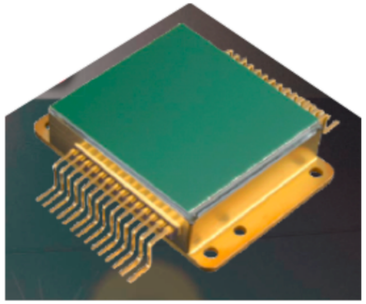
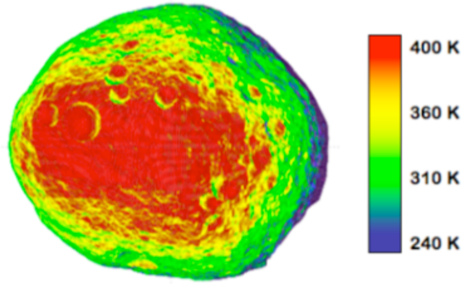


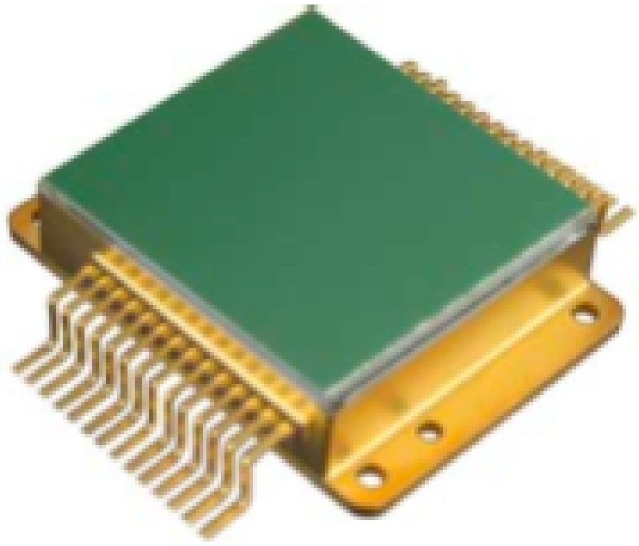


Characterization of the ULIS (UL04171) uncooled microbolometer array and its possible use as a detector of a mid-ir instrument for Marco Polo

Javier Licandro, Guillermo Herrera, Enrique Jóven, Miquel Serra-Ricart and Alejandro Oscoz Abad

Instituto de Astrofísica de Canarias

The mid-infrared detector for THERMAP



THERMAP DETECTOR
uncooled microbolometer array (640x480, 25μm pixels) detector from the french company ULIS

THERMAP TRL objectives The only component presently considered as critical is the microbolometer detector. We will intensively work on the detector during the Assessment phase, and **plan to reach a TRL of 5**.

Tasks first defined to be done at the IAC

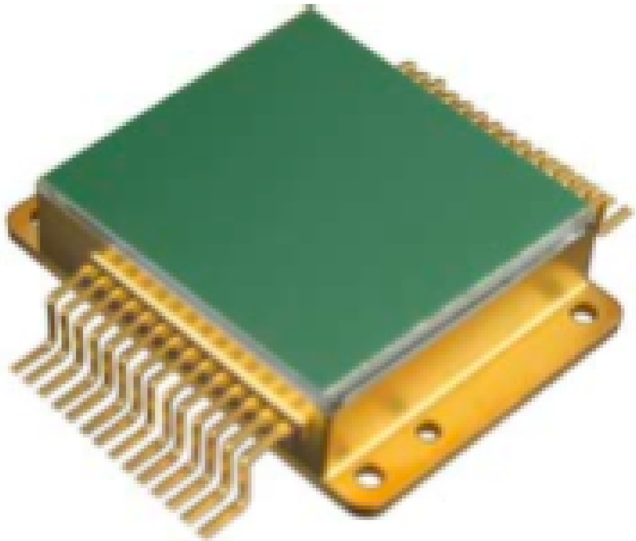
To develop the control electronics, **power supply** and a **demonstrator experiment** to perform a series of tests to answer the following questions:

- What is the effect of the operating temperature on the performances, and what is the acceptable range?
- Which thermal stability is required to reach a given absolute radiometric accuracy?
- What is the dynamic range of the detector?
- What is its sensitivity?
- What is the spatial homogeneity of the detector response?
- How long is the readout time and how fast can the detector be operated?

The uncooled Microbolometer array detector

SPECIFICATIONS

- *Pixel-pitch: 25 µm*
- *NETD < 120 mK @ f/1, 300 K, 60 Hz*
- *Dimensions (LxWxH): 23.5 x 32 x 7.7 mm^3*
- *Power consumption < 300 mW (without TEC)*
- *Spectral response: LWIR*
- *sensitive area: 16 x 12 mm^2*
- *Row by row reading mode*
- *Weight < 25 g*



FEATURES

- *Amorphous silicon microbolometer*
- *Uncooled operation (with or without TEC)*
- *Adjustable integration time*
- *1 or 2 analog outputs available*
- *640 x 480 pixel focal plane array*
- *Digital selection mode via a serial link*
- *Power supply: 5 V for analog, 3.3 V for digital*
- *Output dynamic range 1.0 V to 4.2 V*
- *H, V image flip array*
- *28-lead vacuum flat-pack*
- *On-chip temperature sensor*
- *MIL STD 883-810 qualification (in progress)*
- *Lead free and RoHS compliant*
- *Typical responsivity: 5 mV/K*
- *Frame rate up to 60 Hz*
- *User defined windowing capability*

The spectral response gauge

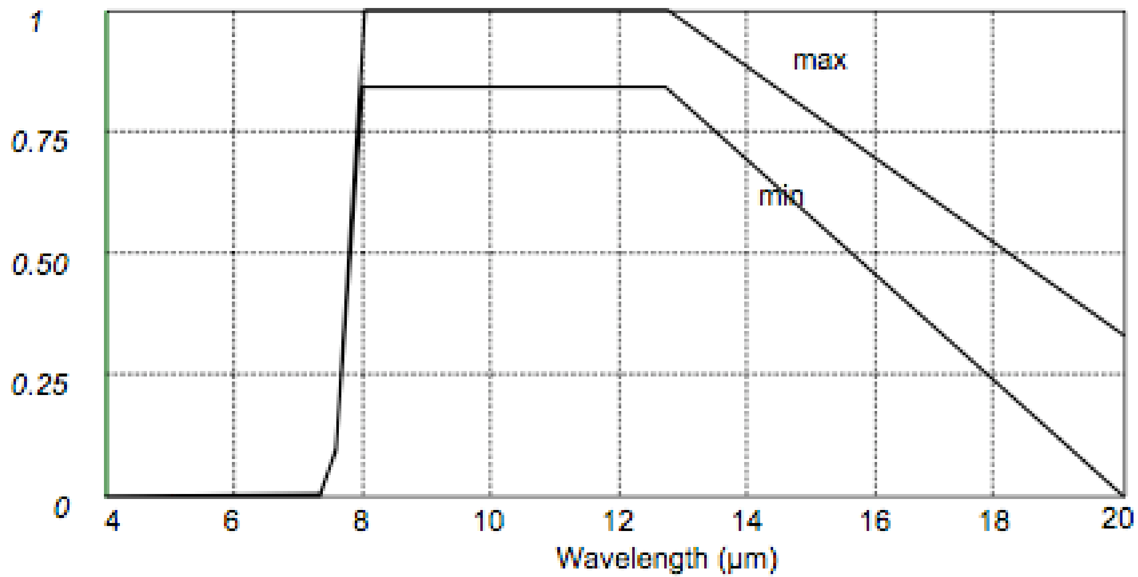


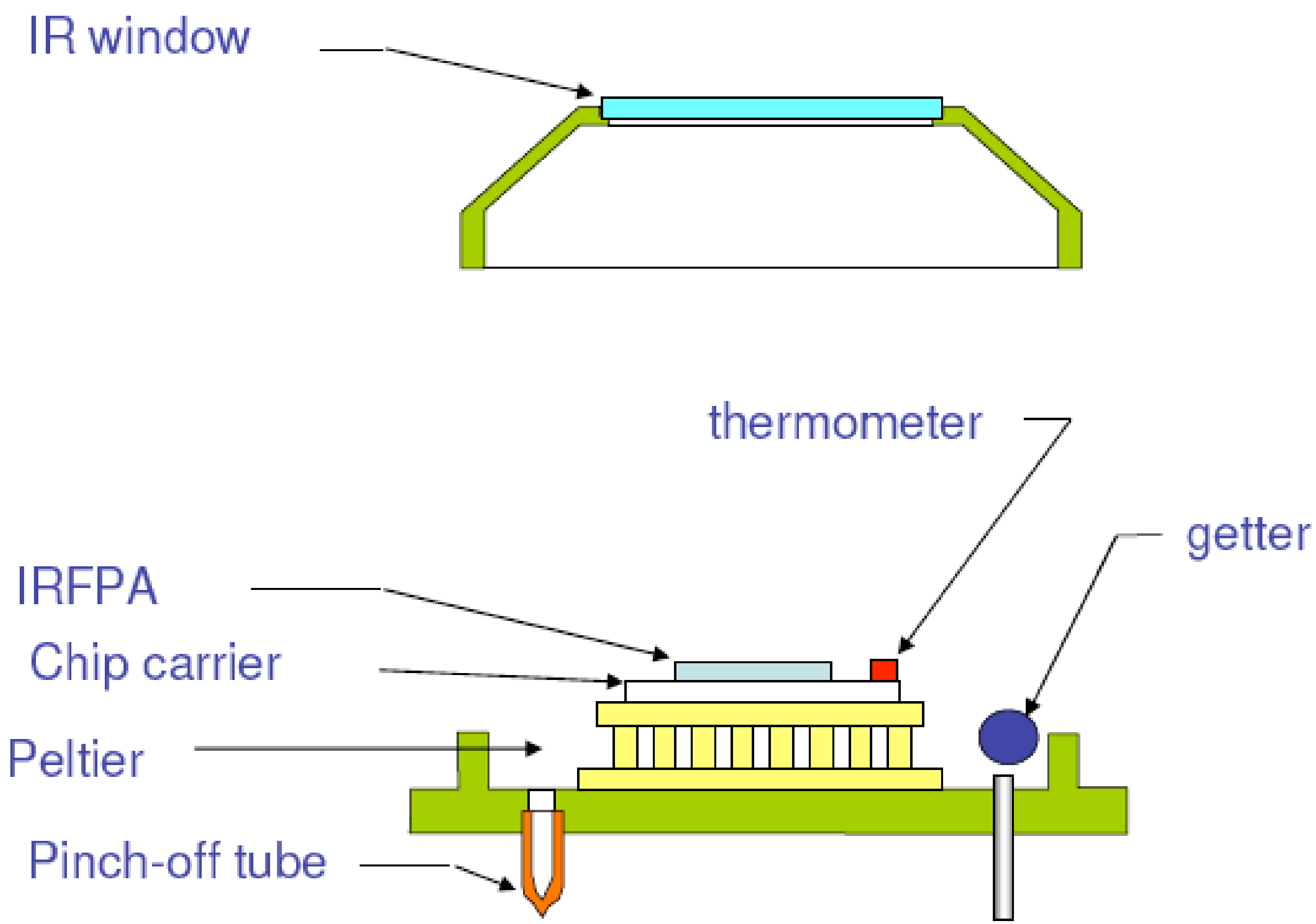
Figure 2: Normalized spectral response gauge of UL 04 17 1

Our detector arrived last Thursday

Price: 8.500€

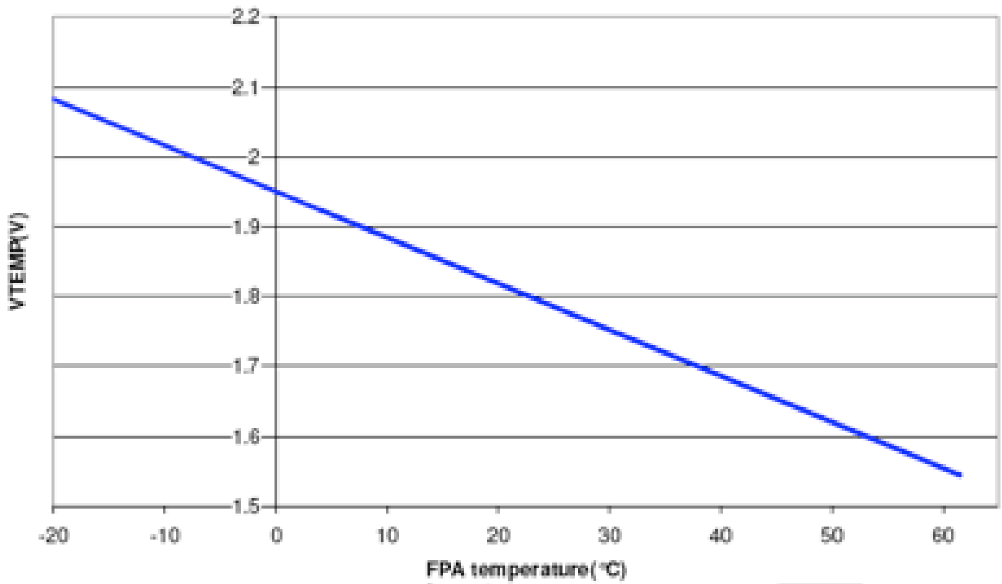
Just arrived after 9 month, first important delay !!!

The uncooled Microbolometer array detector

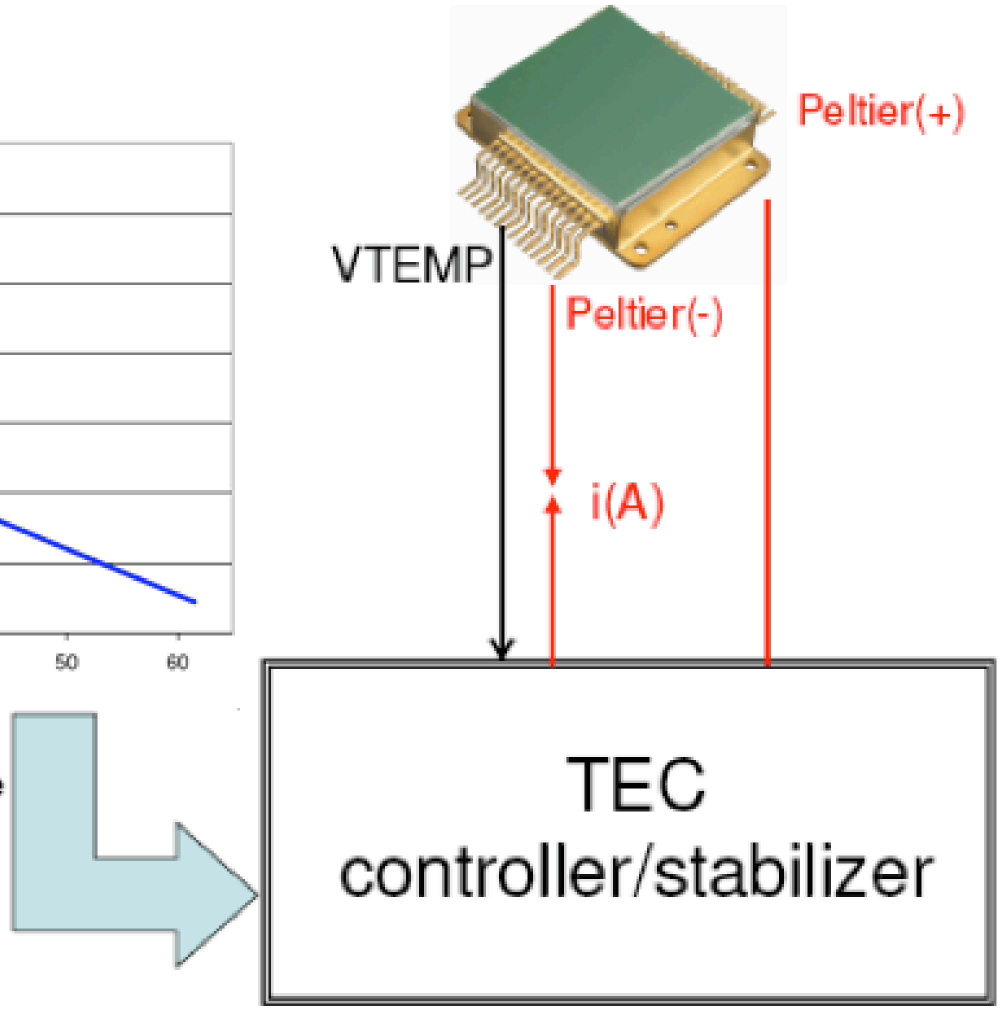


Uncooled IR detector packaging structure

The integrated Thermo Electrical Cooler

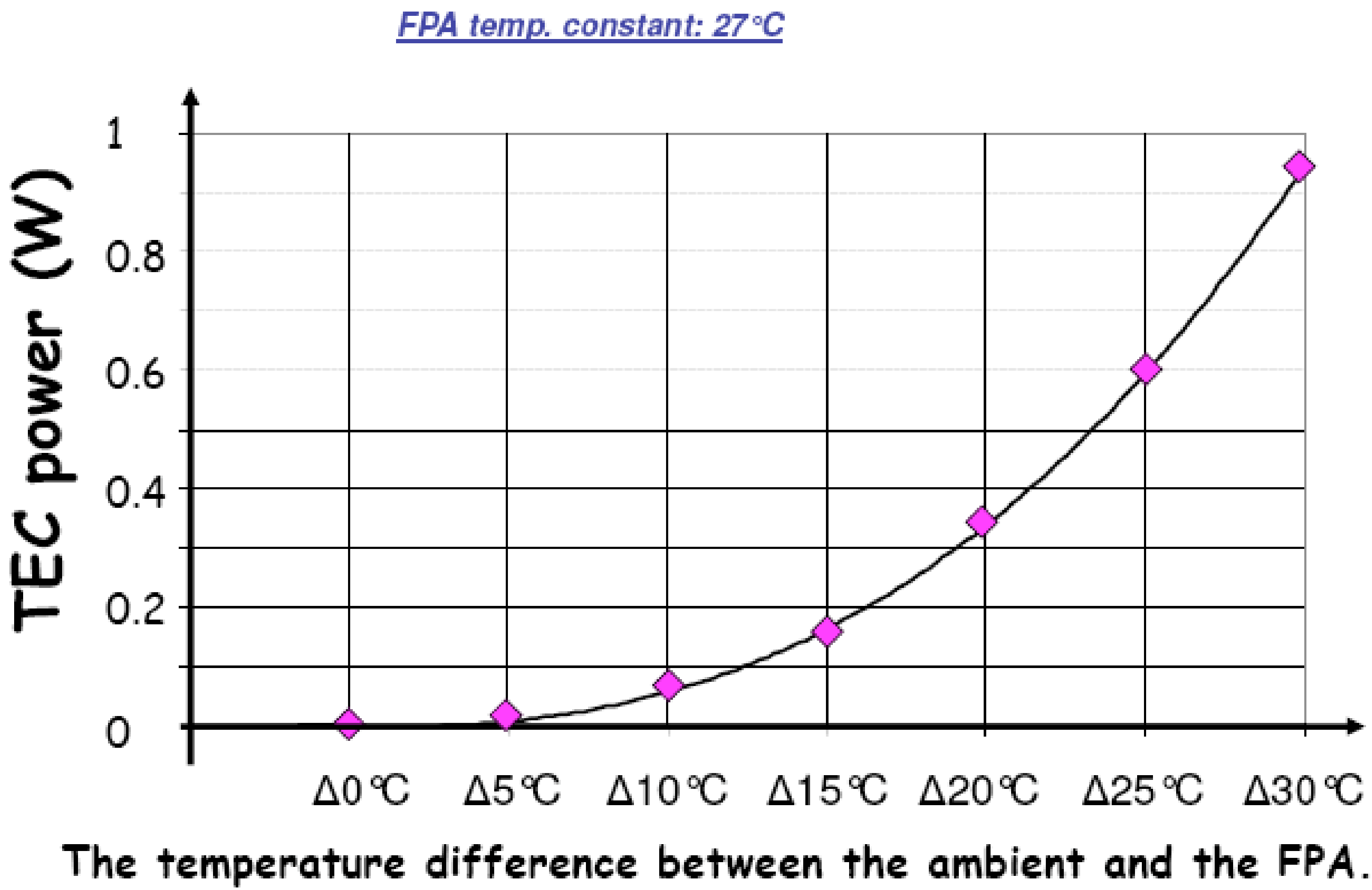


Set point temperature voltage
1.752 V for a 30°C working temperature

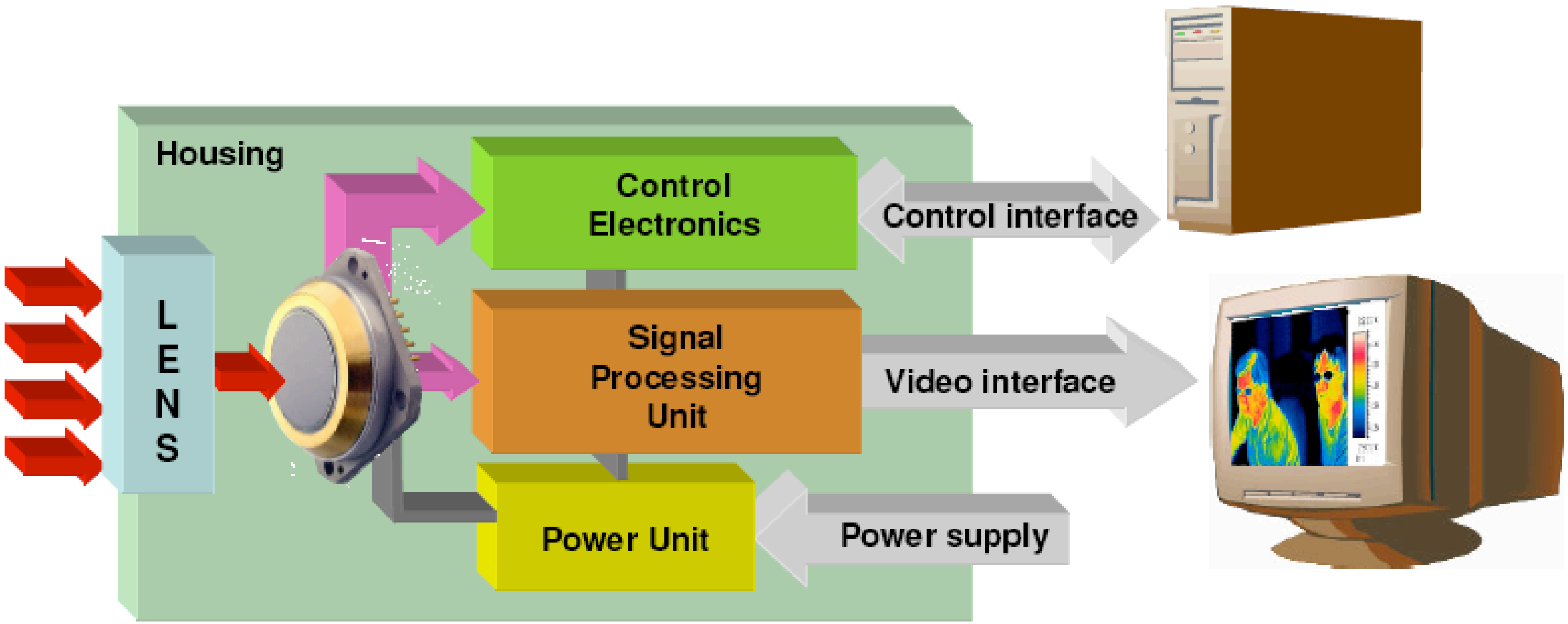


Focal Plane Array regulation accuracy and stability < 10mK

The TEC power consumption



The electronics needed for the detector



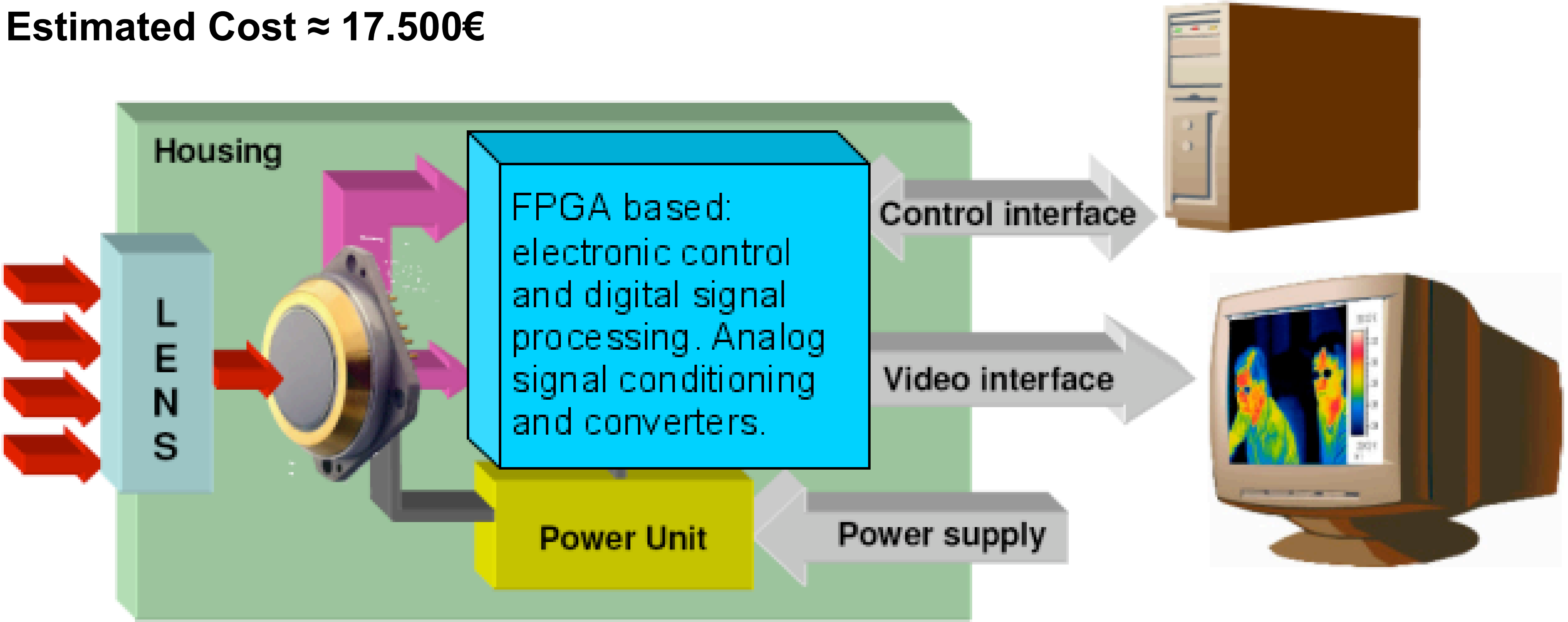
Should consist of:

- An amplifier to adapt the dynamical range to the Analog Digital Converter (ADC)
- An ADC
- A sequencer to manage these electronics
- The control command and output interface

The electronics developed for the detector

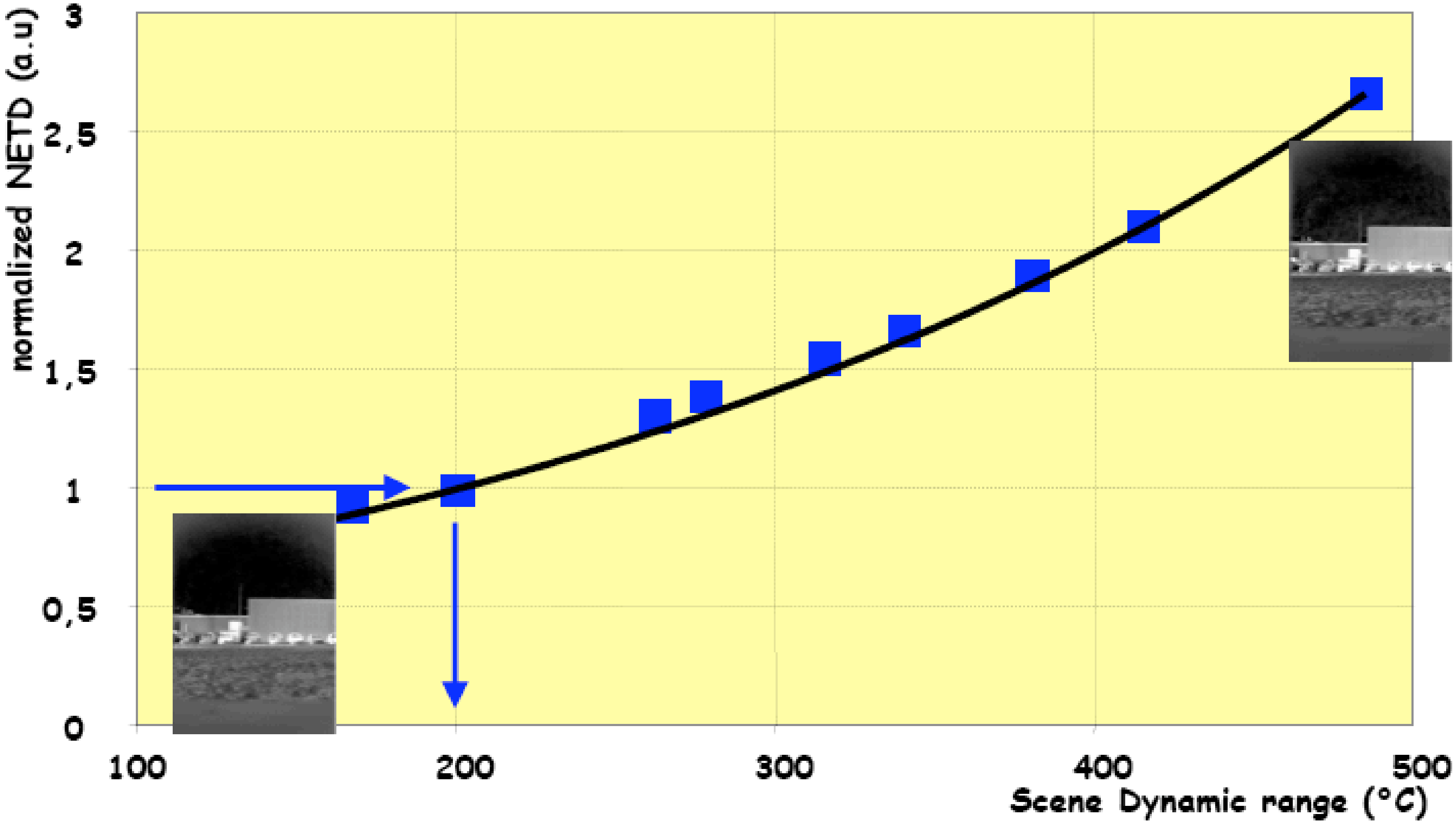
The electronic is developed and built at the IAC by Ing. G. Herrera

Estimated Cost ≈ 17.500€



- ➢Based on Field Programmable Gate Arrays (FPGAs) that allow to implement application specific programs
- ➢Control will be able to reach the maximum frame rate of the Microbolometer FPA trying to push the system to the top of its limits

Dynamic range vs NETD trade off



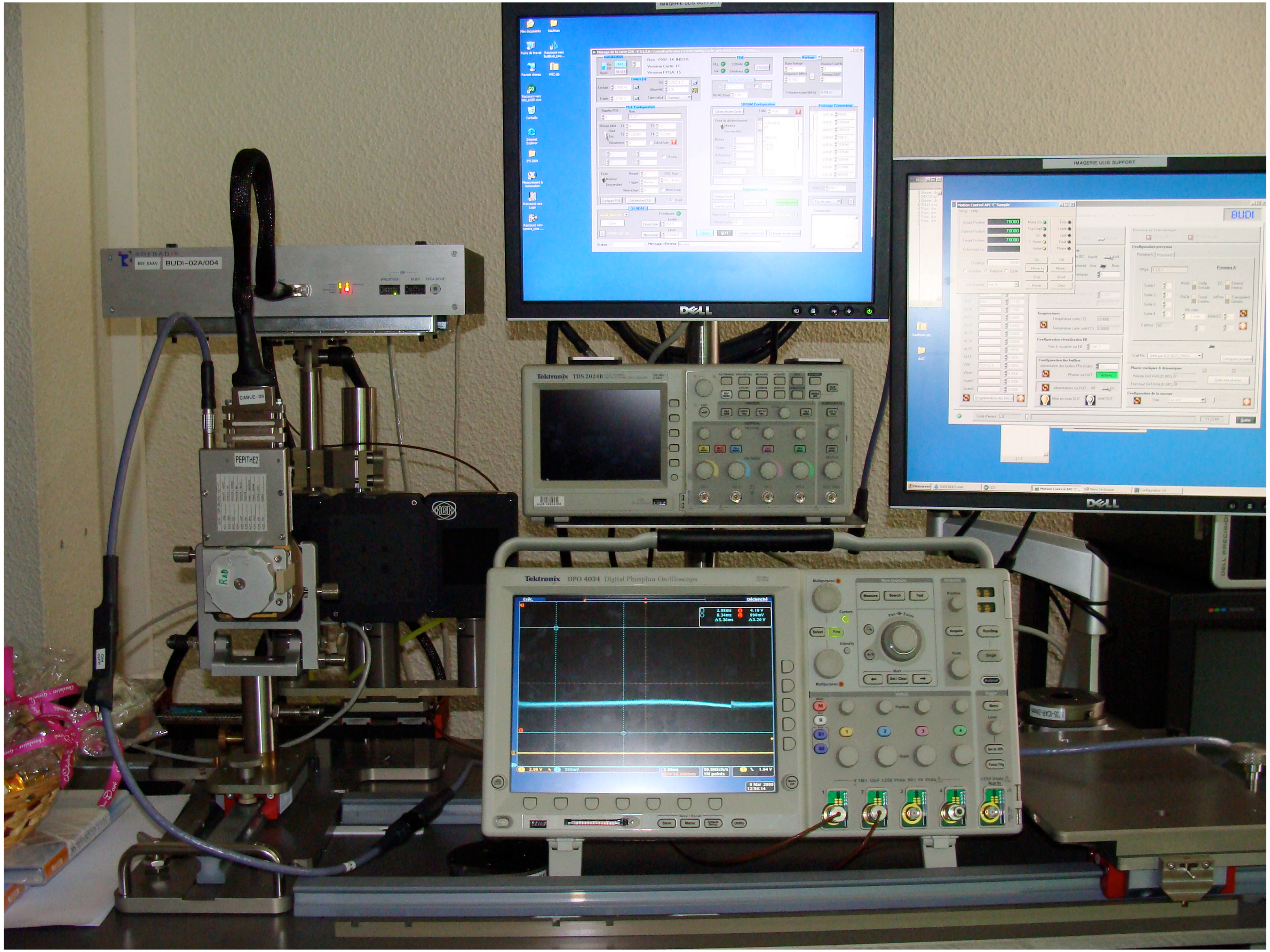
NETD & Dynamic range depend on the operating point

Some tests planned

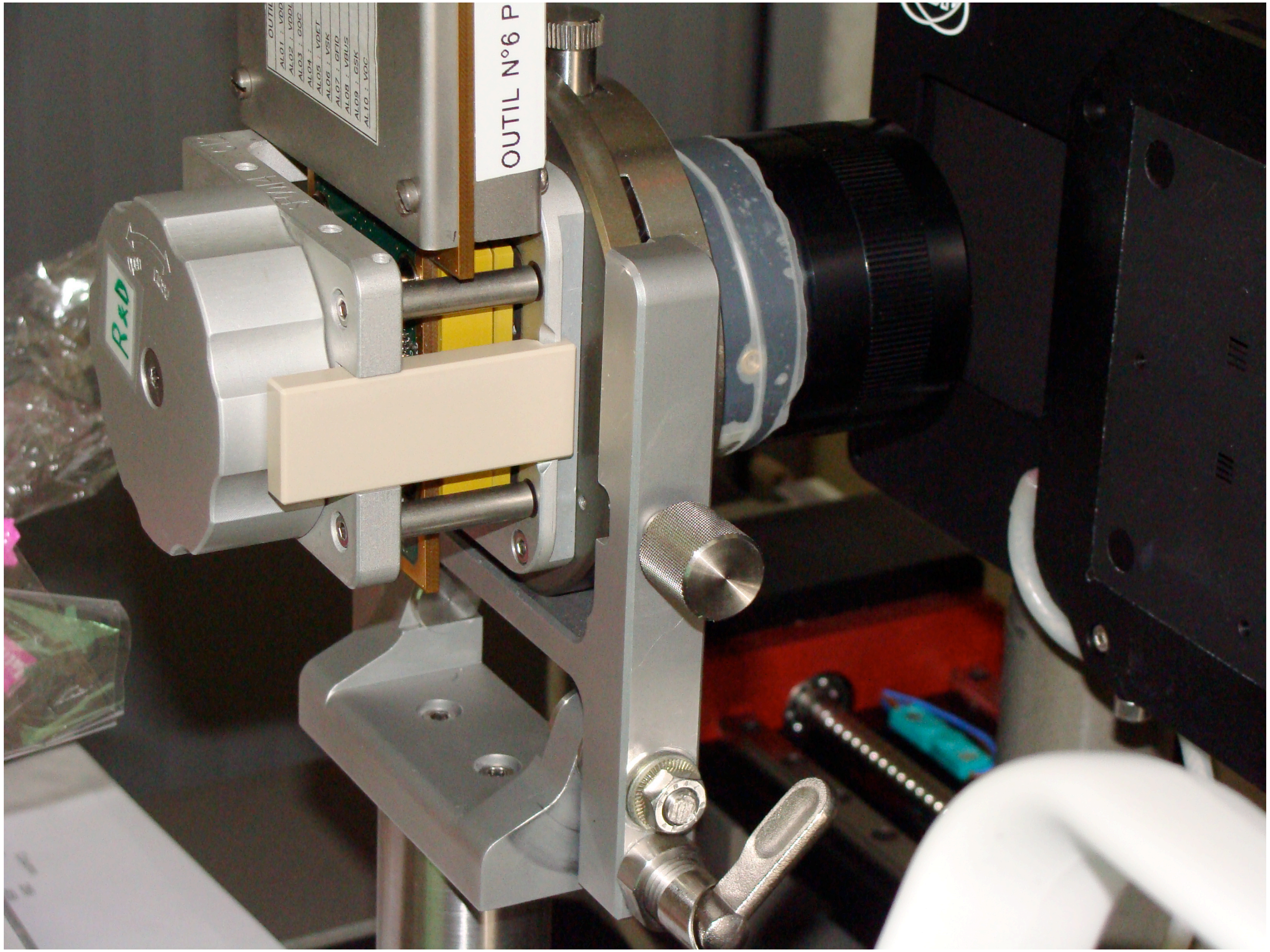
Estimated Cost ≈ 20.000€

- **Sensitivity/accuracy as a function of operating temperature.** The detector is in principle optimized for an operating temperature of typically 300K. The trade-off between operating temperature, electronic capability and sensitivity has to be tested for different operating temperature in the range 200-320K (TBD). Need a black-body.
- **Sensitivity/accuracy of the detector to its environment.** This has to be tested, for different environment temperature between 200-320 K (TBD). Need a climate chamber.
- **Sensitivity/accuracy of the detector to the observed scene.** On an asteroid the expected temperature range is 200 - 400 K
- **Sensitivity/accuracy as a function of integrating time.**

The Microbolometer experiment mounted at ULIS

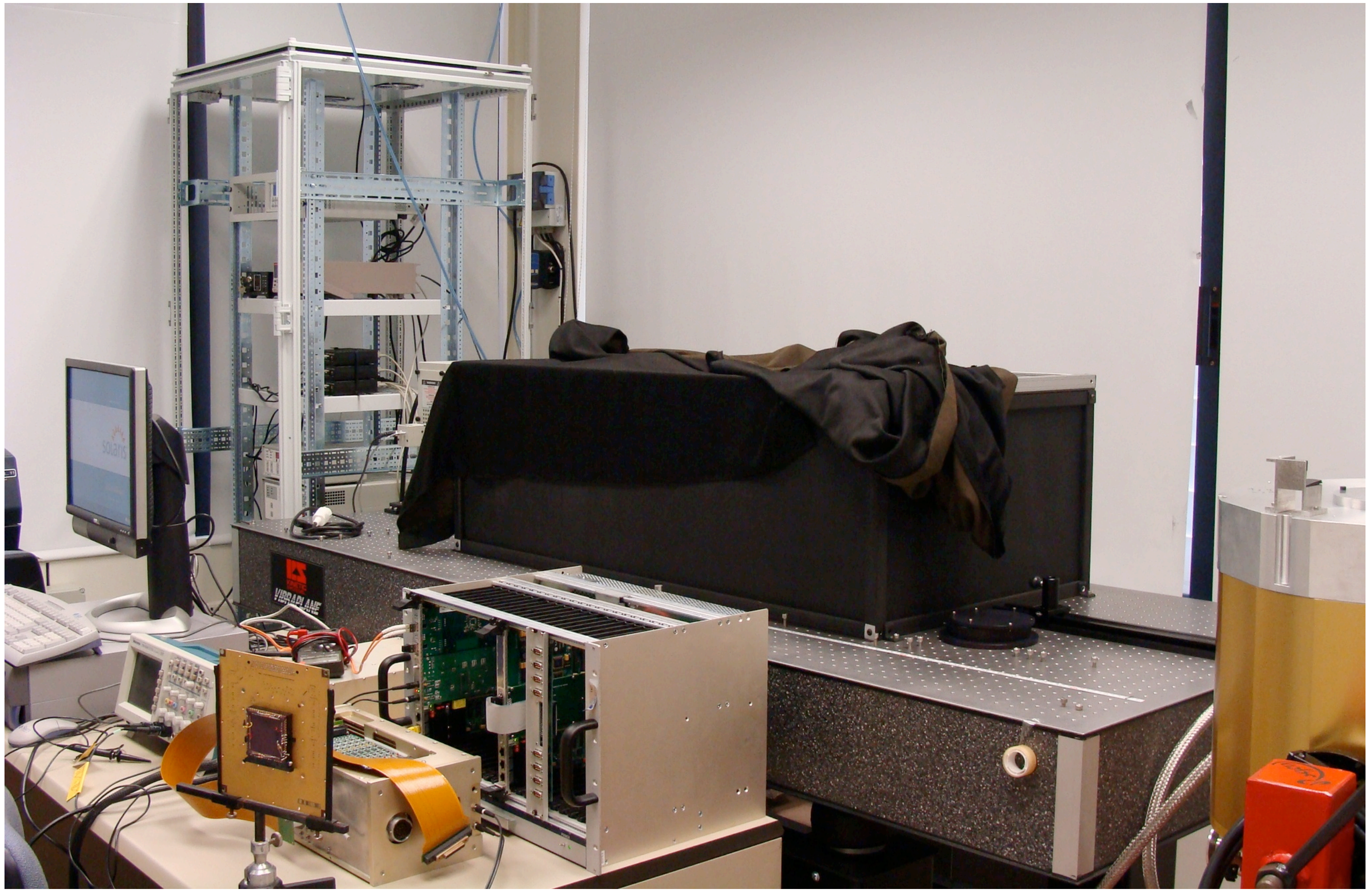


The Microbolometer experiment mounted at ULIS



The IAC Astronomy Image and Sensors Laboratory (LISA)

The Microbolometer will be first mounted and tested here



- LISA is the IAC test-bench for detector calibration and characterization
- perform a variety of test to the detectors to verify the requirements demanded

The IAC Climate Chamber

Environment controlled tests will be done in the IAC Climate Chamber

- The Climate Chamber is able to control both Temperature and Humidity.
- Temperature control range goes from -20ºC to +50ºC (+/- 0.5ºC).
- Humidity control range goes from 5% to 95% (+/- 1-2%).

The IAC Climate Chamber

The IAC Climate Chamber is big enough to hold a complete 150cm optical path test-bench.

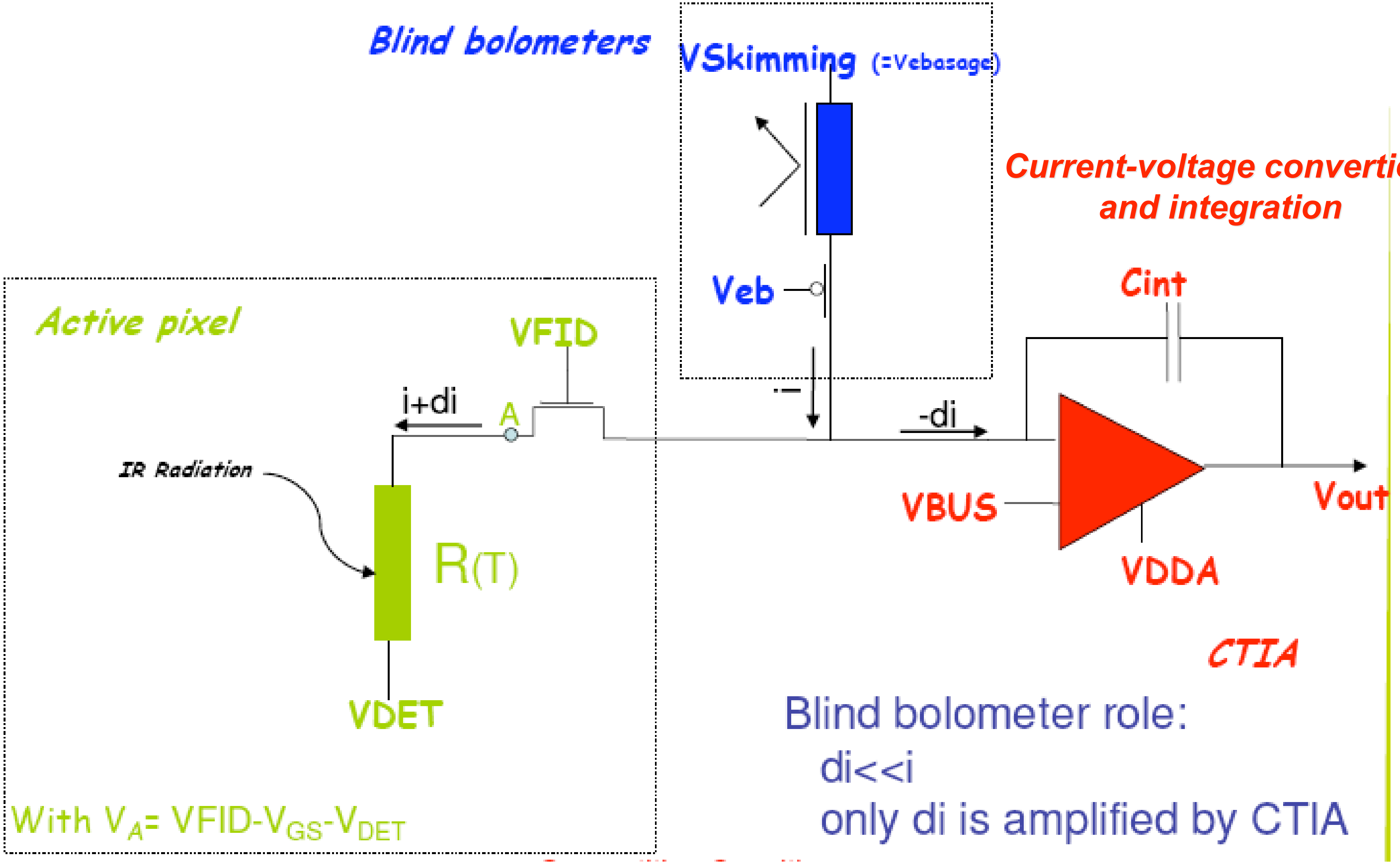
Expected Study outputs

- A document should be produced with the electronics reference design: detector controller, amplifier and ADC, mechanism controller, power conditioning, interface.
- Results of the characterization tests & open issues.

Sub-product

A complete camera system that will be tested for other astronomical and non-astronomical uses.

The electrical pixel scheme



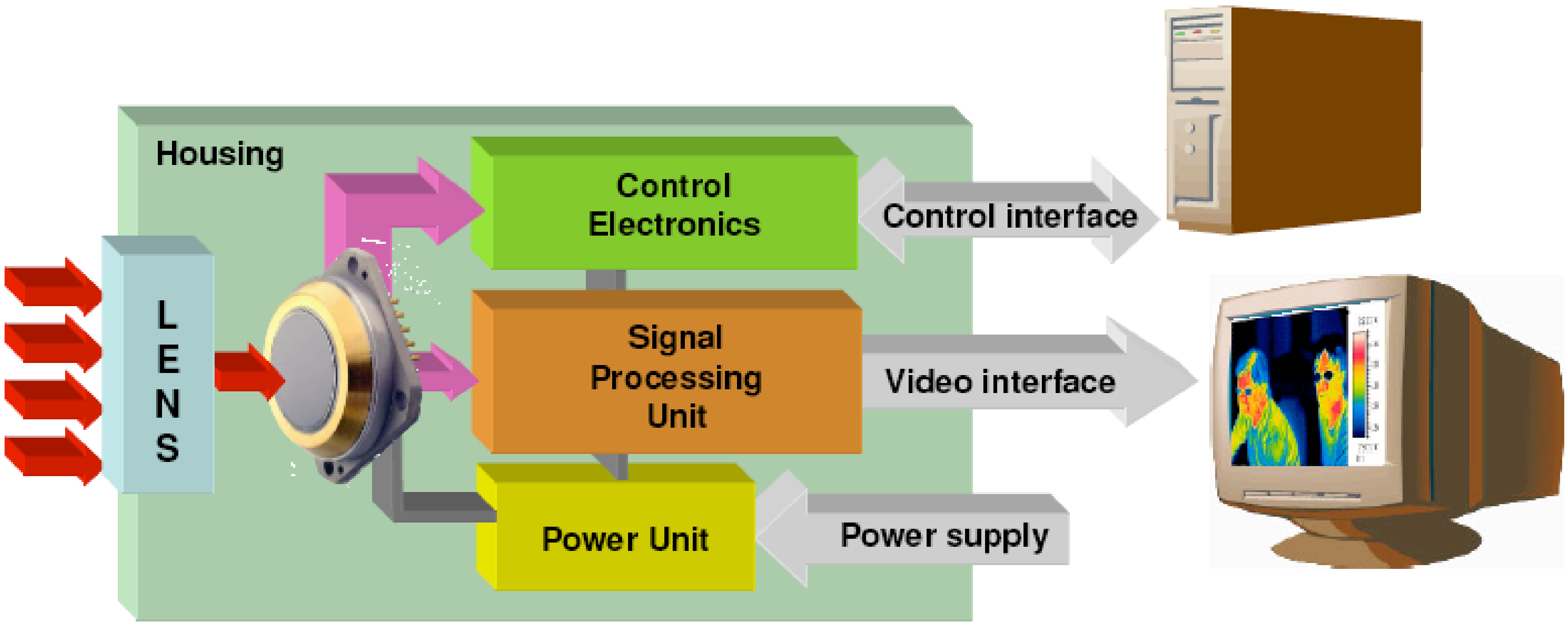
Blind bolometer role:

di<<i

only di is amplified by CTIA

- Operating point depends on :
  - ✓ Tuning of detector
    - FID = gain
    - Vskimming = Offset
    - Capacitance
  - ✓ Integration time
  - ✓ FPA temperature

The electronics needed for the detector



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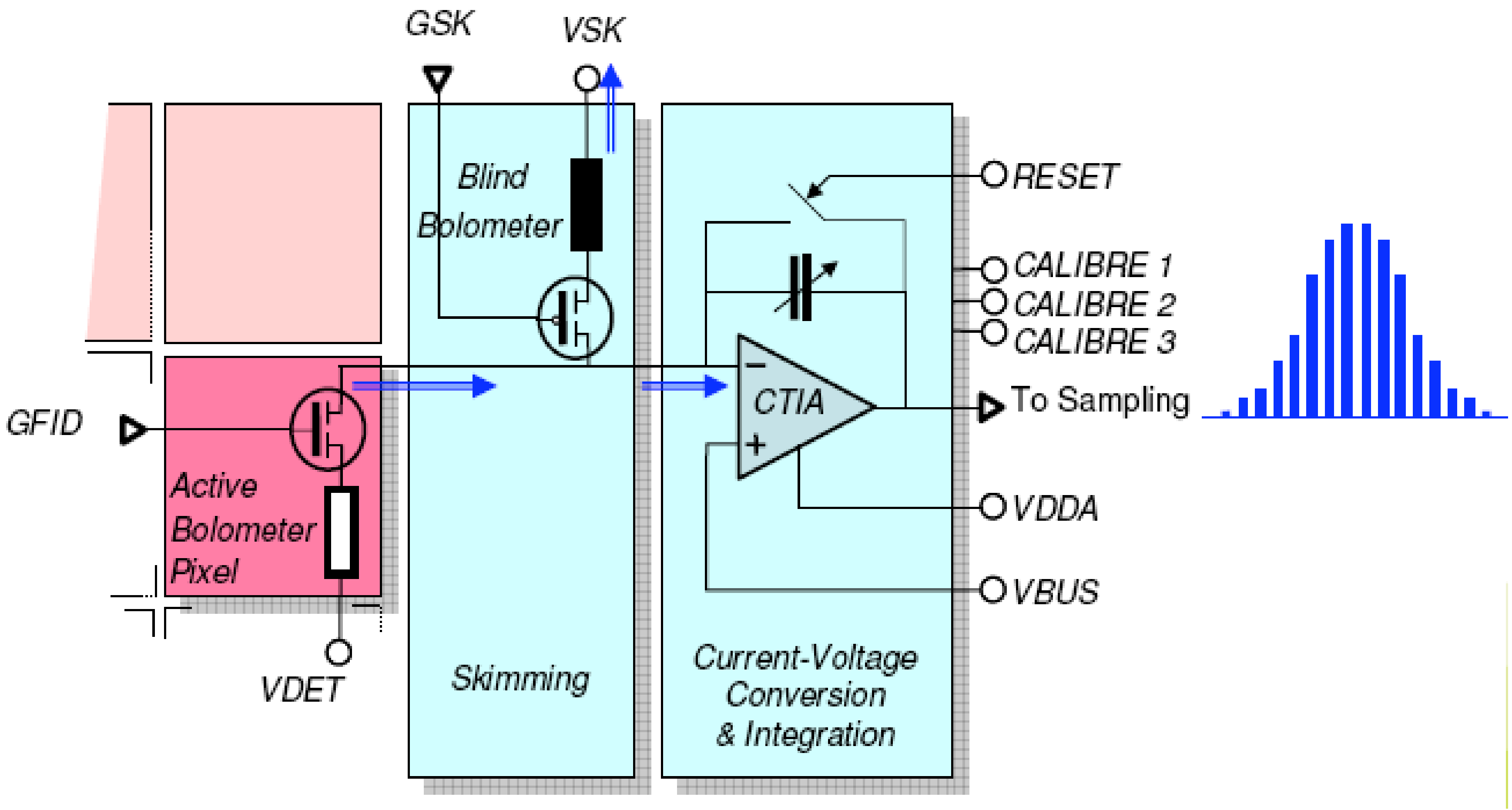

GSK
VSK
Blind
Bolometer
RESET
CALIBRE 1
CALIBRE 2
CALIBRE 3
GFID
CTIA
To Sampling
Active
Bolometer
Pixel
VDDA
VBUS
VDET
Skimming
Current-Voltage
Conversion
& Integration

Image quality depending on operationg

High NETD/ high Dynamic range

Better NETD/ lower Dynamic r

A visit to ULIS factory

- Operating point depends on :
  - ✓ Tuning of detector
    - – FID = gain
    - – Vskimming = Offset
    - – Capacitance
  - ✓ Integration time
  - ✓ FPA temperature

Tuning of the FPA

UL 03 04 1

Generally speaking, VFID and VSkimming are tunable biases

VFID(V)	Resp(mV/K)	Normalized NETD(mK)	Available scene dynamic range(℃)
3.6	7.70	1.0	167
3.4	6.40	1.17	205
3.2	5.20	1.42	247
2.8	4.36	1.5	278
2.6	3.71	1.67	315
2.4	3.35	1.8	340
2.2	2.92	2.0	380
2.0	2.54	2.27	415
1.8	1.98	2.87	485