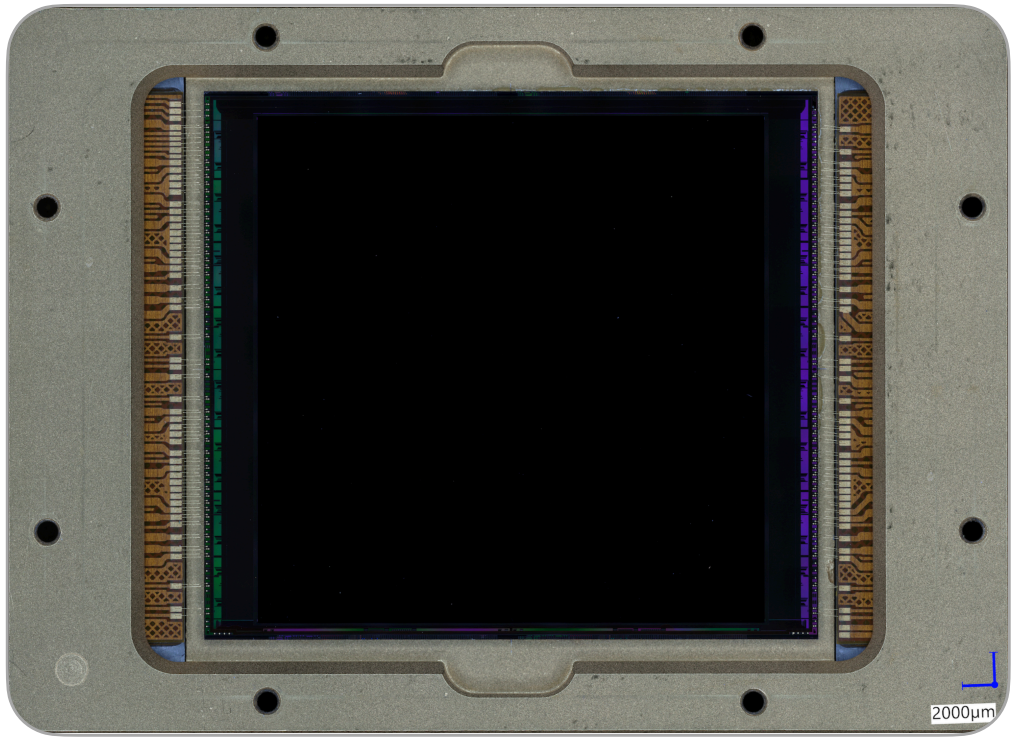
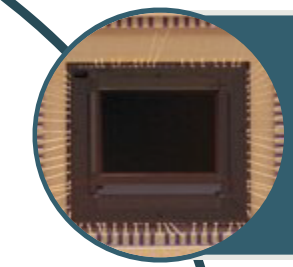
Caractérisation des détecteurs infrarouge APD IBEX au CEA



Jean Le Graët - CEA/IRFU - ESA

EUROPEAN SPACE AGENCY

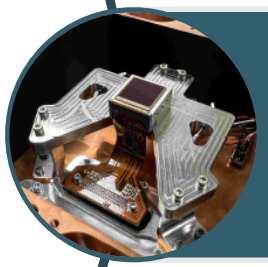
IBEX detector



Saphira

320 x 256 or 512 x 512 pixels

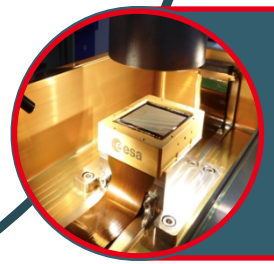
Used as wavefront sensor for the VLT



Ike Pono

1k x 1k or 2k x 2k

Collaboration with University of Hawai'i and NASA. First large format LmAPD.



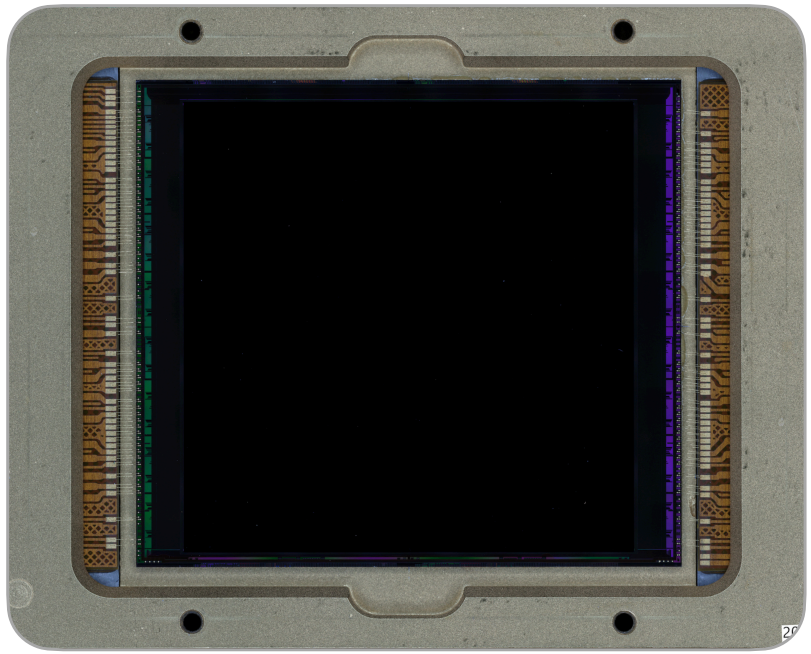
IBEX

2k x 2k

Collaboration with ESA. Large format array optimised for dark current performance.

GOAL:

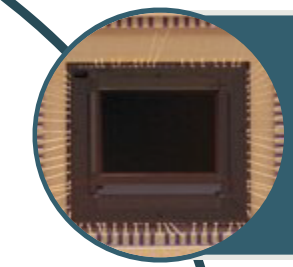
Develop a European large format NIR detector for ultra-low background applications enabling single photon detection



- **2048x2048** pixels + 4 top and 4 bottom reference rows
- 15 µm pixel pitch
- Cut-off wavelength **2.5 µm** (with avalanche)
- Pixel clock **270 kHz** on 16 outputs (Frame rate ~ 1Hz)

EUROPEAN SPACE AGENCY

IBEX detector



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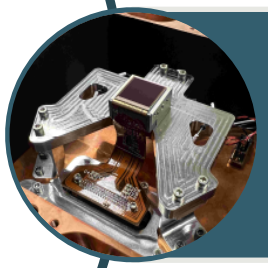

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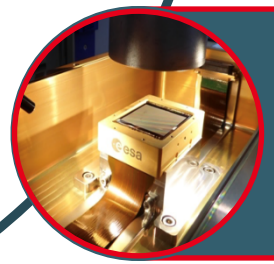

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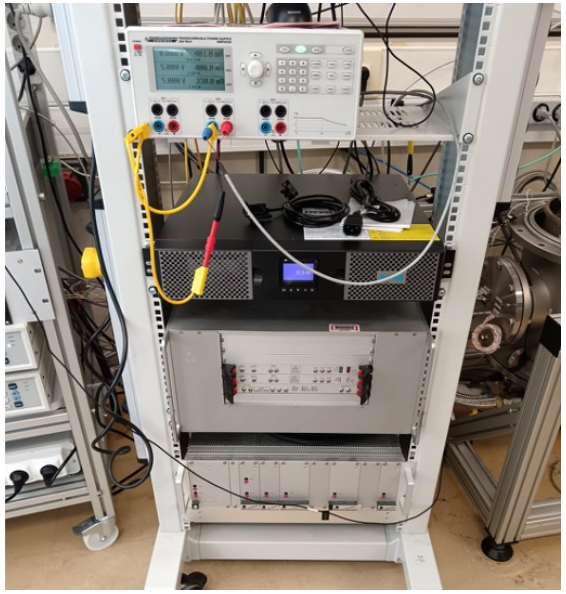
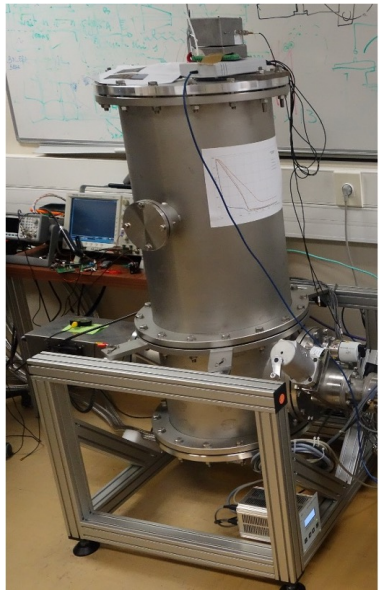
cea LEONARDO esa EUROPEAN SPACE AGENCY

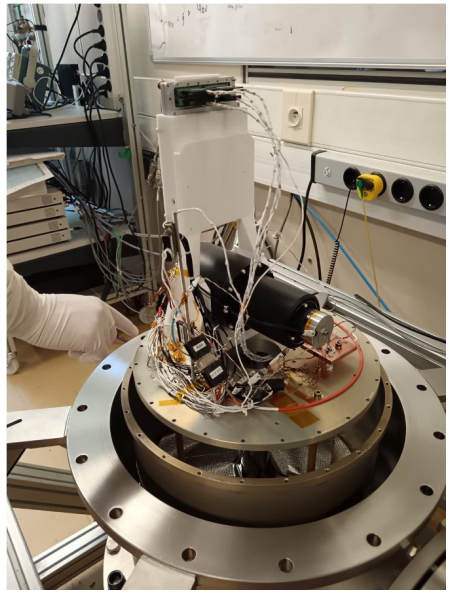
CEA test bench



NGC controller (ESO)



Verticalix cryostat



Cold plate + detector

- **Designed for dark current** — measured ALFA DC at ~0.004 e^-/s/px
- **IBEX is NGC-driven** — external supply for avalanche bias (>10 V)
- **Cold preamplifier** — low-noise readout chain
- **Flexible illumination** — internal LED / black body, or external via optical fiber

Avalanche gain

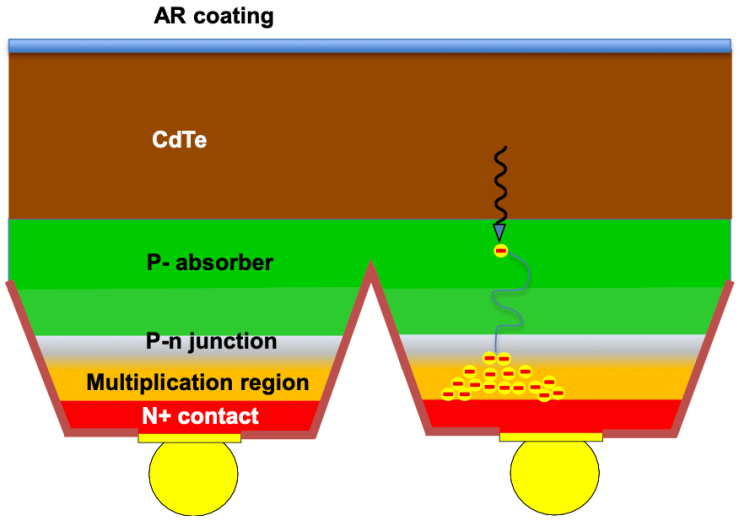
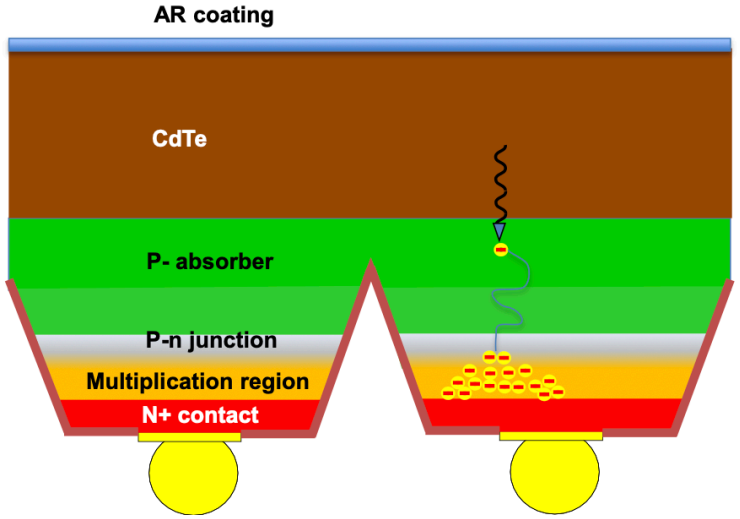


Figure 2: Schematic of MCT growth structure

- Applying bias accelerates photoelectrons, multiplying the signal via impact ionization

Avalanche gain



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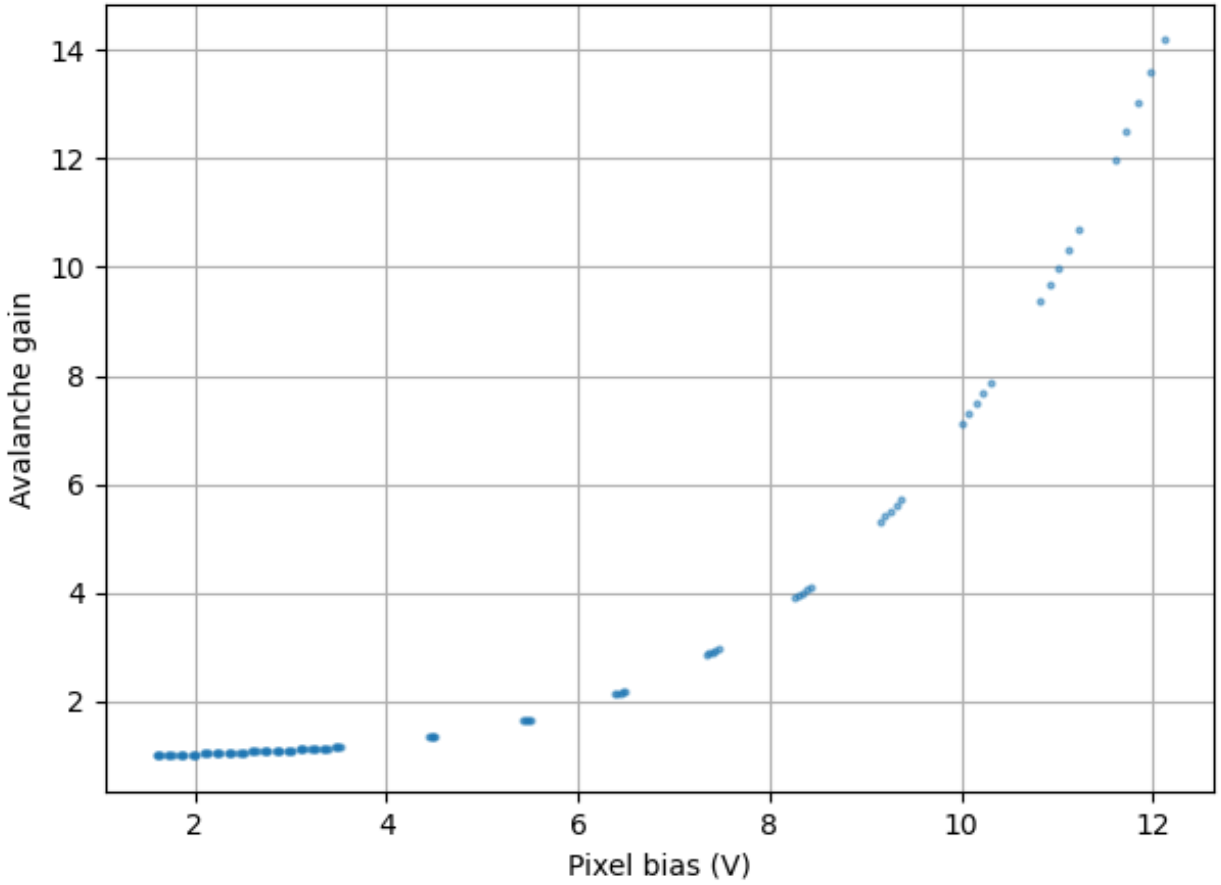

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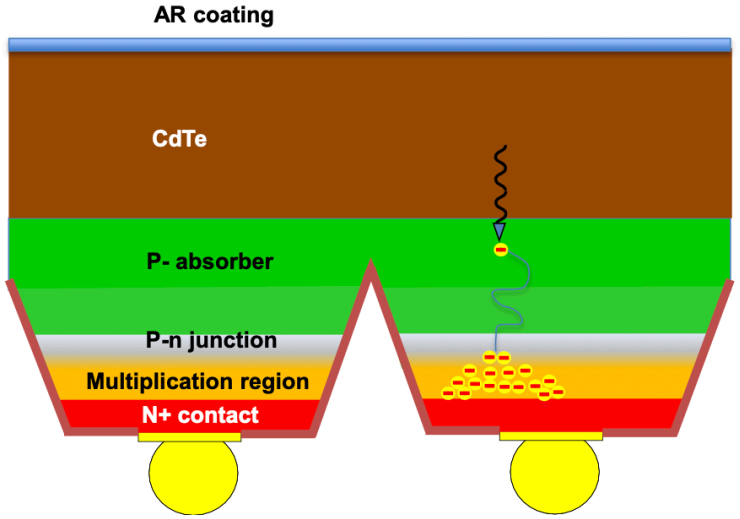

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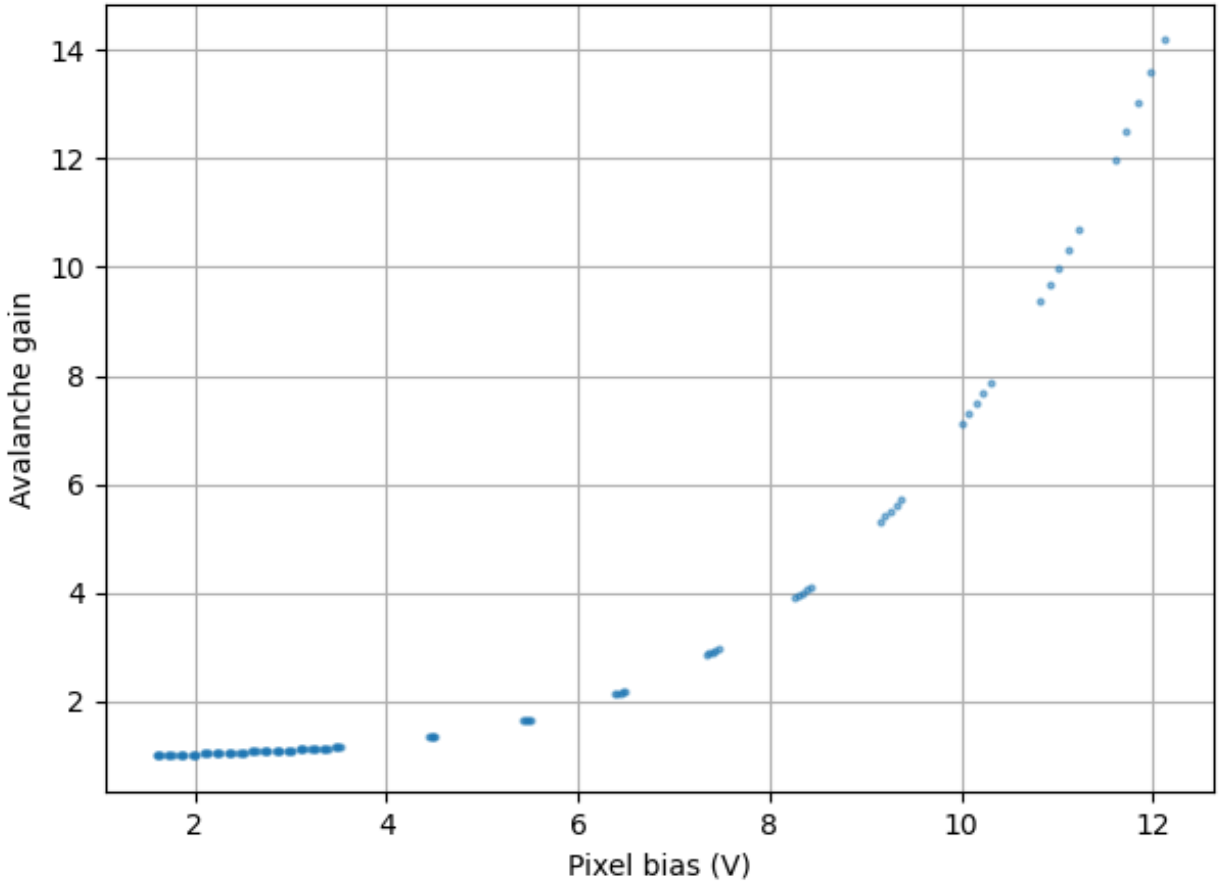
Readout noise contribution is reduced



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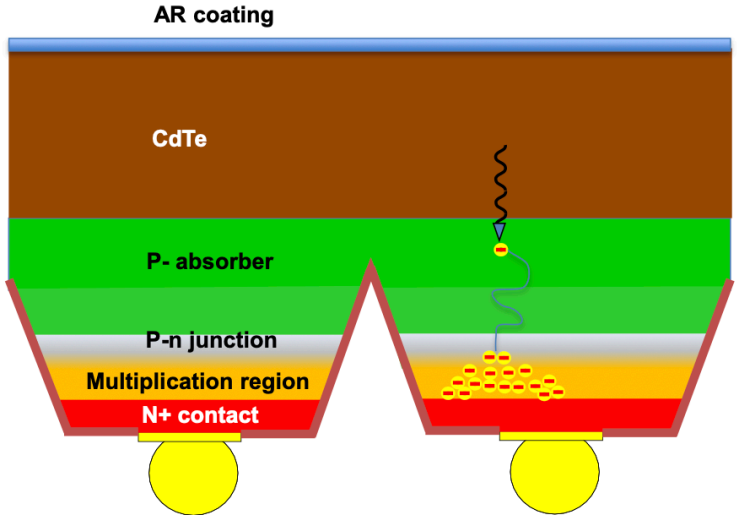

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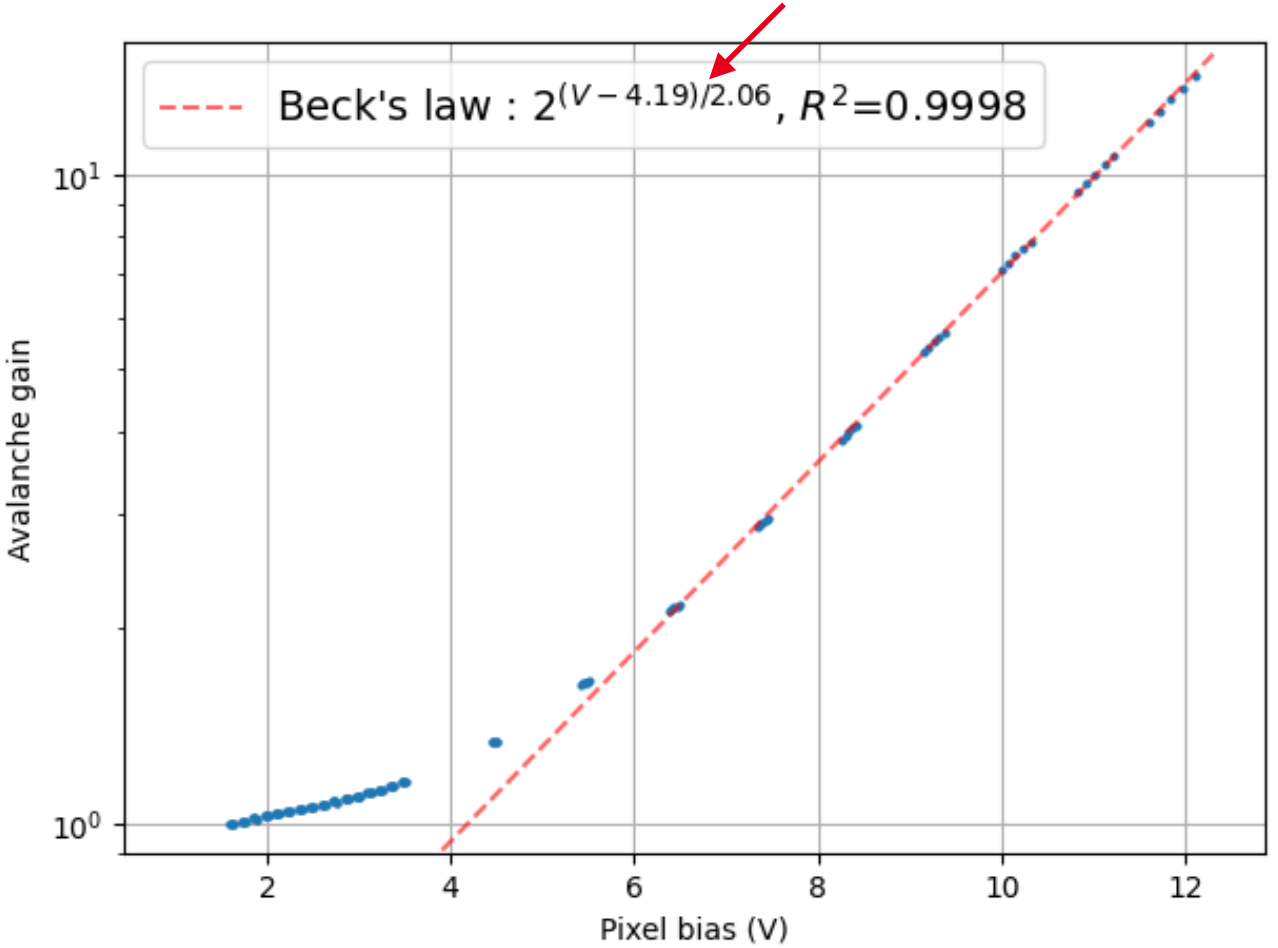
Consistent with Leonardo estimation



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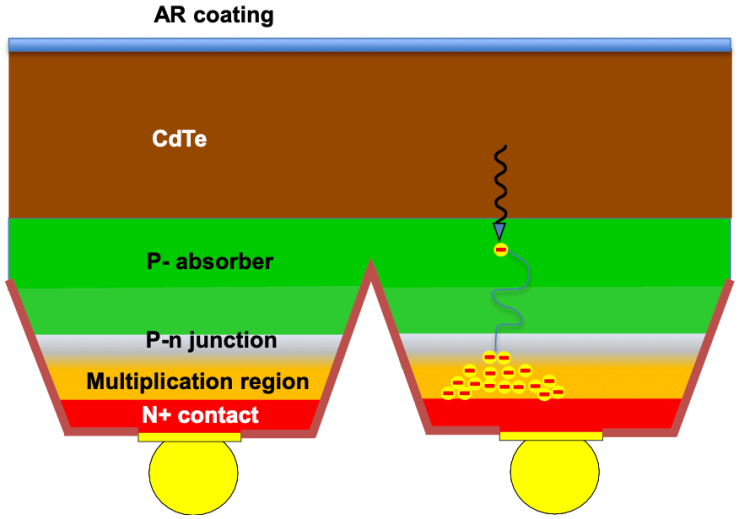

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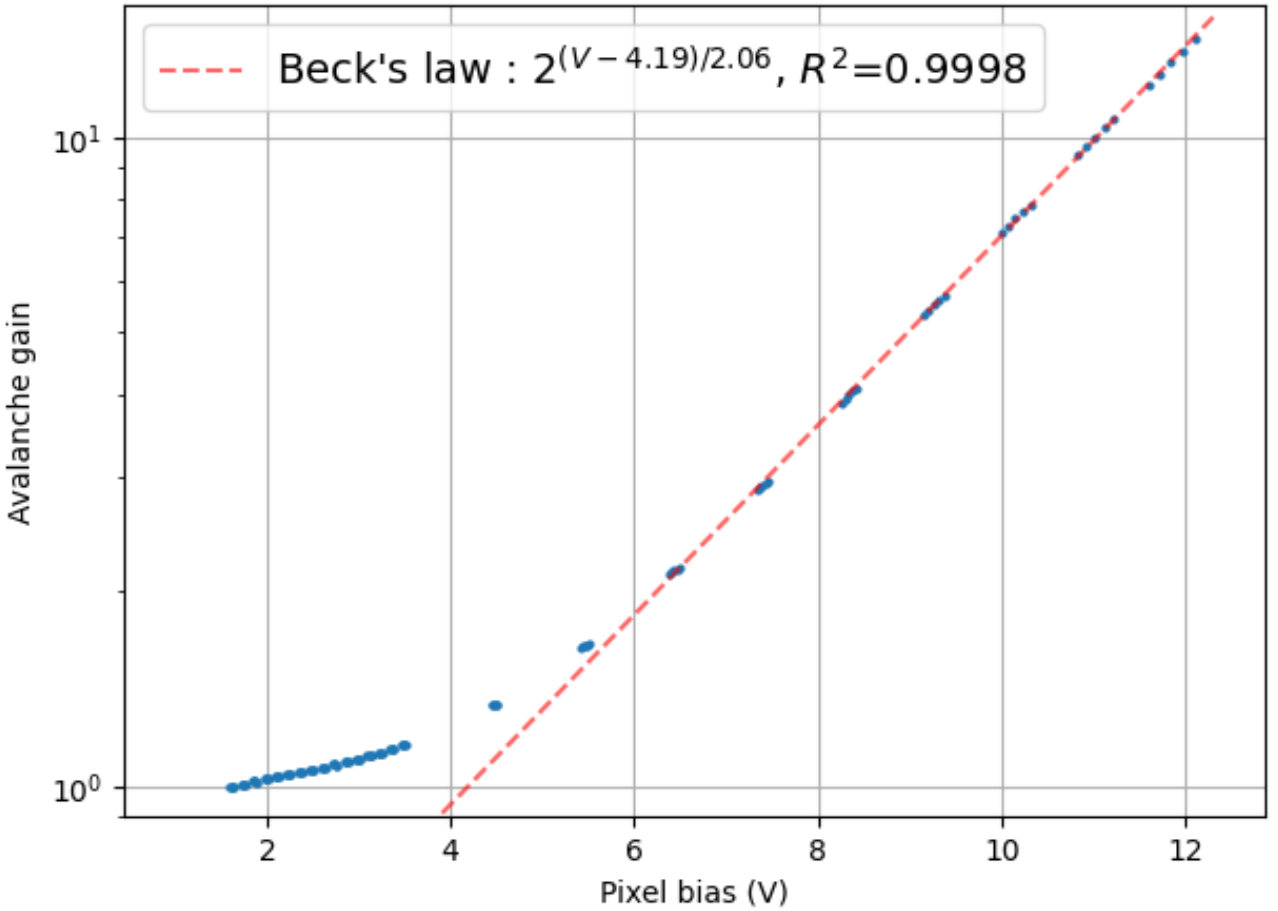
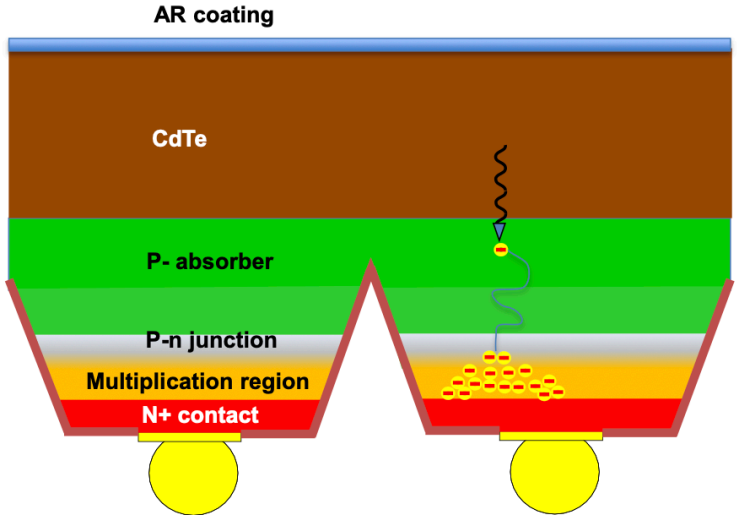


Median readout noise measured at CEA : **14 e- rms**

Avalanche gain



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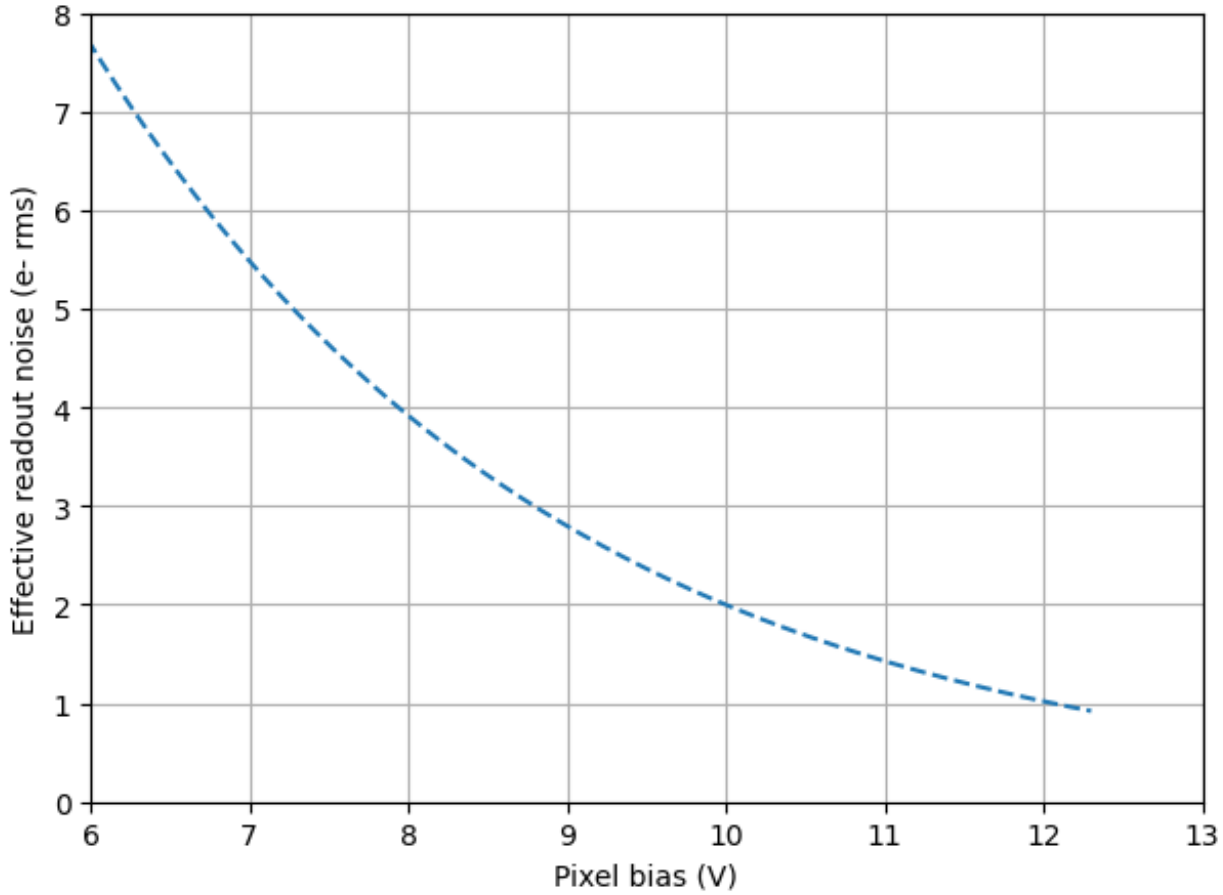
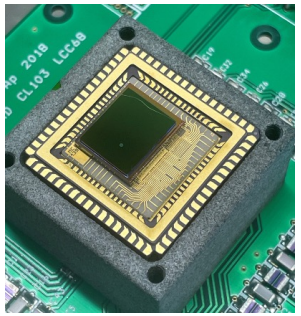


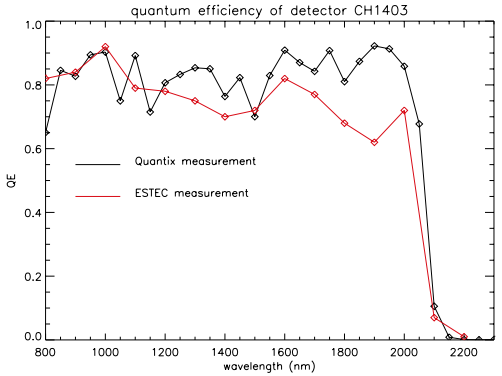
Median readout noise measured at CEA : **14 e- rms**

With a bias of 12V, effective readout noise **below 1 e- rms**

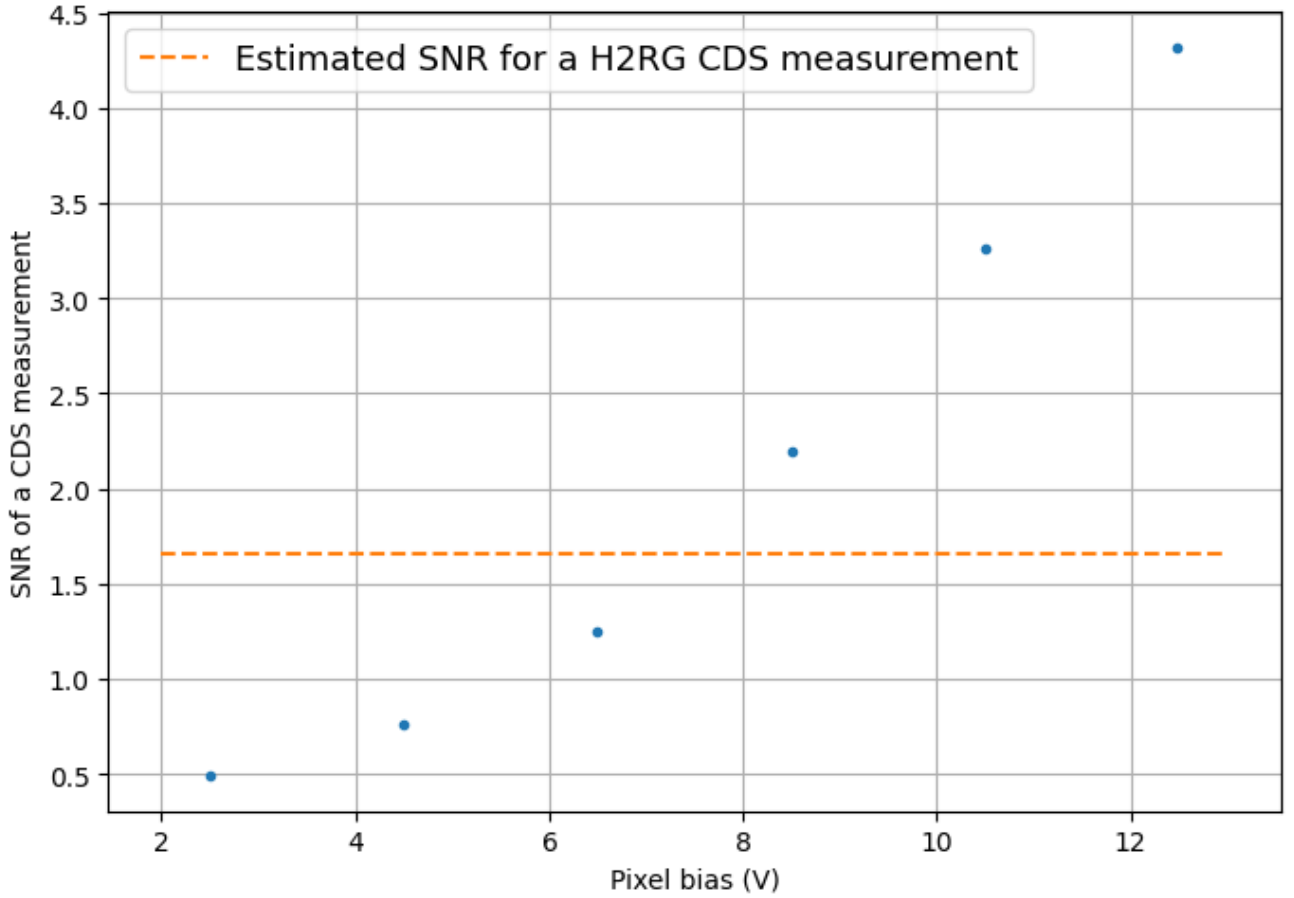
SNR measurement

- Allows to estimate the performance without having to decorrelate QE, avalanche and conversion gain
- True flux is estimated using a calibrated Lynred detector in the same illumination setup





- Flux is about **35 photons/s/px**
- Signal and standard deviation are estimated across **100 CDS** measurements



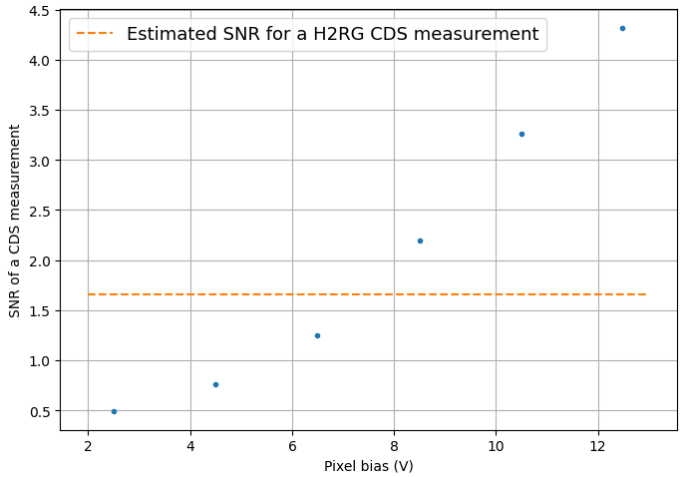
With a **bias > 8V,**

IBEX SNR (using CDS) is **better** than **H2RG**

Conclusion

Results

- IBEX detectors are fully functional
- Measured performances are consistent with Leonardo predictions
- SNR at low flux is very encouraging



Ongoing analysis

- Quantum efficiency measurement
- Estimation of the excess noise factor
- Characterization of the persistence
- PRNU analysis

More on IBEX coming at SPIE Copenhagen, see you there!