

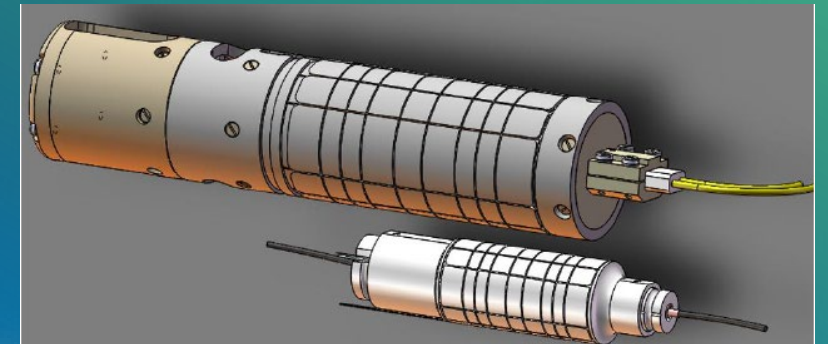
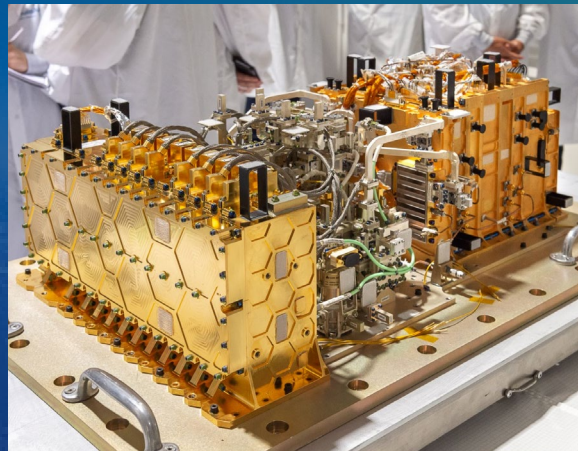


# Living Planet Symposium Take The Pulse Of Our Planet



## EXAMPLES OF INNOVATIVE TECHNOLOGICAL EO DEVELOPMENTS IN CNES

**EO National Missions Strategy and Programmes**  
**23 May 2022 – 13:30-15:10**



Dr. Selma Cherchali

Head of Earth Observation Program

Strategy Directorate

# Prepare to the Future

**COMET**

**R&T call  
of ideas**

**Thesis**

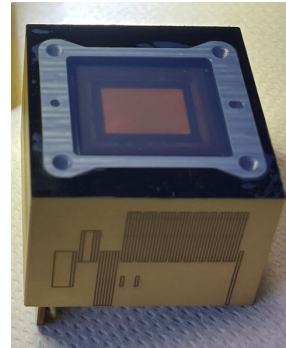
**Research &  
Industrial  
partnership**

**Technical  
Roadmap**

**Technical  
developments :  
R&T &  
Demonstrators**



*Additive Fabrication  
© Almia-CNES*

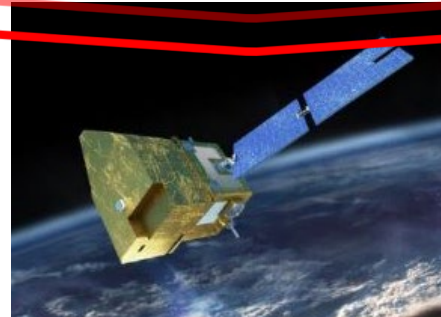


*Visible Caméra  
© 3Dplus*



**Mission &  
System :  
Phases 0  
(PASO)  
and Phase A**

*Microcarb  
© CNES*



**Project development :  
Phases B, C, D, E**

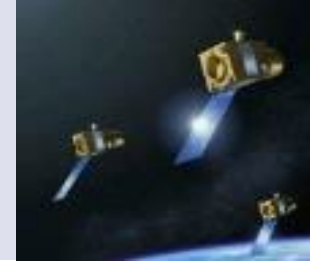
## R&T Structuring (1/2)

Preparing new generation orbital infrastructures for **Localisation, Navigation & system**



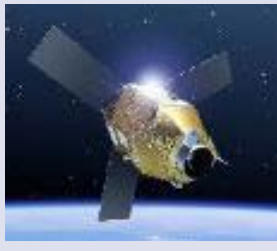
LN

Developing methodologies and technologies needed to **Protect** the future systems



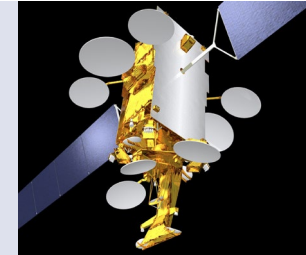
RE+VN

Promote the emergence of new generation **Earth Observation** system



OT

Improving the use of **Space Telecommunication** and their competitive positioning



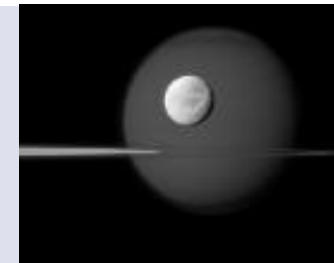
TC

Enhance space infrastructure and data to strengthen their use and develop **Applications**



DU

Develop French skills in preparation of the future programmes for **Universe studies and Exploration**

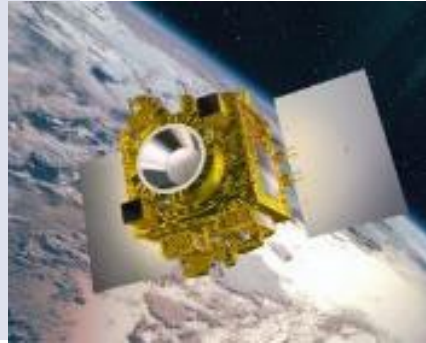


SU



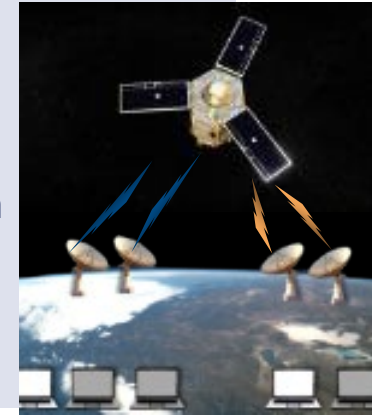
## R&T Structuring (2/2)

Constantly improving the **Platform** families (including balloons) and their corresponding key technologies



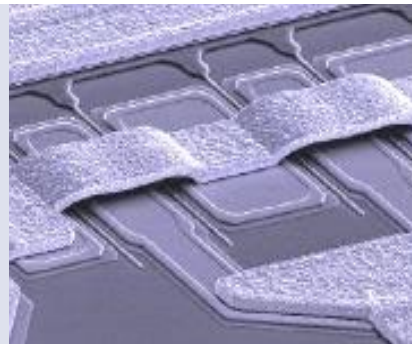
PF

Simplifying **Satellite to Ground** communications systems to make them more reliable and reduce price projections



BS

Mastering **Micro-technologies** in the space environment and keeping abreast of the evolution of nanotechnologies with a view for their use in the space sector



MT

Developing **Generic Techniques** and technologies for spacecrafts



TG

## R&T for Orbital Systems

Conducted with various **institutional** research organisations and **industrials**

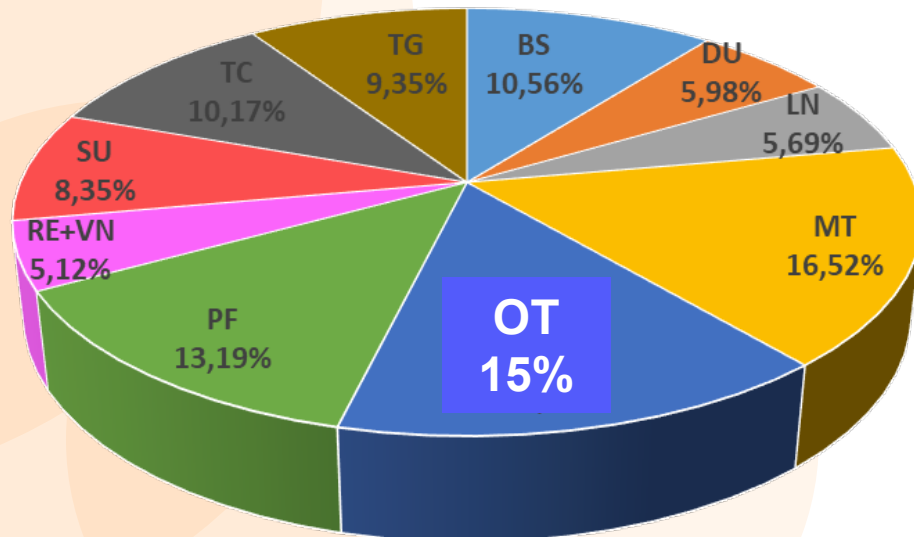
**Co-financing** is the rule

Earth  
Observation

Telecoms

Space  
Sciences

PPRT 2021



**OT** : dedicated to EO payloads development

- VHR optic imagers
- Multi/Hyper spectral radiometers
- Optic Active & passive sounding instruments
- Microwave sounding instruments
- Altimeter and radar

## EO Priorities

### Science

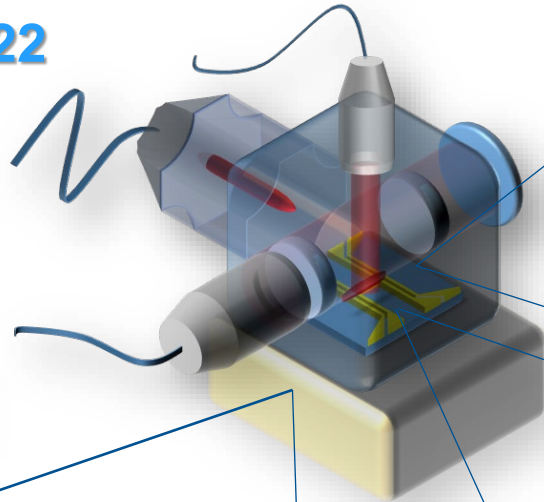
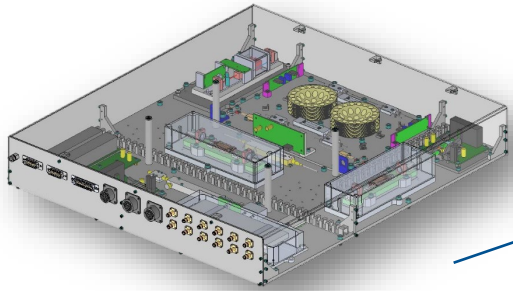
- The study of the radiative impact of aerosols and clouds, in particular by lidar techniques
- Improvement of the reference system and measurement of the gravity field,
- The measurement of the surface ocean current,
- Monitoring of biodiversity and terrestrial ecosystems by high resolution hyperspectral measurements,
- Measurement of ocean salinity and soil moisture at high resolution,
- The strong involvement of France in the definition of Copernicus long term

### General

- Repetitiveness of observations,
- Miniaturization,
- Combination and assimilation of multi-source and voluminous data
- Support for industrial competitiveness and a technical basis for institutional missions

# R&D Atom accelerometers for space

## R&T from 2004 to 2022



- **Performances & On-board operability:**



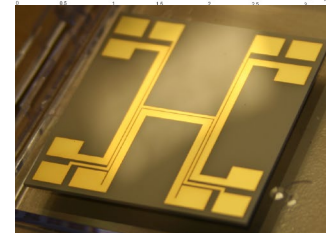
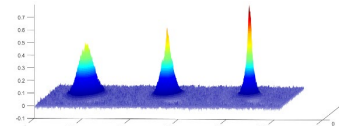
- On-board metrological performances.
- Vibrations and rotations effect study.
- Validating key technologies

- **Laser system:**

- Fiber telecom based laser system.
- Frequency doubling (MUQUANS).
- Qualification TRL 6.

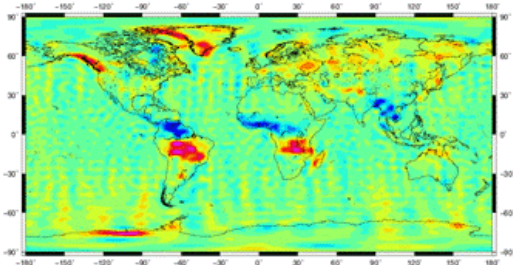


- **Ultra-cold atomic source:**



- Ultra-cold atomic sources in micro-gravity.
- Atom-chips for atom trapping and cooling.

## Phase 0 GRICE (2017-2019)\*

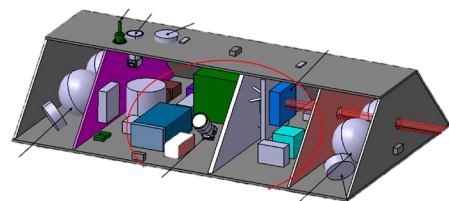
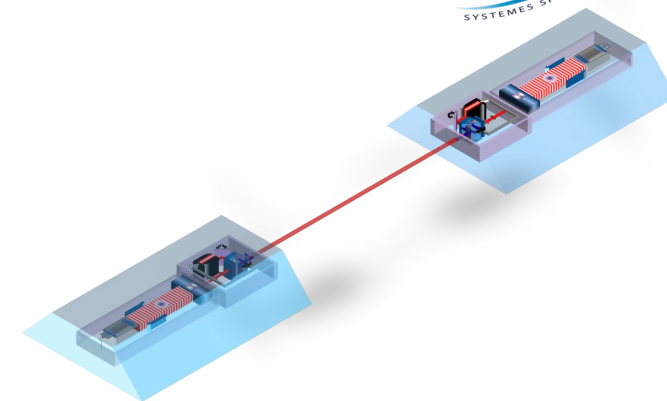


### Mission concept:

- Dual satellite mission concept
- Composite acceleration gradient measurement

### Mission performances:

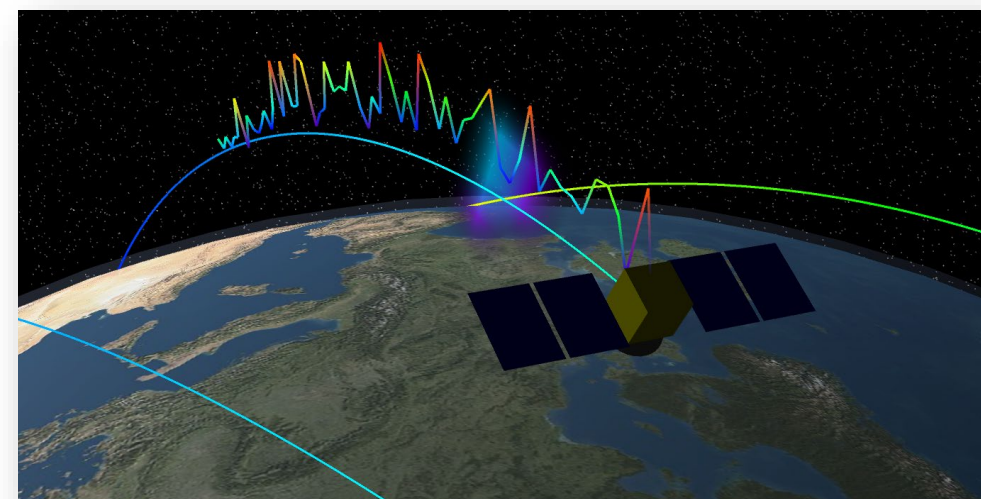
- Numerical simulation of the mission performances
- Composite acceleration gradient measurement



## Phase 0 CARIOQA (2019-2021)

### Quantum Pathfinder mission definition:

- Instrument definition
- Mission study

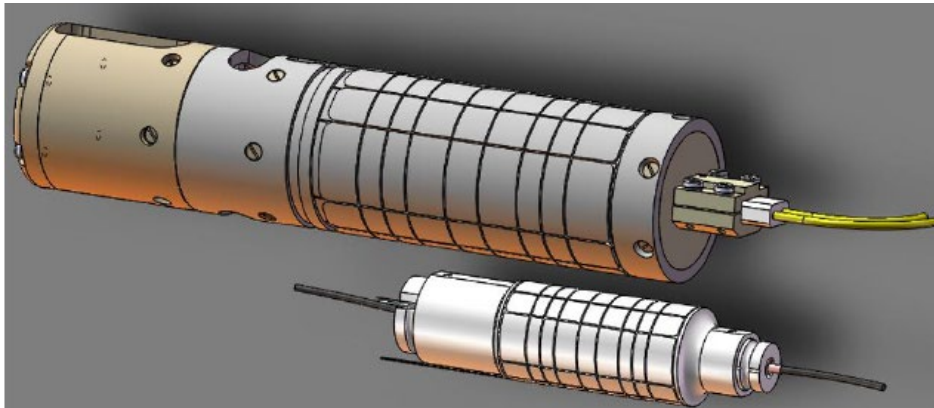


\*T. Lévêque et al, « Gravity Field Mapping Using Laser Coupled Quantum Accelerometers in Space », *Journal of Geodesy*, 95, 1 (2021).

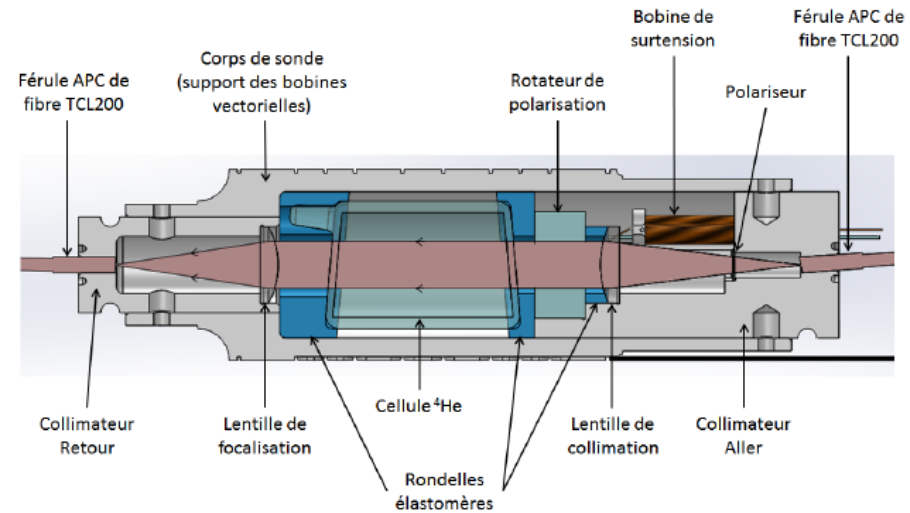


## Magnetometer : from SWARM to NanoMagSat

- **2013 to 2019 : Development of key technologies to miniaturize the sensor & test of a complete probe**



NanoMagSat probe Vs SWARM probe



Inside design of the NanoMagSat probe

Output TRL : 4/5 (development of a complete engineering model (EM), fully operational tests on EM, environmental tests on critical components)

- **2019 - 2021 : Improvement of the vector mode to complete NanoMagSat payload + new target applications ("space weather", planetary science...)**
- **Then switch to a ESA framework**

## From R&T to orbit: SARAL AltiKa

### **1998 – 2003 (CNES R&T)**

Technological: Ka amplifier, waveform generator, ASIC ...

Physic of measurement: propagation, wave/surface interaction

### **1999: Instrument feasibility study (phase 0)**

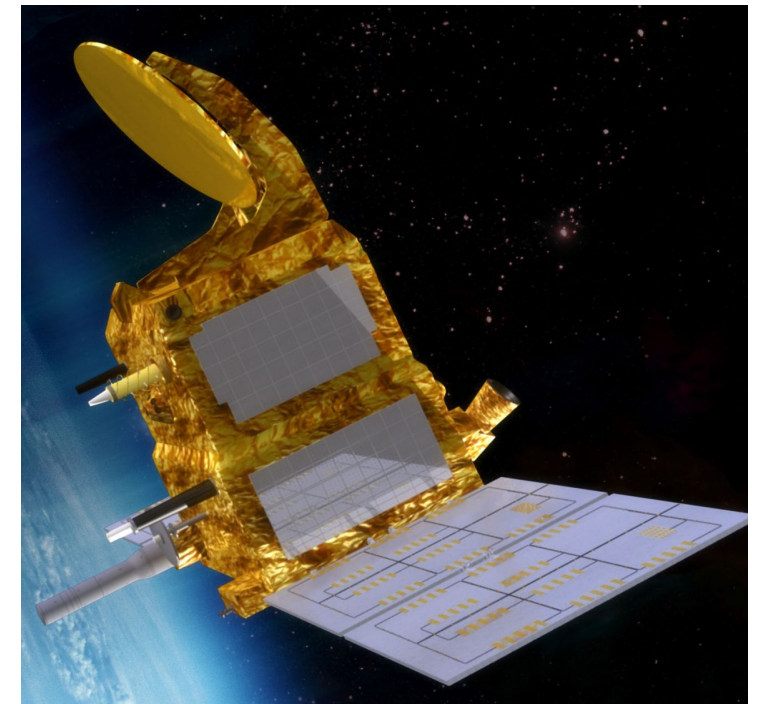
### **2000: End of Phase A**

### **Franco-Indian cooperation (CNES/ISRO)**

**Dec 2005: K.O. phase C/D**

**Dec 2008: Instrument delivery (TAS. Fr) : 2010**

**Fev 2013 Launch SARAL**

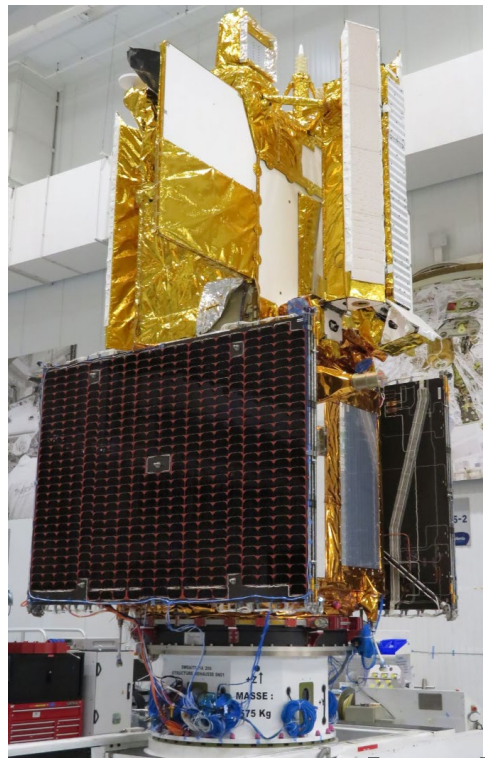


15 years

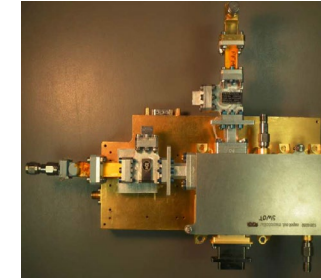
# SWOT/KaRIN/RFU: From R&T to SWOT AIT

## RFU development

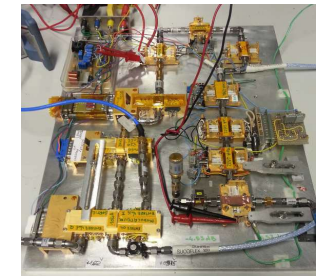
- CNES responsible for the dev of the analog part of the KaRin instrument (JPL lead)
- Development entrusted to TAS-Fr (Honeywell-UK has developed the Dx)



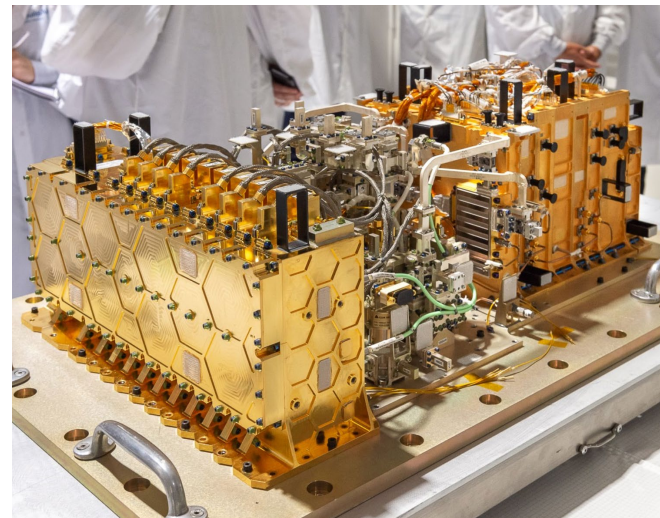
**SWOT AIT [2022]**



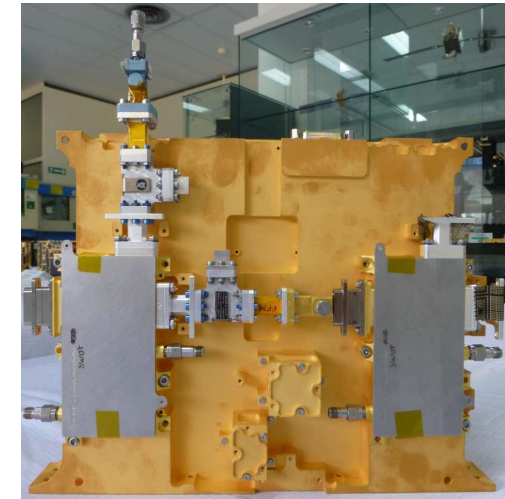
**Rx macro-hybrid [2014]**



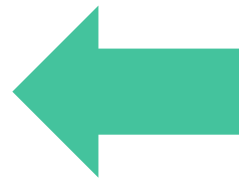
**Tx BB**



**RFU PFM [2020]**



**Interferometric Rx chains [2015]**



\* Credit THALES ALENIA SPACE