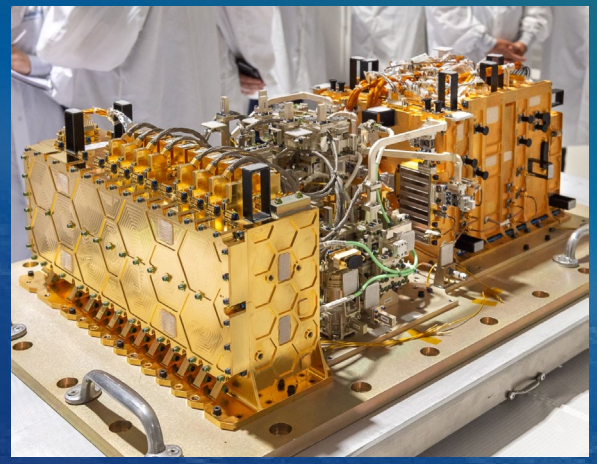
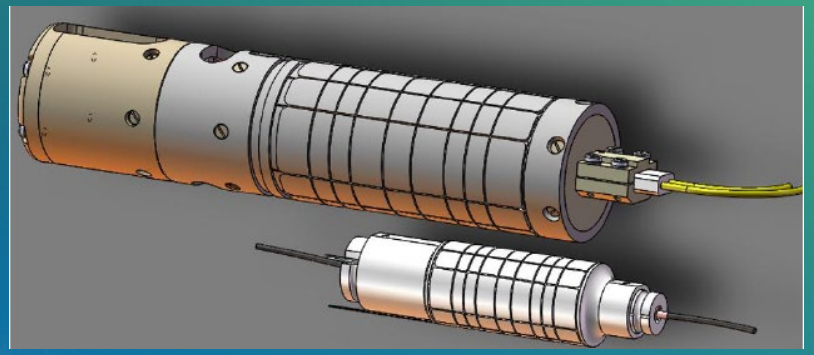
Living Planet Symposium
Take The Pulse Of Our Planet

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

R&T call of ideas

COMET

Thesis

Research & Industrial partership

Technical Roadmap

Technical developments : R&T & Demonstrators

Additive Fabrication
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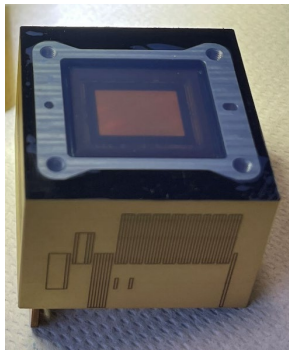

Visible Caméra
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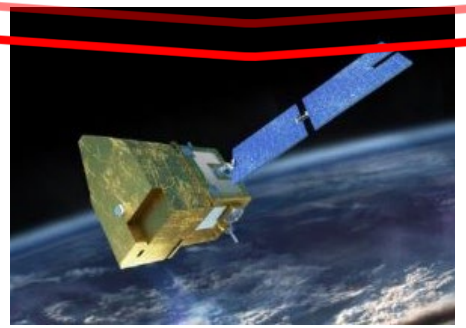
Mission & System : Phases 0 (PASO) and Phase A



Microcarb
© CNES

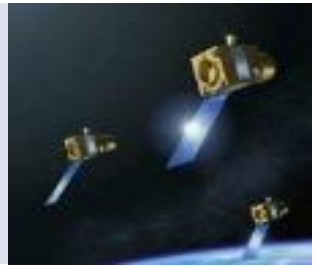
Project development : Phases B, C, D, E

R&T Structuring (1/2)

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

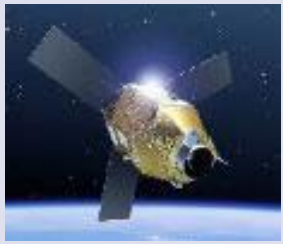
LN

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



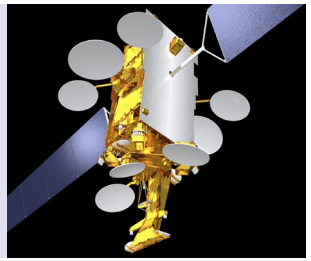
RE+VN

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



OT

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

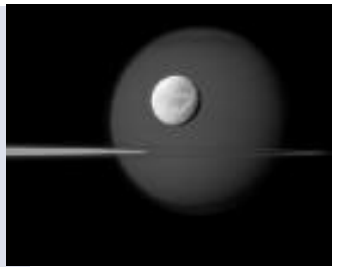


TC

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

DU

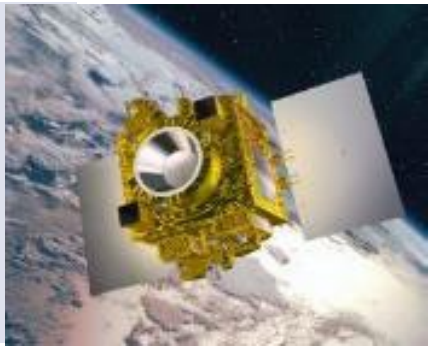
Develop French skills in preparation of the future programmes for **Universe studies and Exploration**



SU

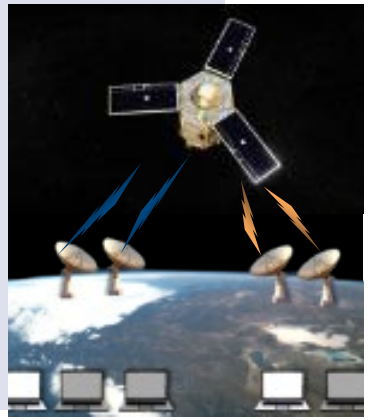
R&T Structuring (2/2)

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

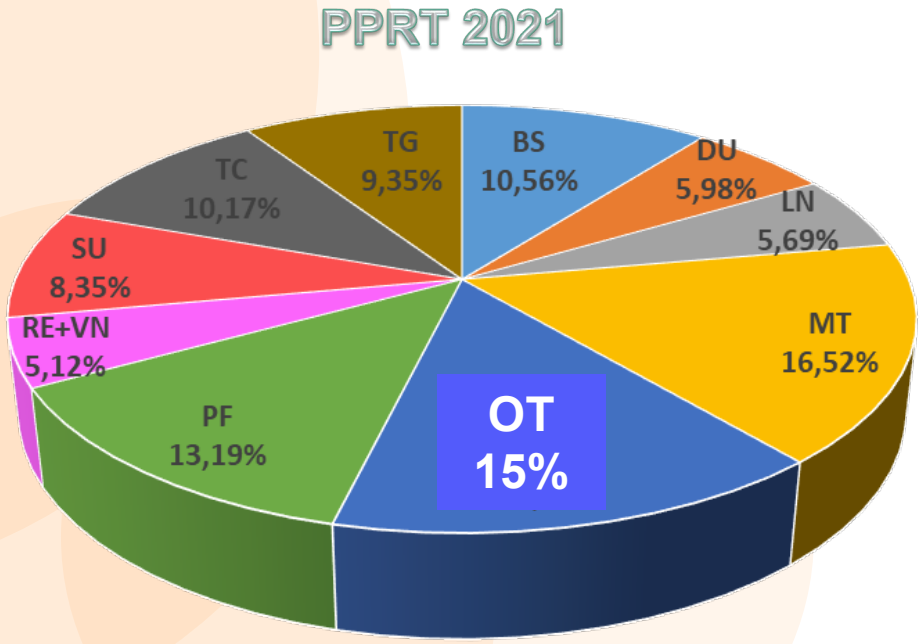
R&T for Orbital Systems

- Conducted with various **institutional** research organisations and **industrials**
- **Co-financing** is the rule

Earth Observation

Telecoms

Space Sciences



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

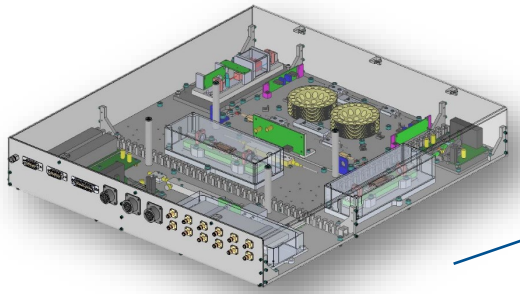
- The study of the radiative impact of aerosols and clouds, in particular by lidar techniques
- Improvement of the reference system and measurement of the gravity field,
- The measurement of the surface ocean current,
- Monitoring of biodiversity and terrestrial ecosystems by high resolution hyperspectral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

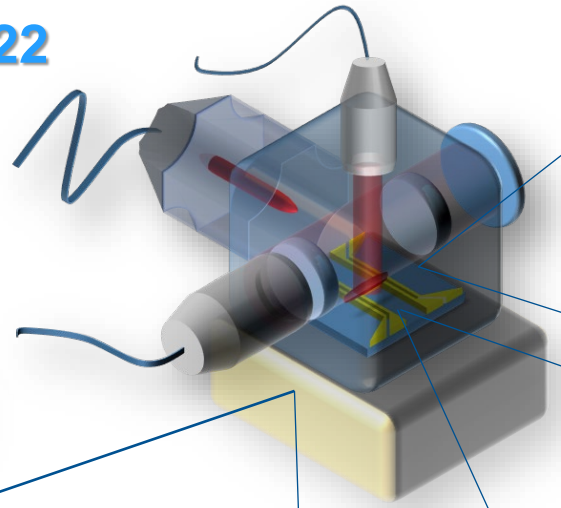
General

- 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



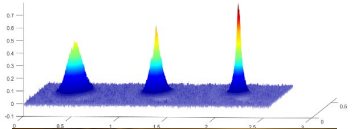


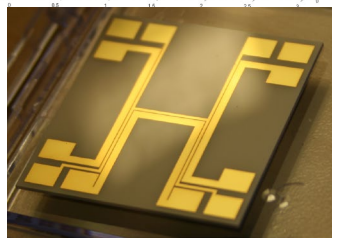
- **Laser system:**
  - Fiber telecom based laser system.
  - Frequency doubling (MUQUANS).
  - Qualification TRL 6.

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

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

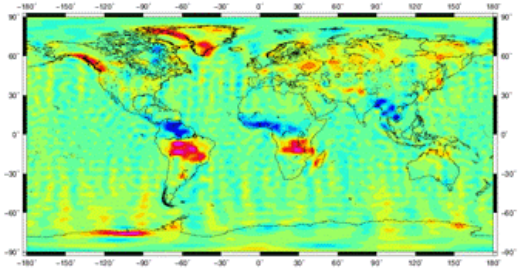
- **Ultra-cold atomic source:**

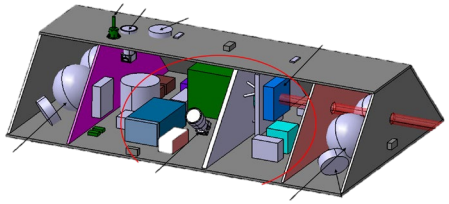




  - Ultra-cold atomic sources in micro-gravity.
  - Atom-chips for atom trapping and cooling.

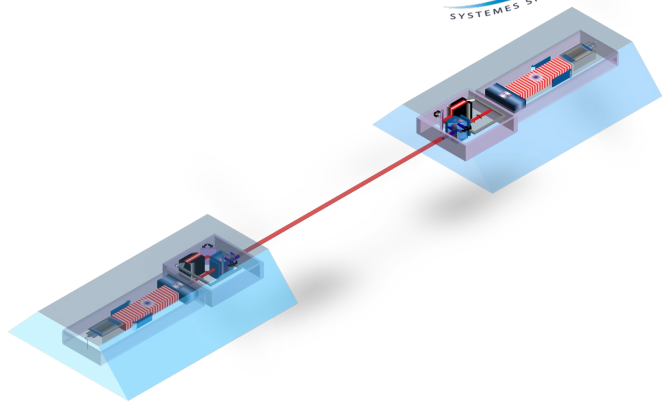
Phase 0 GRICE (2017-2019)*





Mission concept:

- **Dual satellite mission concept**
- Composite acceleration gradient measurement



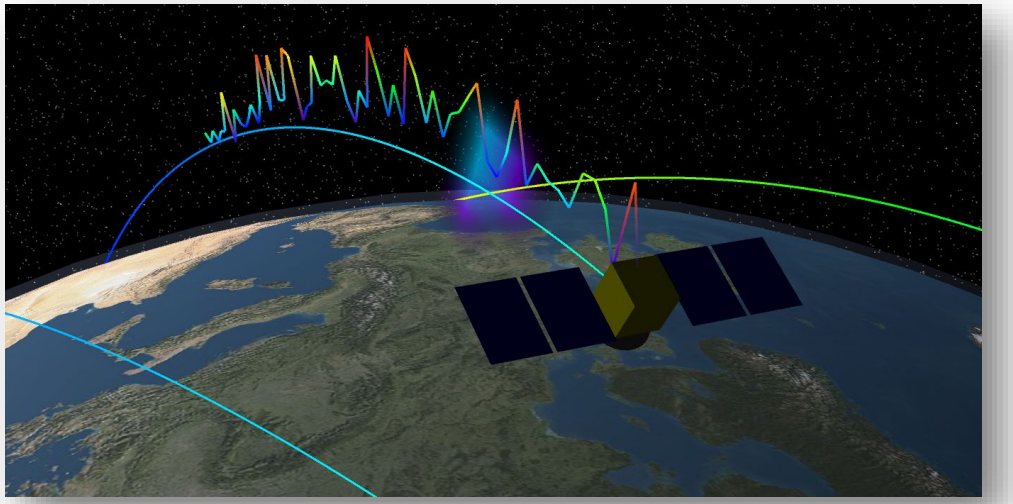
Mission performances:

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

Phase 0 CARIOQA (2019-2021)

Quantum Pathfinder mission definition:

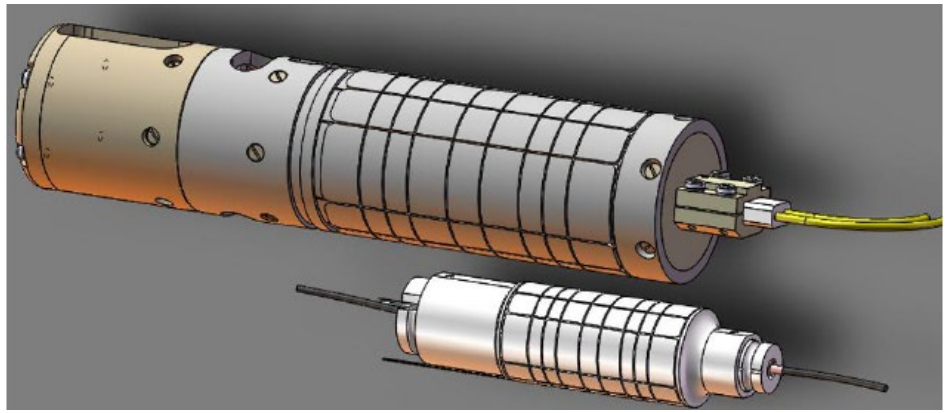
- **Instrument definition**
- **Mission study**



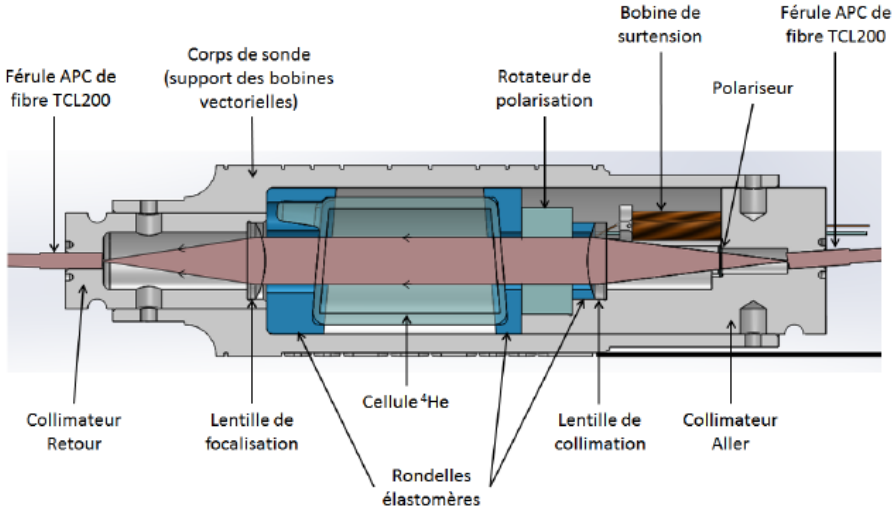
**T. Lévèque et al, « Gravity Field Mapping Using Laser Coupled Quantum Accelerometers in Space », Journal of Geodesy, 95, 1 (2021).*

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

15 years

1998 – 2003 (CNES R&T)

Technological: Ka amplifier, waveform generator, ASIC …

Physic of measurement: propagation, wave/surface interaction

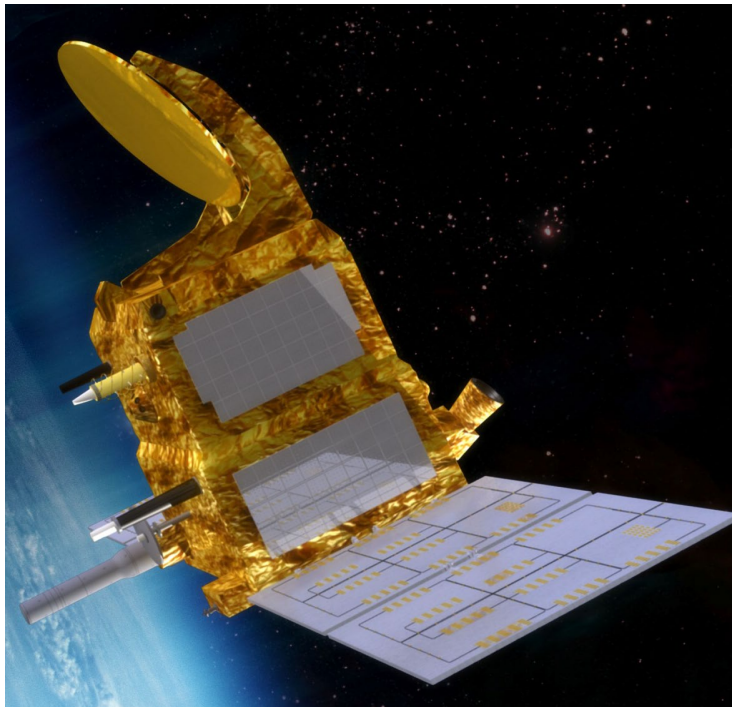
1999:Instrument feasability study (phase 0)

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

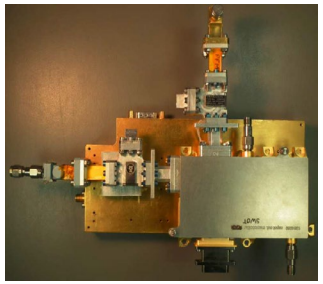


SWOT/KaRIN/RFU:From R&T to SWOT AIT

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)*

R&D *[2012]*



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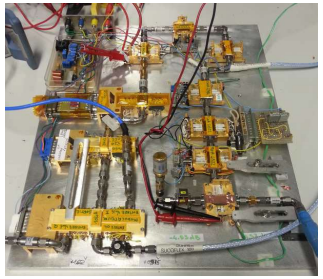
Rx macro-hybrid *[2014]*



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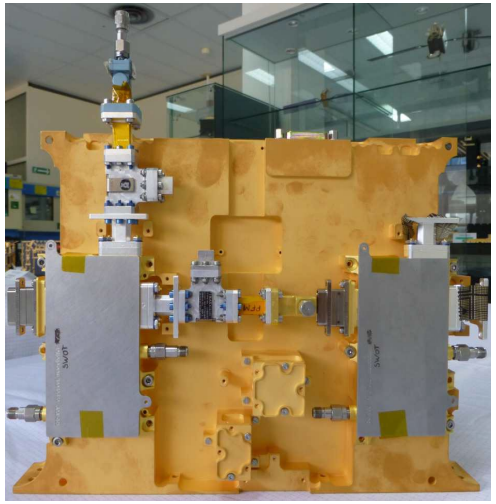

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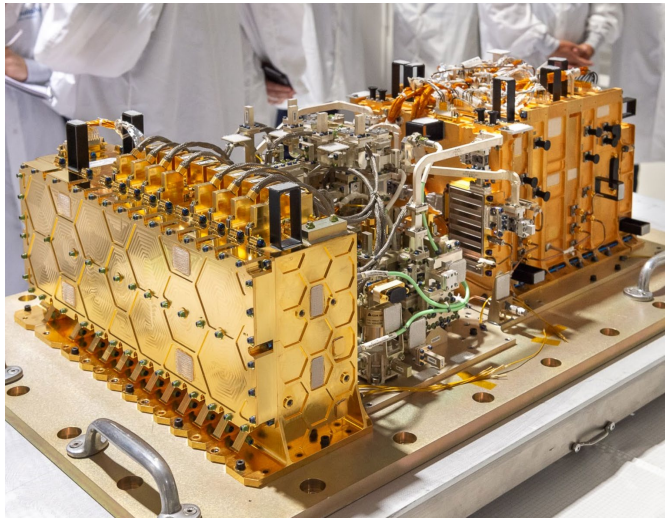
Interferometric Rx chains *[2015]*



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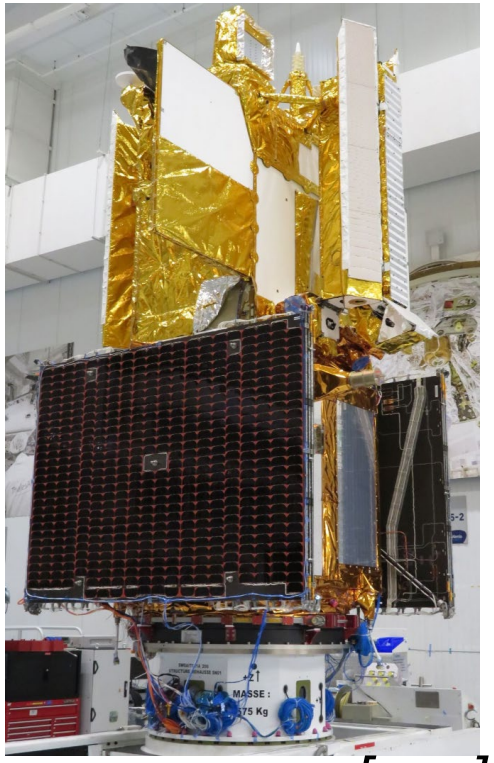
RFU PFM *[2020]*



SWOT AIT *[2022]*

* *Credit THALES ALENIA SPACE*