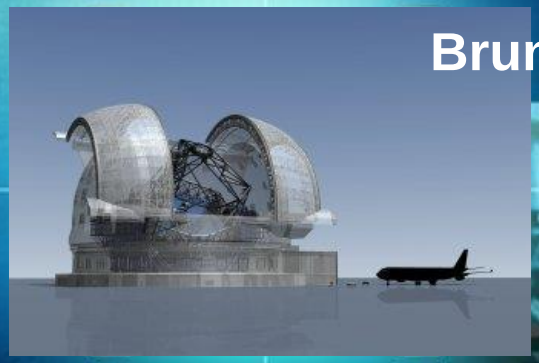
SOFRADIR
Sensing your future

4/11/2016

# Developments and opportunities of Large Infrared Detectors for Astronomy at Sofradir

Bruno FIEQUE (Project Manager – Space Departement)



# Sofradir Group:
## Middle size company

Groupe SOFRADIR

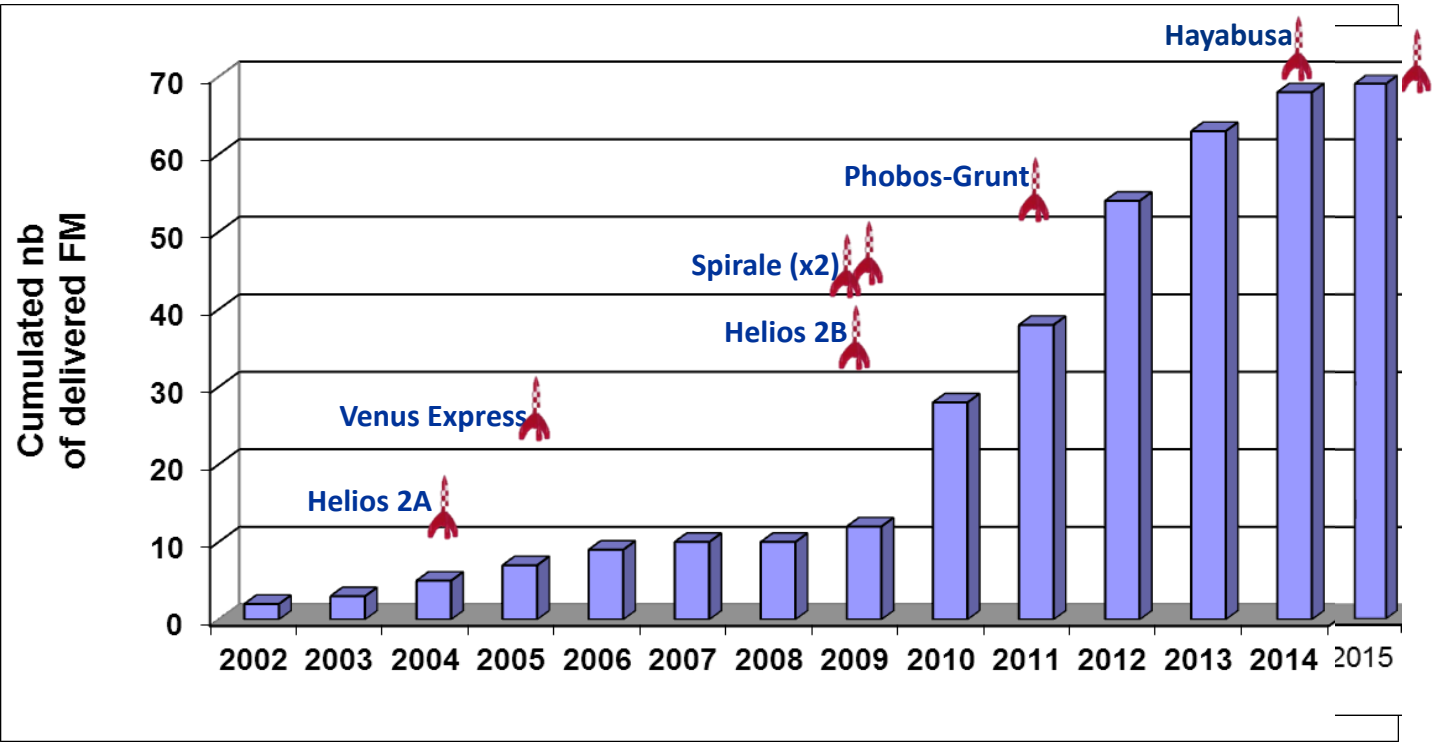
50% Thalès

50% Sagem

More than **900** people – 2015
Turnover 2015 : **214 M€**

# Sofradir in Space

- **A unique position in Europe: we are the only space-qualified IR 2D detector European company to have delivered scores of flight models:**
  - **70 Flight Models already delivered over the past decade**




Sofradir onboard Ariane 5 & Soyouz

- **Sentinel-2 : 12 new Sofradir detectors in space since June 2015**
- **Exomars: + 3FM in 2016** ***(near Mars for 12 days !)***
- **We foresee 20-25 FM launched in space in the next 3-5 years**

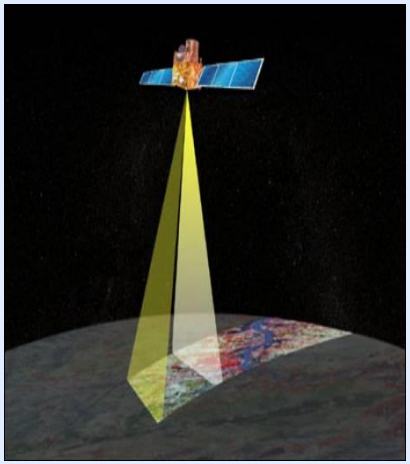
# Sofradir offers all services for space applications

- **Studies** (preliminary evaluation of technologies, development of new building blocks, development of new products)
- **Customized detectors for programs launched by space agencies**
- **COTS products used "as it is" or with minor customization**

## Military applications

- Surveillance
- Mission preparation
- Early Warning System

## Civilian applications

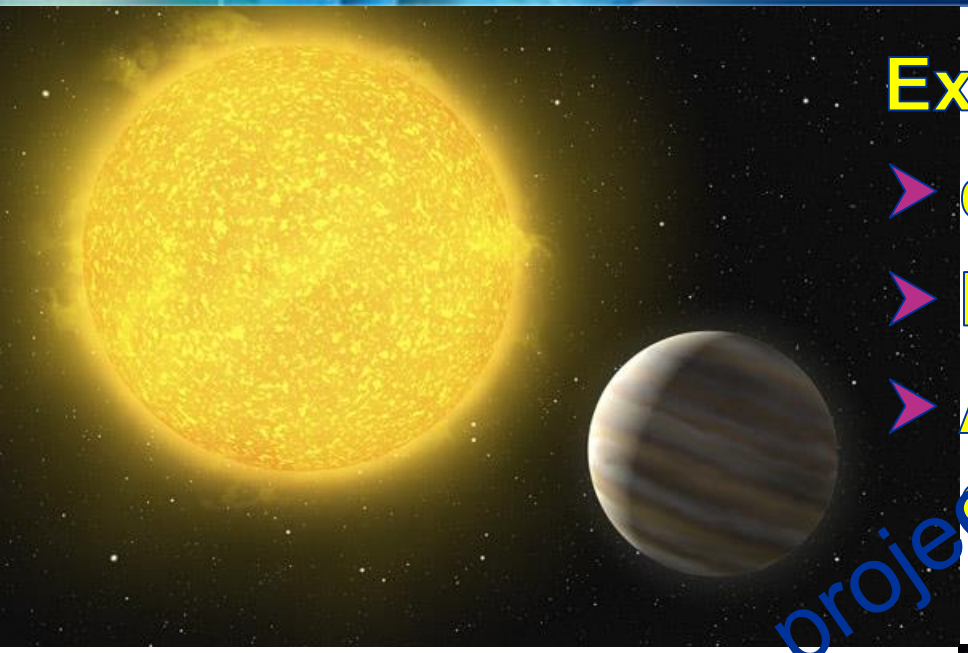


- Meteorology
- Agriculture surveillance
- Global warming studies

## Deep space science, Astronomy

- Planet studies (Venus, Mars, Mercury)
- Asteroids studies
- Telescopes

# Low Flux detection for Astronomy



## Exoplanets:

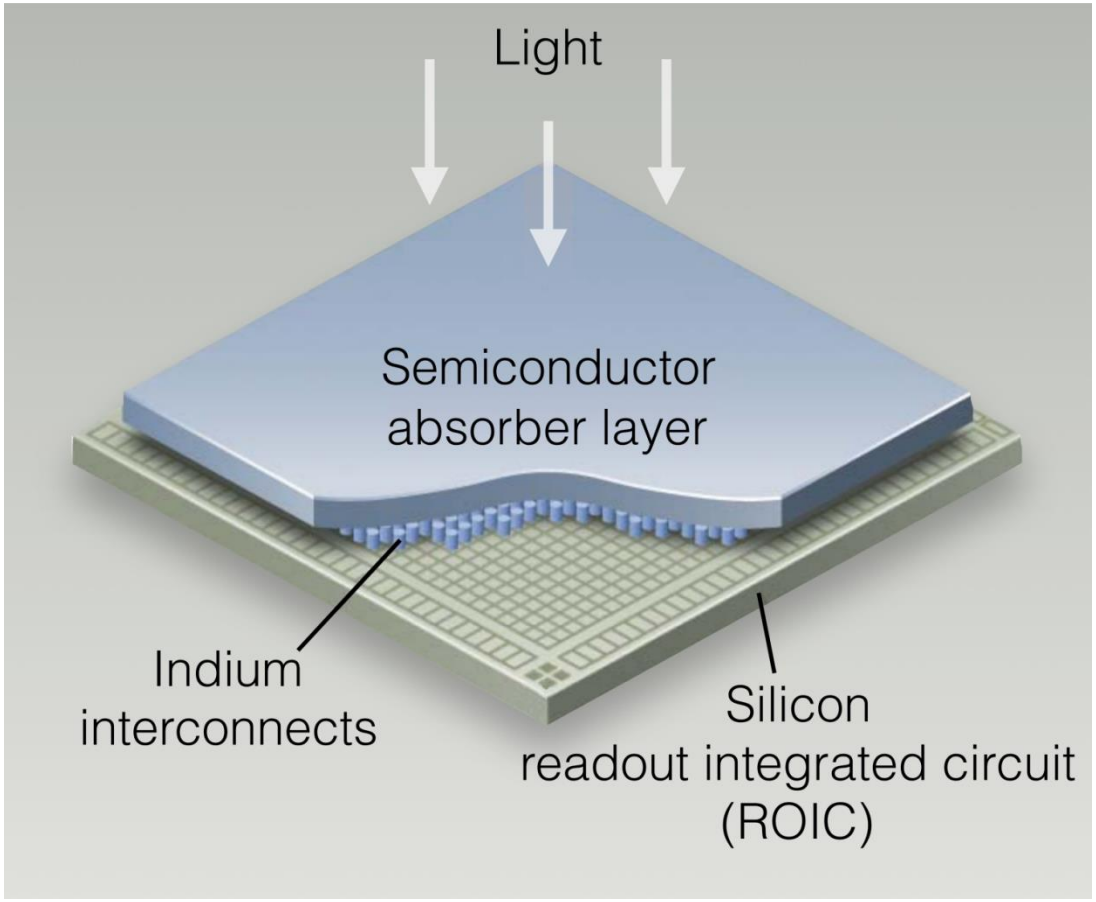
- discovering
- Imaging
- Atmosphere characterization

Many telescope projects need IR detectors

Far galaxies observations and studies

# Ground Telescope need

# Existing technologies for HgCdTe detector manufacturing



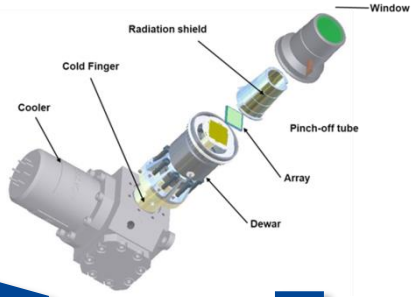
# Space activities take advantage of a solid base of technologies

Metallurgy (CdZnTe crystal growth)

Epitaxy (HgCdTe/CdZnTe)

Photovoltaic technology

Dewar design & development

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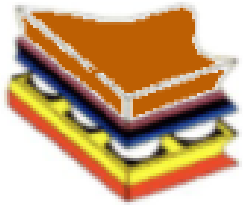


Hybridization & thinning

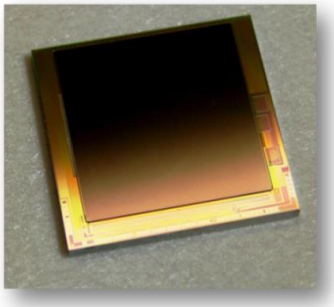
ROIC design

Last steps µelectronic processes

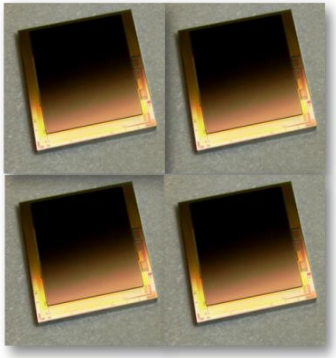
Testing facilities design & development

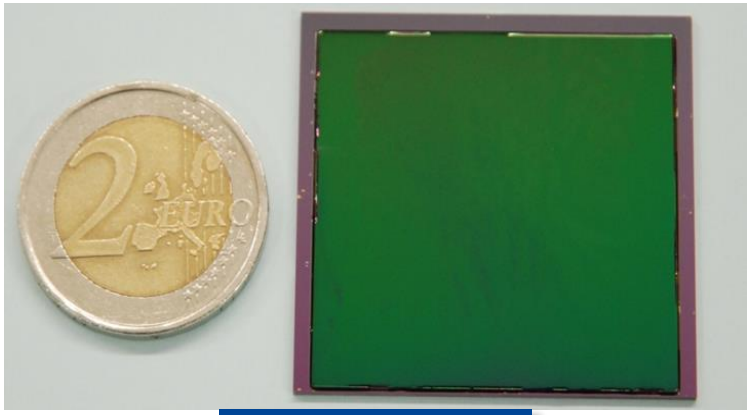
# Large size HgCdTe detector challenges

- **Existing larger Dectector in Europe for space application is NGP from Sofradir : 1024x1024 15µm pitch**



- **Sofradir goal is to multiply by 4 this size up to 2048x2048, 15µm pitch size:**






First mock-up for feasability evaluation at Sofradir

# 2K² NIR/SWIR detector specification

| Parameter | Requirement | Values measured on first prototypes (640x512, 15µm) |
|---|---|---|
| Operating wavelength | 0.9 – 2.0µm | 0.8- 2.1µm |
| Cutoff wavelength | <2.3µm | 2.1µm |
| Quantum efficiency | ≥70% | 74% mean value |
| Operating temperature | ≥100K | 100K |
| Dark current (at 100K) | ≤0.1 e-/pix/s | <0.5e-/s |
| Linear well capacity | ≥60ke- | 60ke- |
| Non-Linearity | ≤3% | 3.2% and 2.5% |
| Cross talk (inter pixel capacitance) | ≤2% | 0.6% to 1.1% |
| Readout noise (single CDS) | ≤18e- rms | 11.4 to 11.5e- |
| Readout speed | ≥100kHz | 100kHz |

- Results obtained on 2 first R&T ESA phases on 640x512 format detector

# Our Goal

- **Federate laboratories, universities, companies… with Sofradir to develop the LARGER NIR/SWIR HgCdTe Detector in Europe for:**
  - Astronomy & Science domain on Ground Telescopes
  - Astronomy & Science domain on Space Telescopes

  - Derived Large IR detector for:
    - *Earth Observation (Sentinel 5 successor for example)*
    - *Hyperspectral applications*
    - *Spectroscopy*

- **Give Europe independancy from US manufacturer (unique provider of very large IR detector : Teledyne)**

# Our Goal

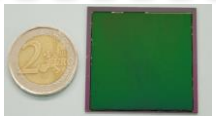
- Involved technologies & development to perform:
  - HgCdTe **material** improvement for Large size detection circuit
  - **Hybridization** technics and processes for Large size detector
  - Thermo-Mechanical **Modeling** of such big squared imagers
  - **Packaging** of such IR detectors taking into account the availability of Focal Plane with multiple number of detectors (butting)
  - **Testing** of such very low flux and low noise detectors

# Work to be done

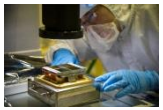
*Shortly in progress And To be completed …*

Product development for Astronomy

Technology scaling



Packaging studies of 2K² buttable detectors



2K² ROIC adaptation for other applications:

- Earth Observation
- Hyperspectral
- Spectroscopy

Industrial Capacity

Testing of Full Packaged 2K² buttable detectors

Testing of 2K² detector

*No yet financed…*


Thank You !