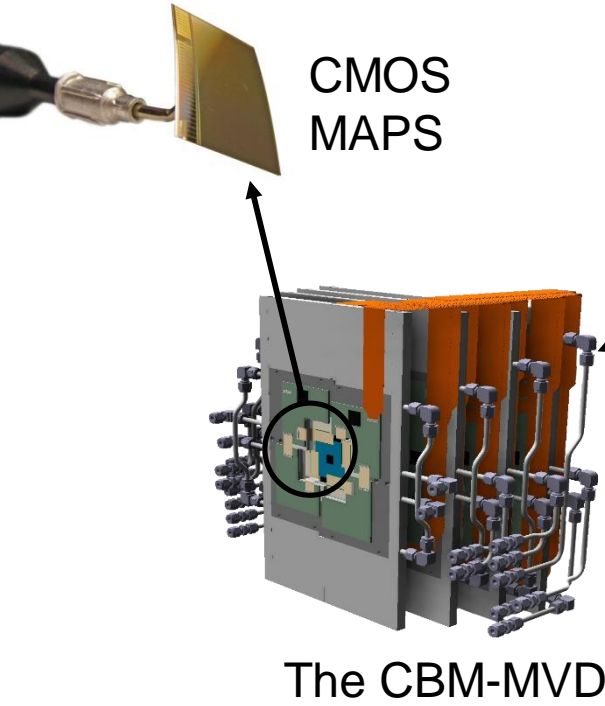
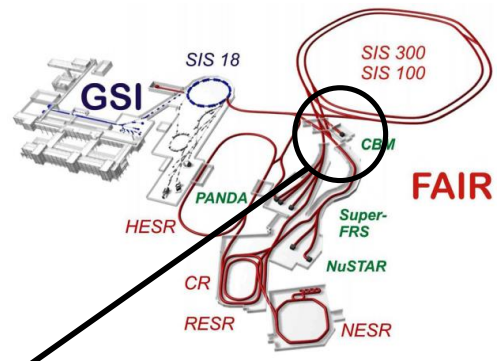
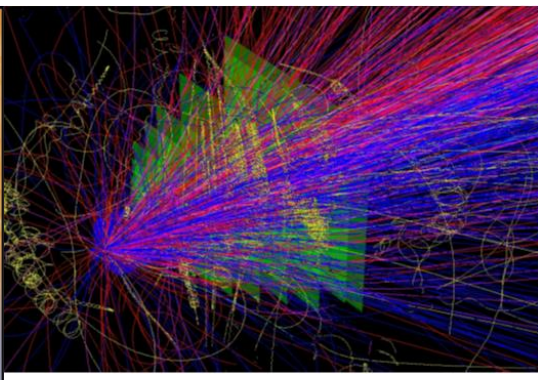
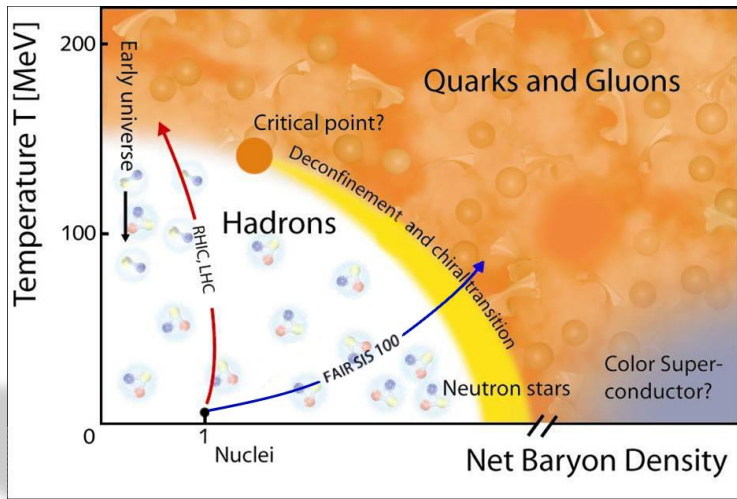
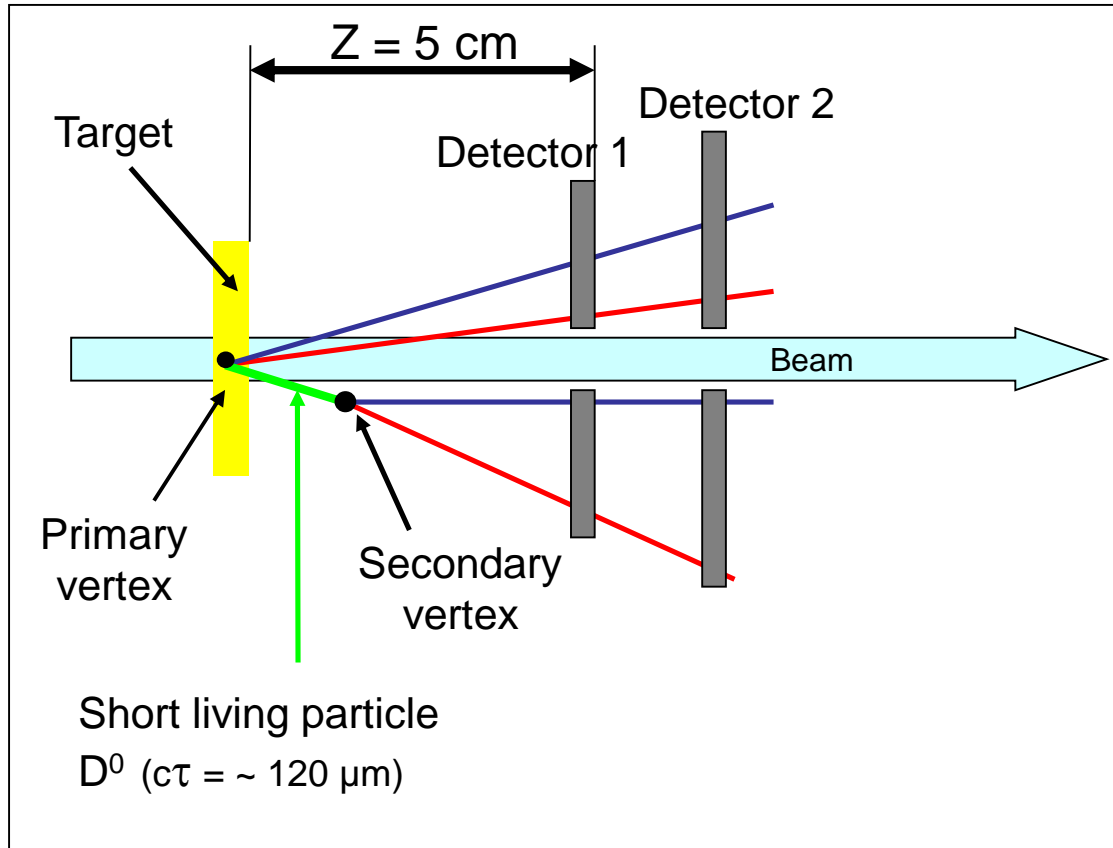


Status of the radiation hardness of CMOS Monolithic Active Pixels Sensors for the CBM experiment

Benjamin Linnik
on behalf of the CBM-MVD-Collaboration

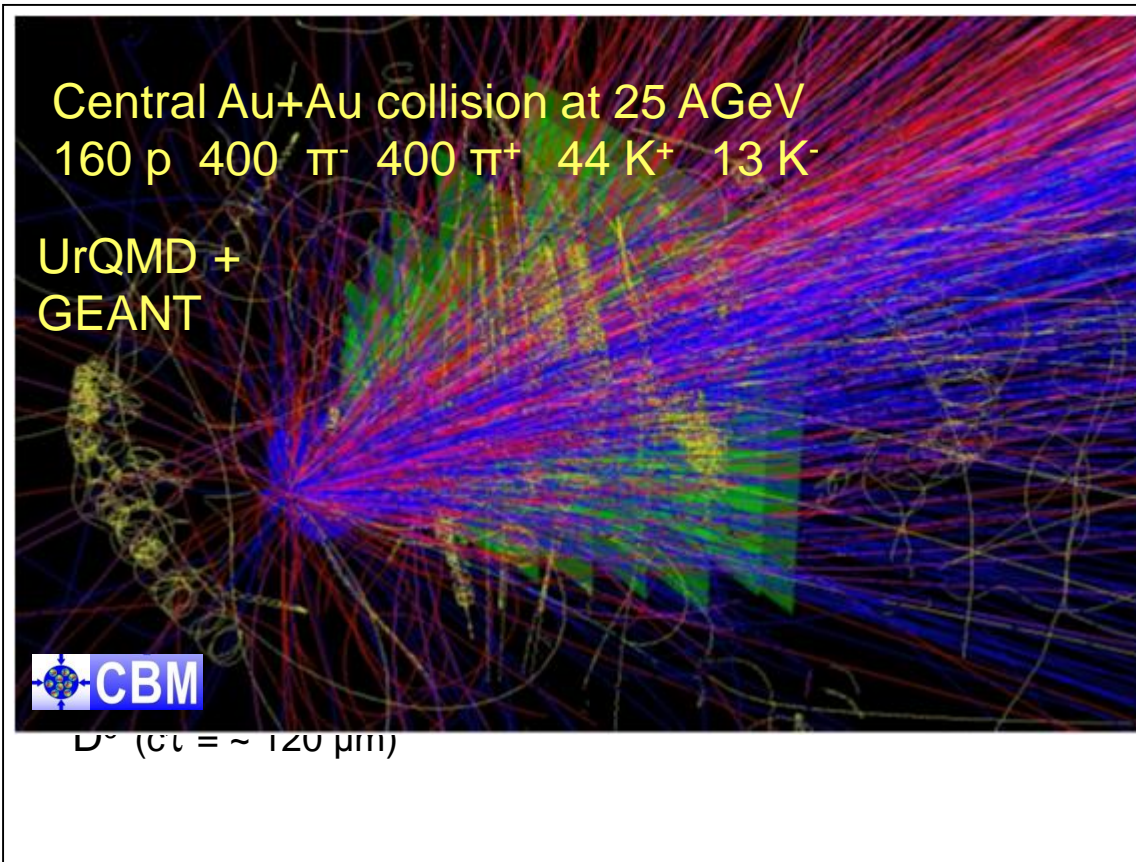


Micro Vertex Detector: Reconstruction of mesons



1) Short decay range:

- High granularity
- Close to target
- Low material budget



1) Short decay range:

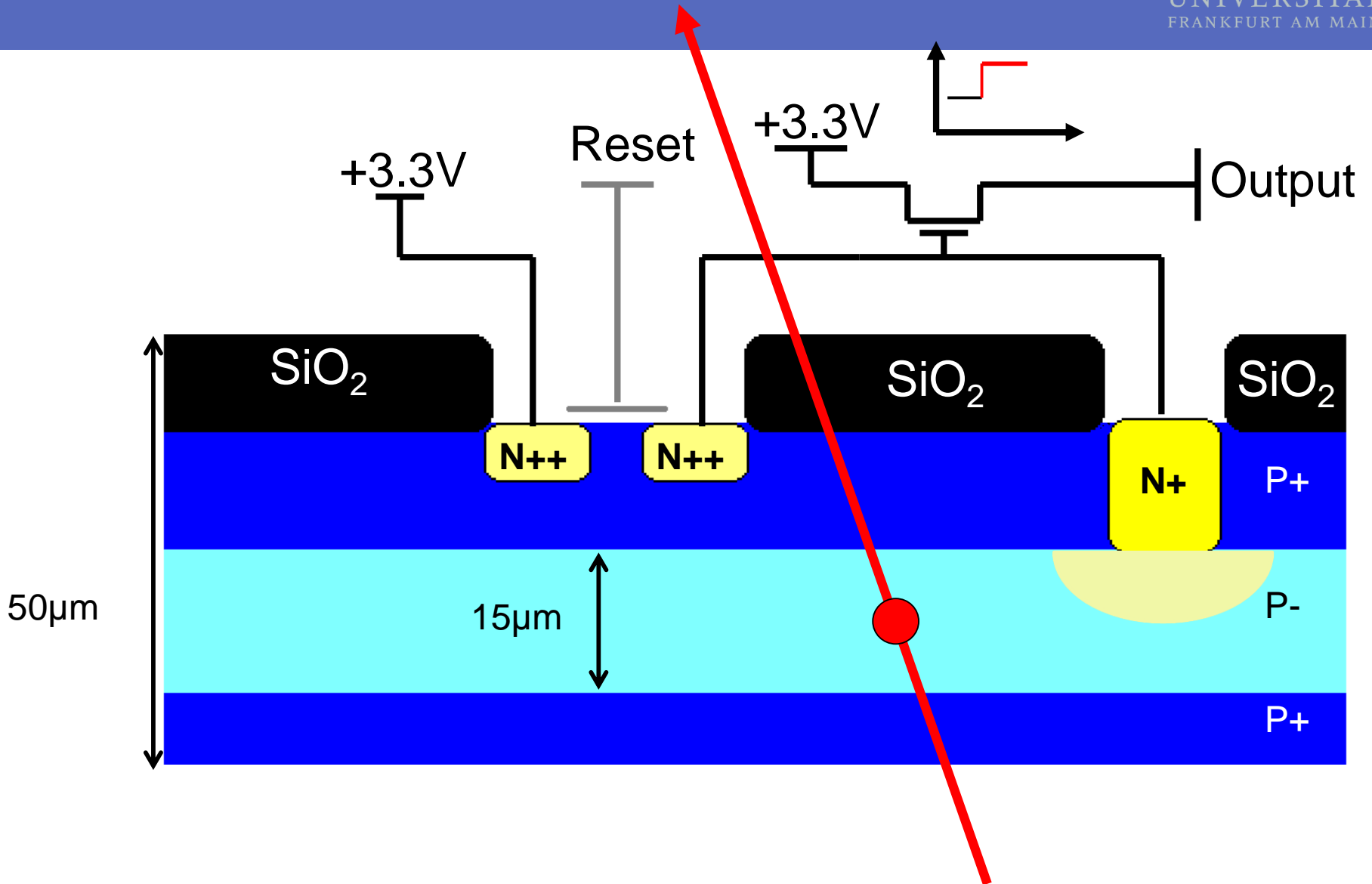
- High granularity
- Close to target
- Low material budget

2) RareProbe, therefore high rates

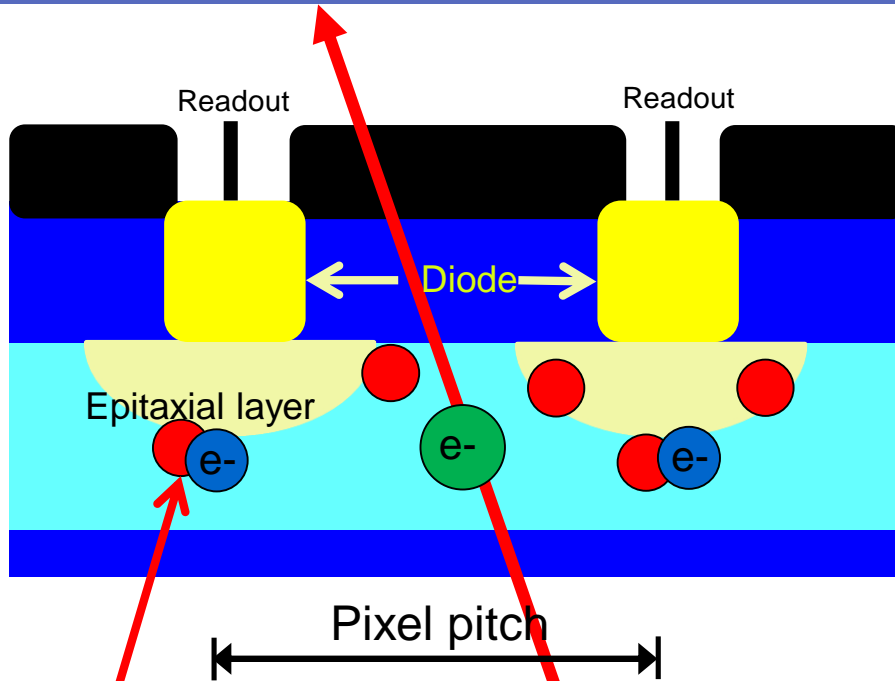
- fast readout
- radiation hard

Wanted: Technology to accomplish this

Sensor R&D: The operation principle



Effects of non-ionizing radiation



Defects due to radiation

Trapping of **signal electrons**

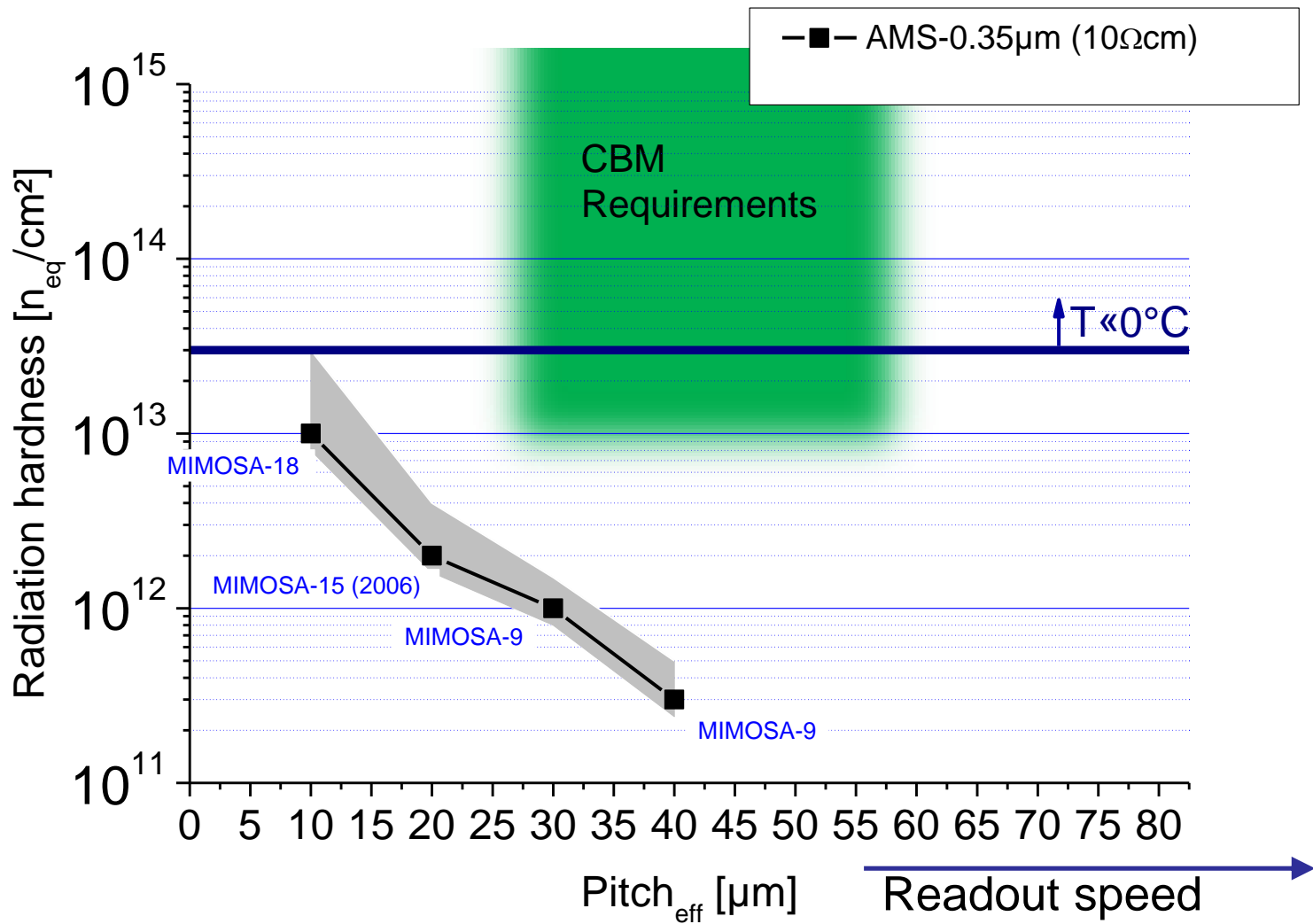
Leakage current → higher noise

❄️ Cooling decreases this effect +

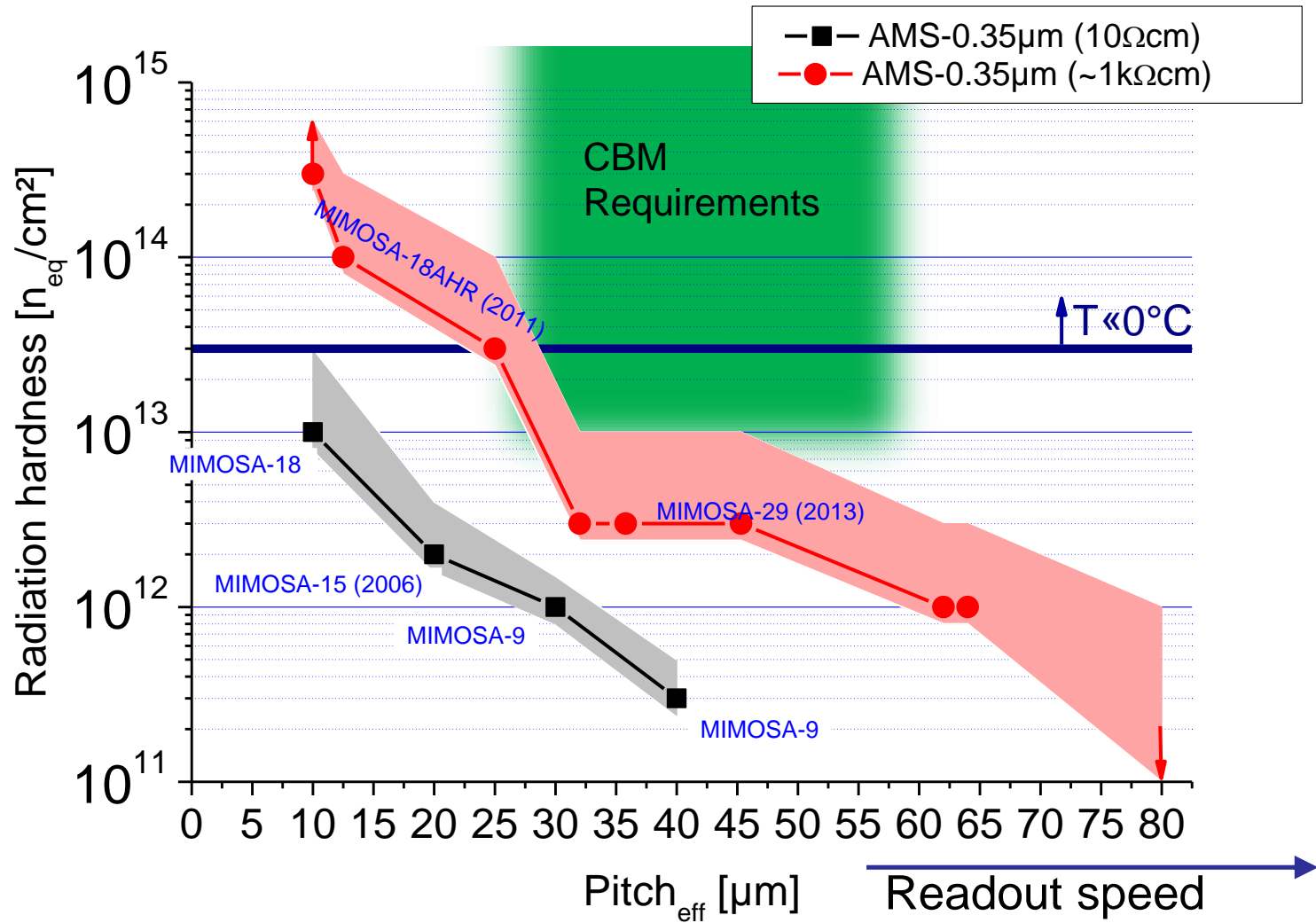
P S/N (Sr-90) > 15 ⇔ typically > 99% MIP - efficiency

$$\frac{\text{Signal}}{\text{Noise}} \xrightarrow{\text{Radiation damage}} \frac{S}{N} = \searrow \gtrsim 15$$

Established knowledge on radiation tolerance

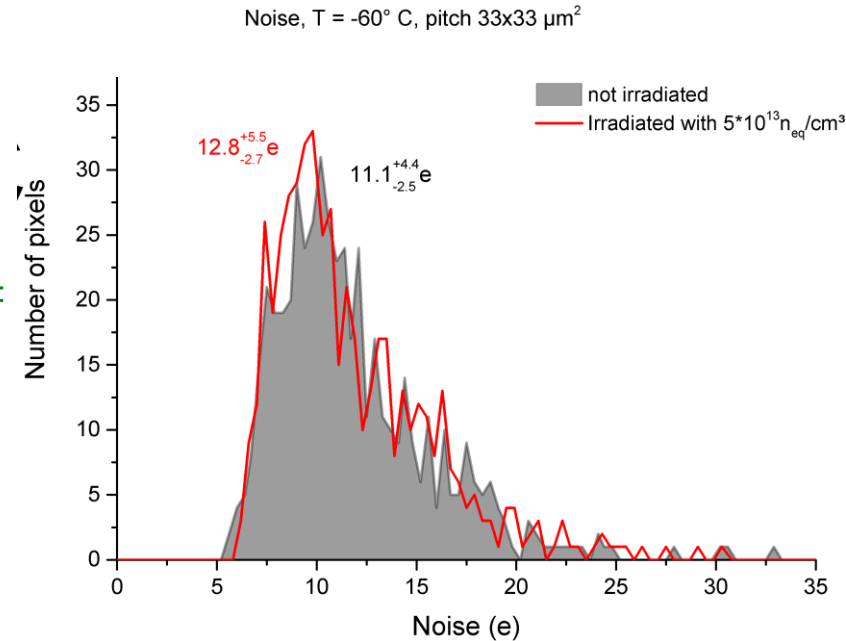
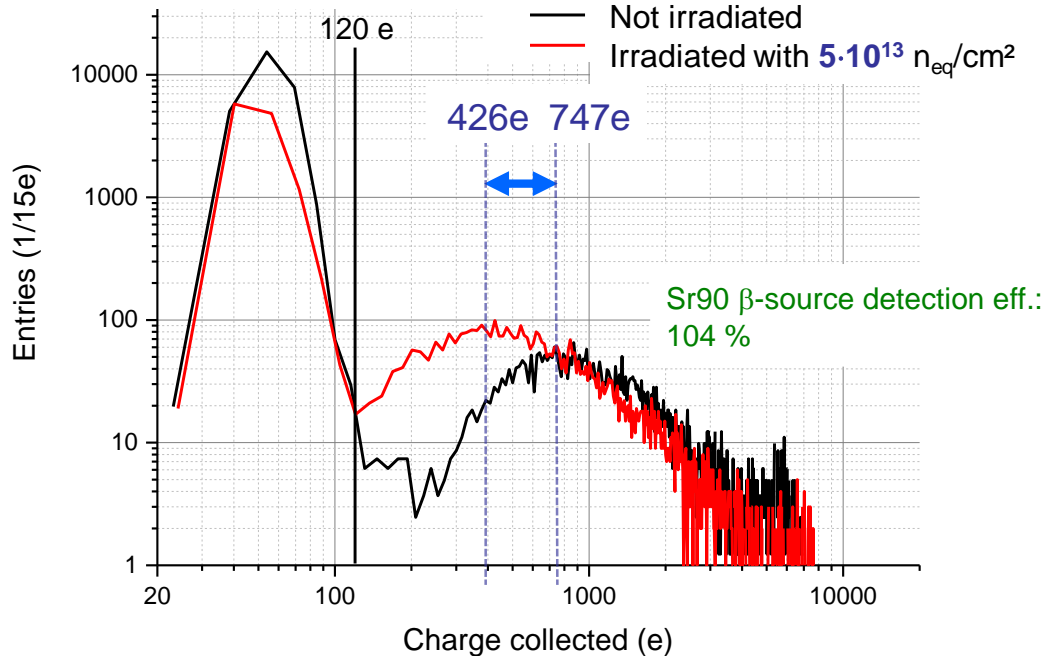


Established knowledge on radiation tolerance



Signal response, 33x33 μm pitch pixel

Test with Sr-90 β -source Pitch: 33x33 μm^2 , T = -60° C



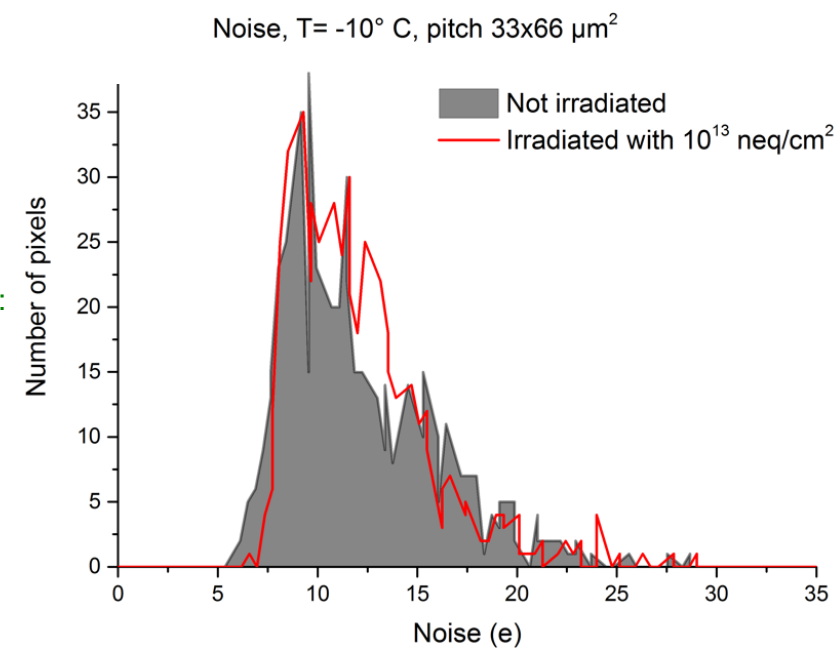
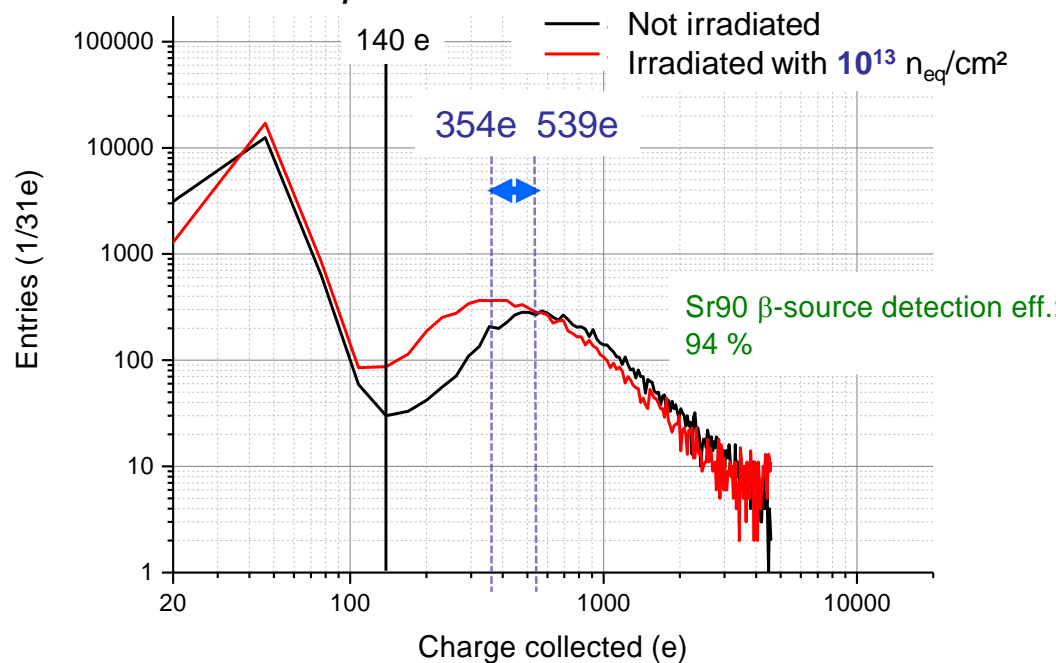
S/N (Sr-90) >15 \Leftrightarrow typically > 99% MIP - efficiency

T = -60° C	Signal MPV (e)	Avg. noise (e)	S/N
Not Irradiated	747	11.1	67
$5 \cdot 10^{13} n_{eq}/\text{cm}^2$	426	12.8	33



Signal response, 33x66 μm pitch pixel

Test with Sr-90 β -source Pitch: 33x66 μm^2 , T = -10° C



S/N (Sr-90) >15 \Leftrightarrow typically > 99% MIP - efficiency

T = -10° C	Signal MPV (e)	Avg. noise (e)	S/N
Not Irradiated	539	12.0	45
10 ¹³ neq/cm ²	354	12.2	29

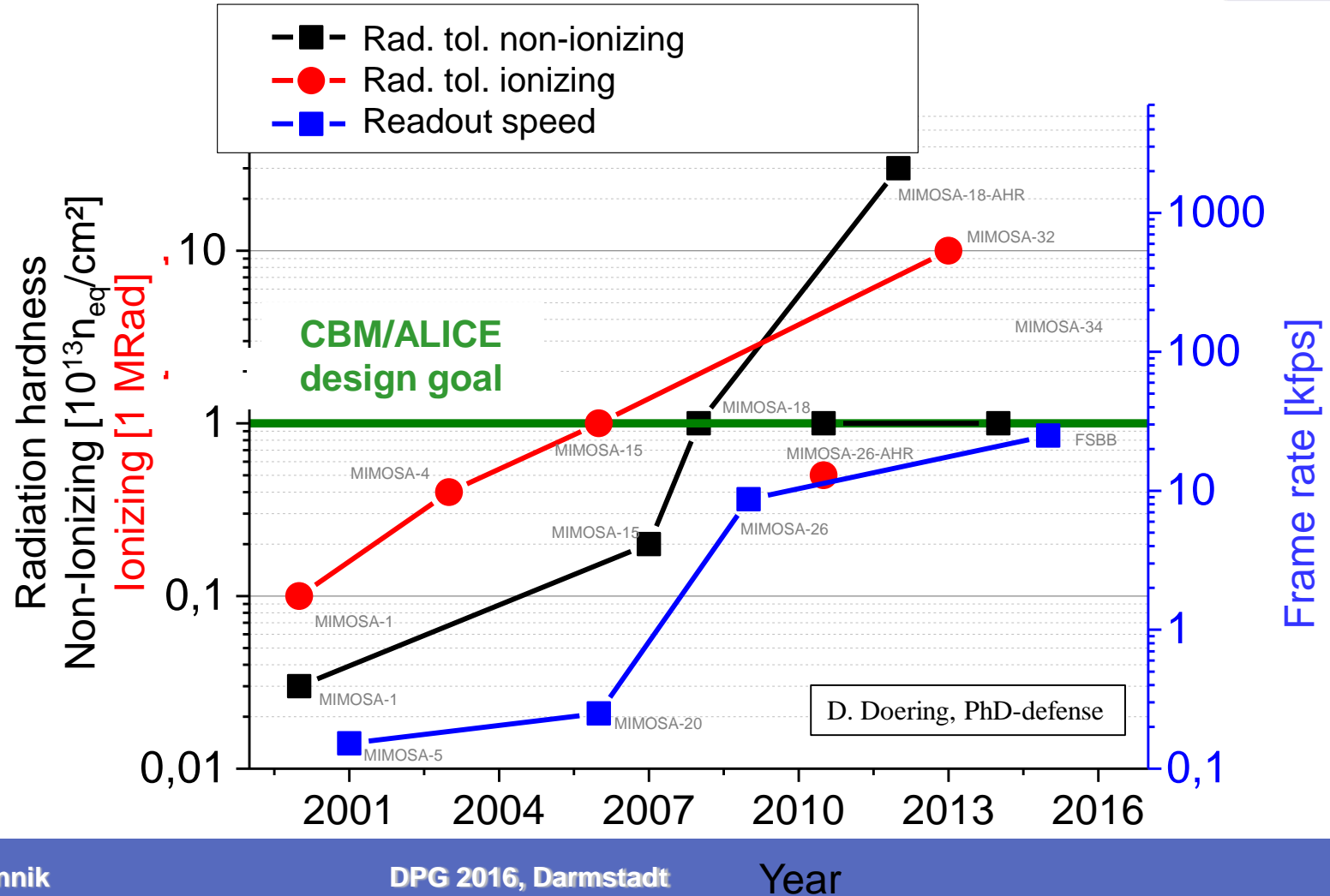




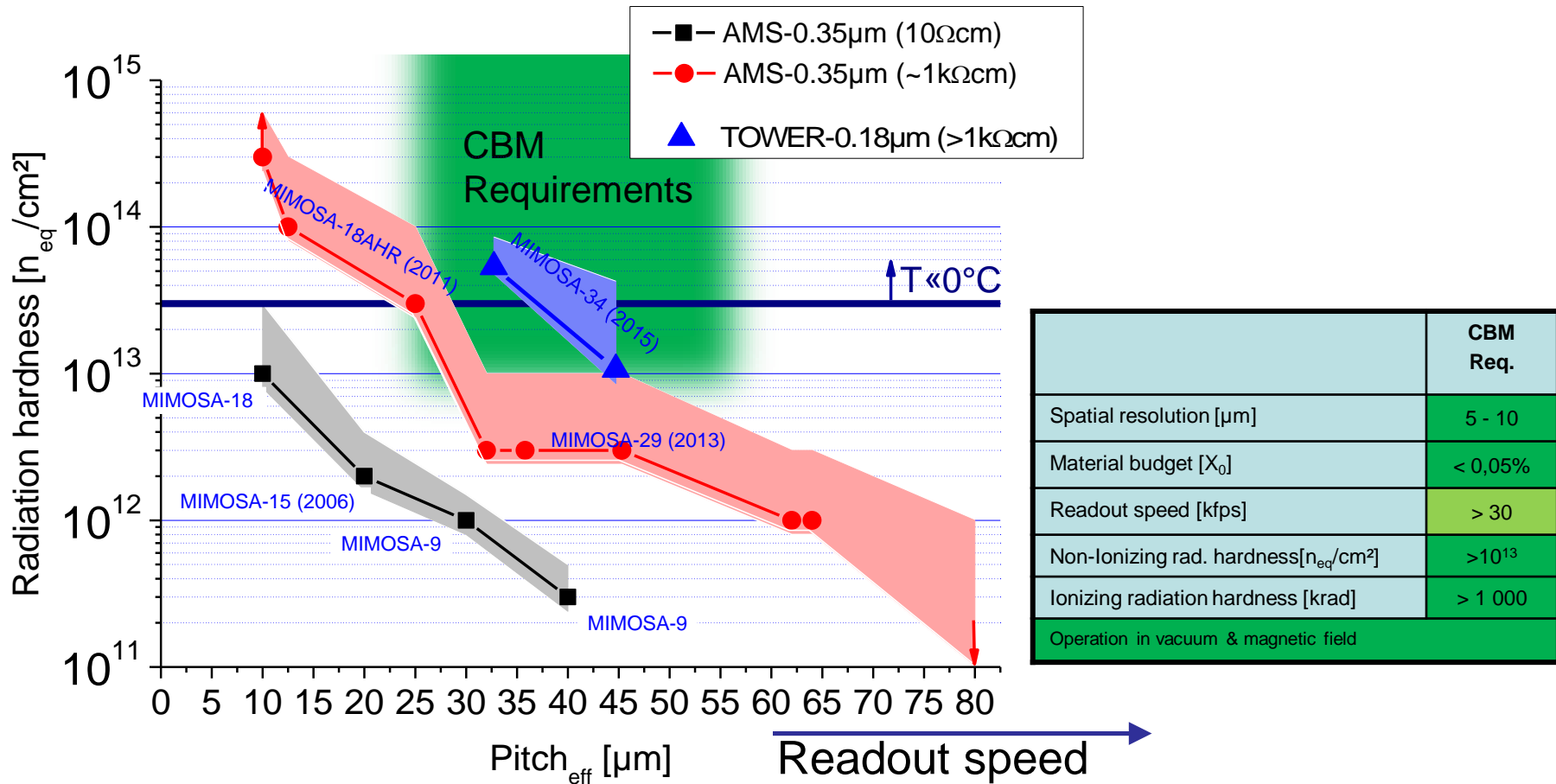
Performances of MAPS

Material budget: 0.05% X_0

Spatial resolution: $\sim 3\text{-}5 \mu\text{m}$



Conclusion and outlook



Larger pixel size means faster readout. Big radiation hard pixels are available.
=> Pixel fulfil the CBM requirements.

Thank You for your attention!