Instrumentation and Remote Sensing

Staff :

Permanent (13):

- 4 C / EC + 2 'émérites'
- 7 ITA (4 IR, 2 IE, 1 AI, 2 T)

Non-permanent (12):

- 5 CDD (1 IE and 4 IR)
- 7 PhD

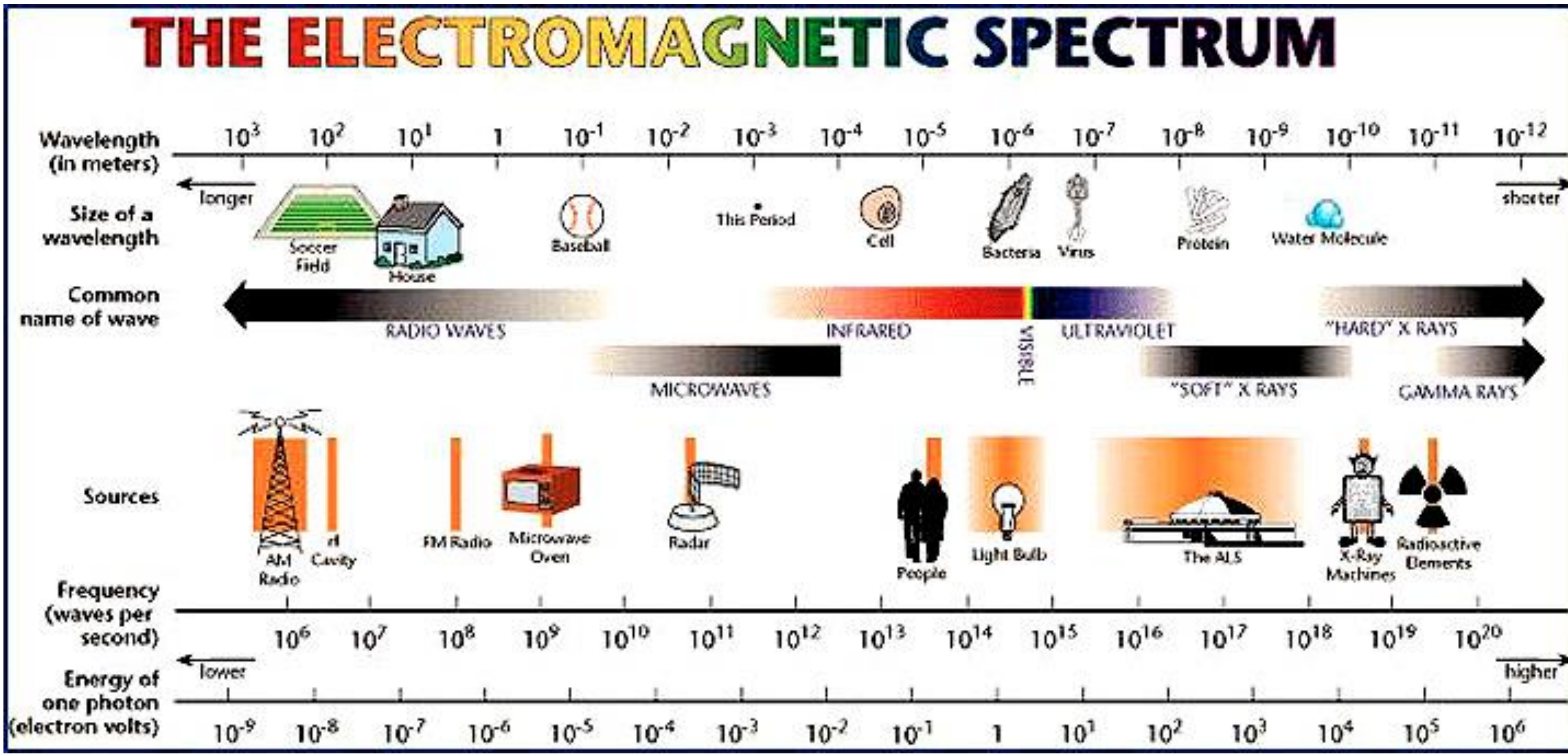
Location:

Paris Observatory

Development of millimeter wave to THz instrumentation for astronomy and Earth observations

Earth remote sensing, mostly from microwave to millimeter wave satellite observations

Pole 4: Terahertz Instrumentation



Instrumentation

Optimizing the detection of millimeter to terahertz radiation for astrophysics, planets and Earth studies

- **Development of Schottky receivers: devices, multipliers, mixers, receiver systems**
- **Development of HEB receivers and QCL THz sources**

For satellite missions, for aircrafts and balloons, for ground observations, with applications for both astronomy and Earth sciences

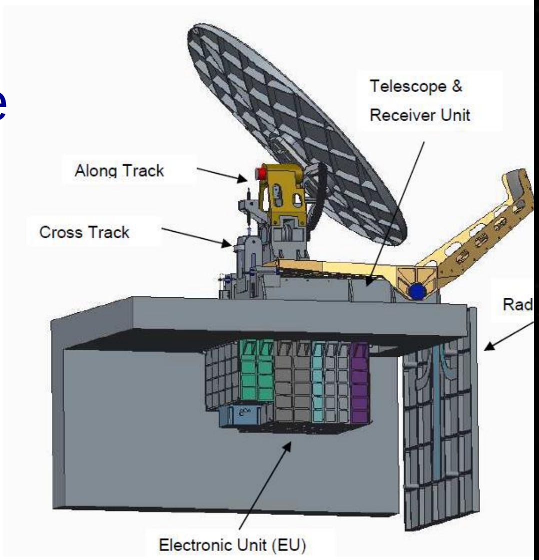
Strong link with C2N (Centre for Nanoscience and Nanotechnology)

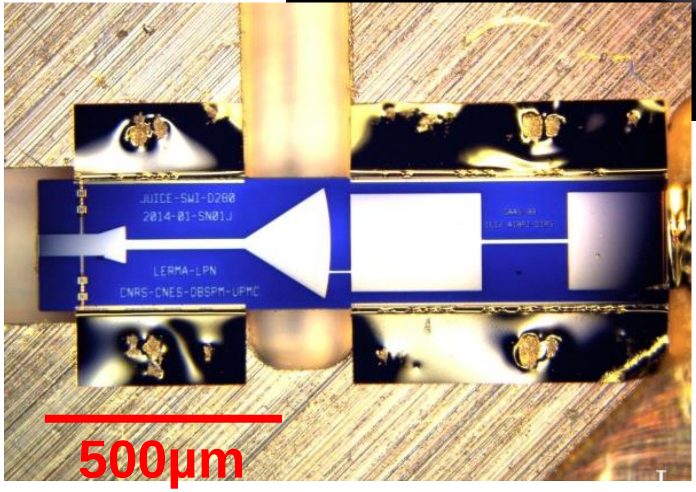
Instrumentation

JUICE/SWI

Temperature structure, composition and dynamics of the atmosphere of Jupiter and its satellites

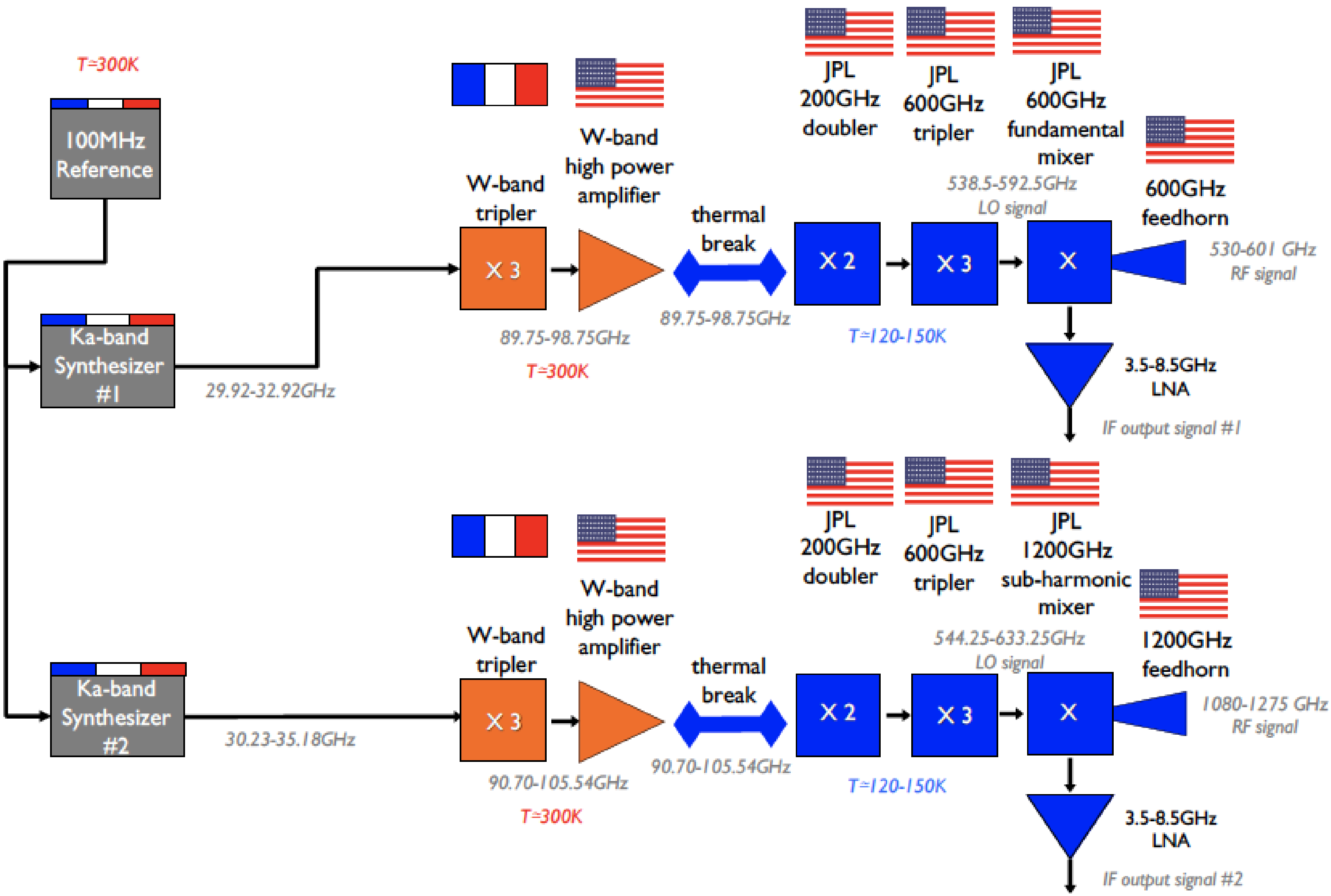
- ESA L1 mission, launch 2022
- SWI: Schottky heterodyne instrument 600 &1200GHz
- LERMA contribution
  - 300GHz doubler for the 600GHz channel
  - 1200GHz channel LO and mixer
- Fabrication at C2N (ex LPN-CNRS)
- Built upon successful LERMA contributions to Herschel/HIFI





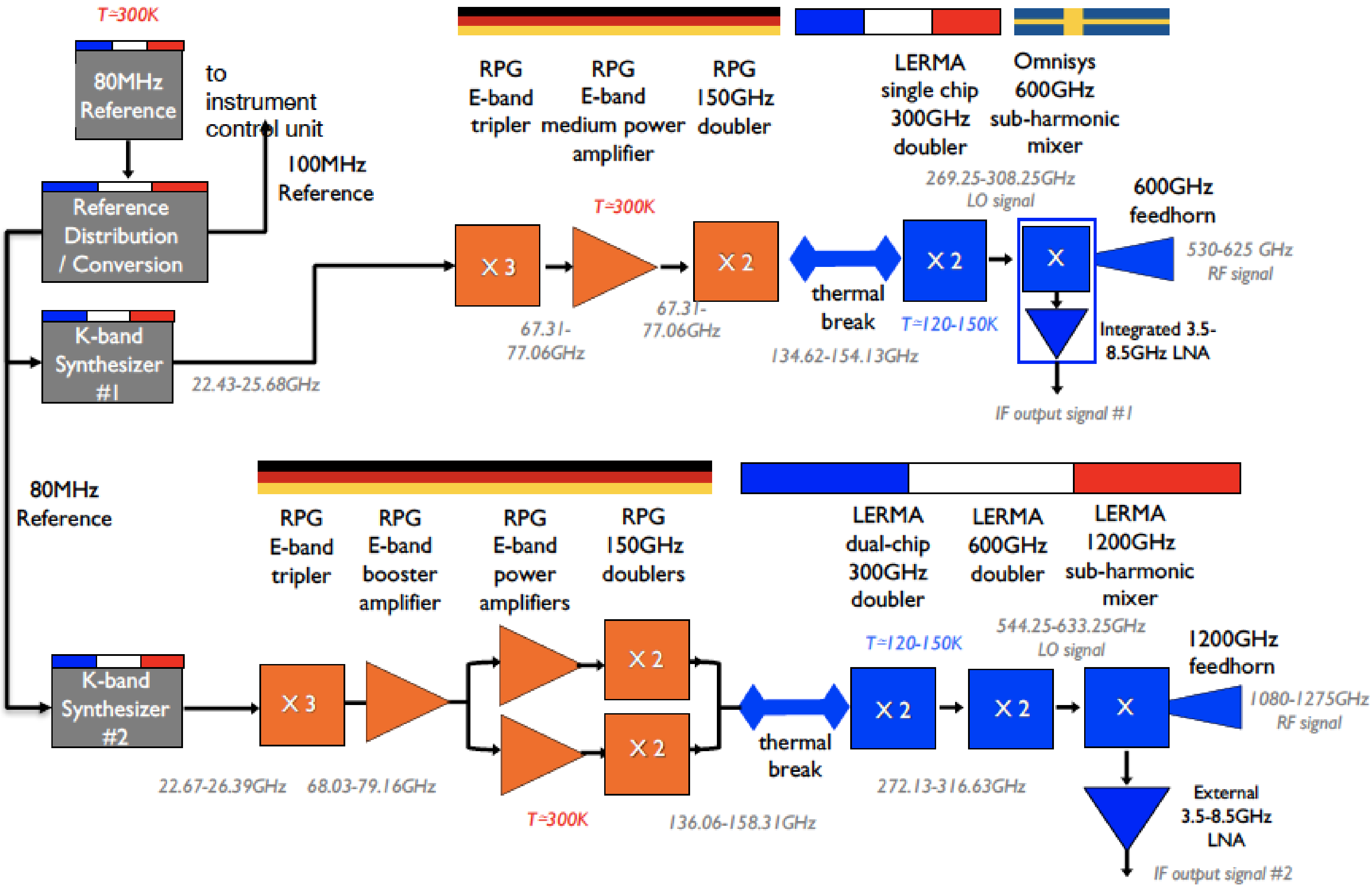
Instrumentation

JUICE-SWI : front-end configuration – proposal to ESA Oct 2012



Instrumentation

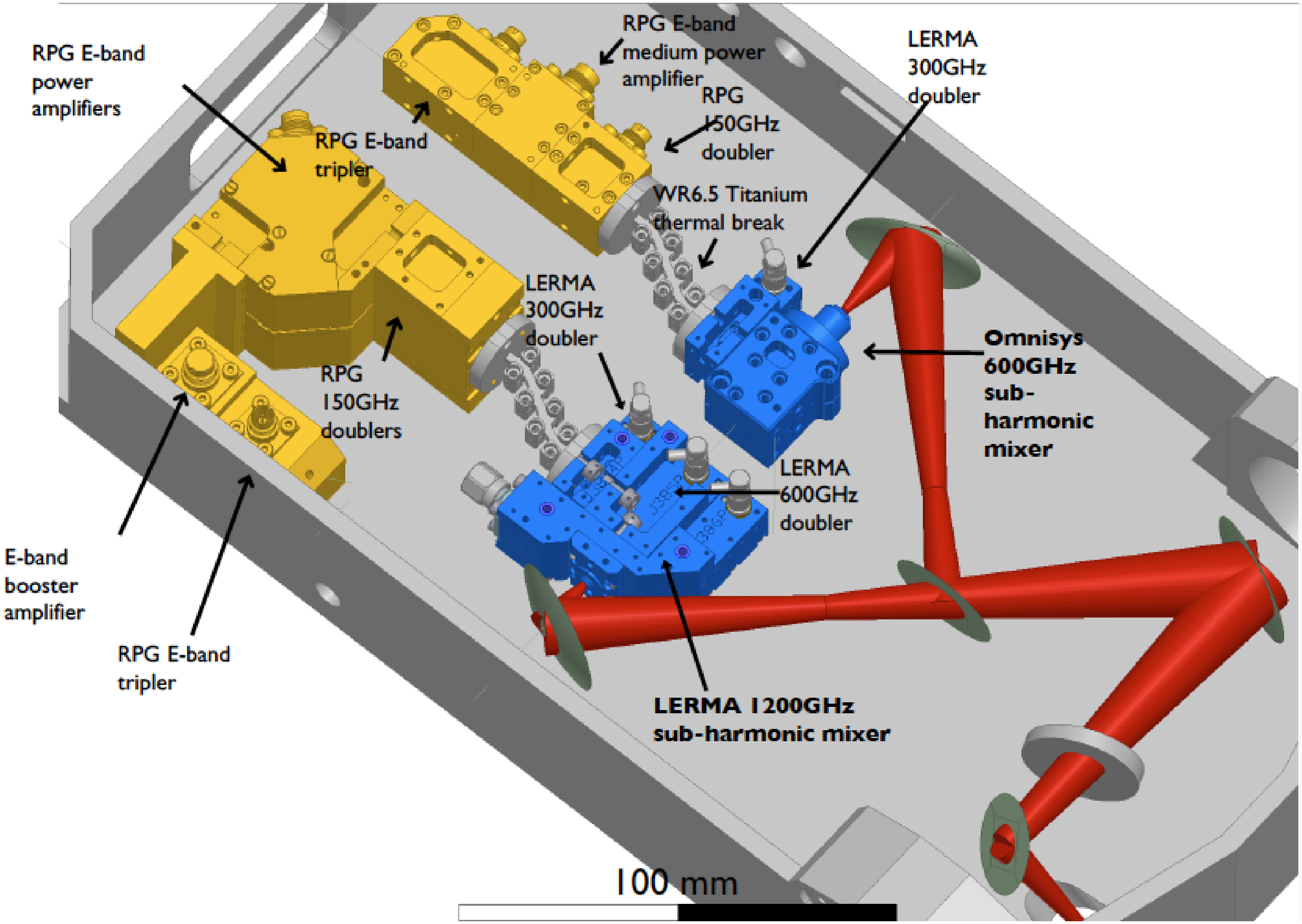
JUICE-SWI : front-end configuration from June 2016



l'Observatoire de Paris | LERMA

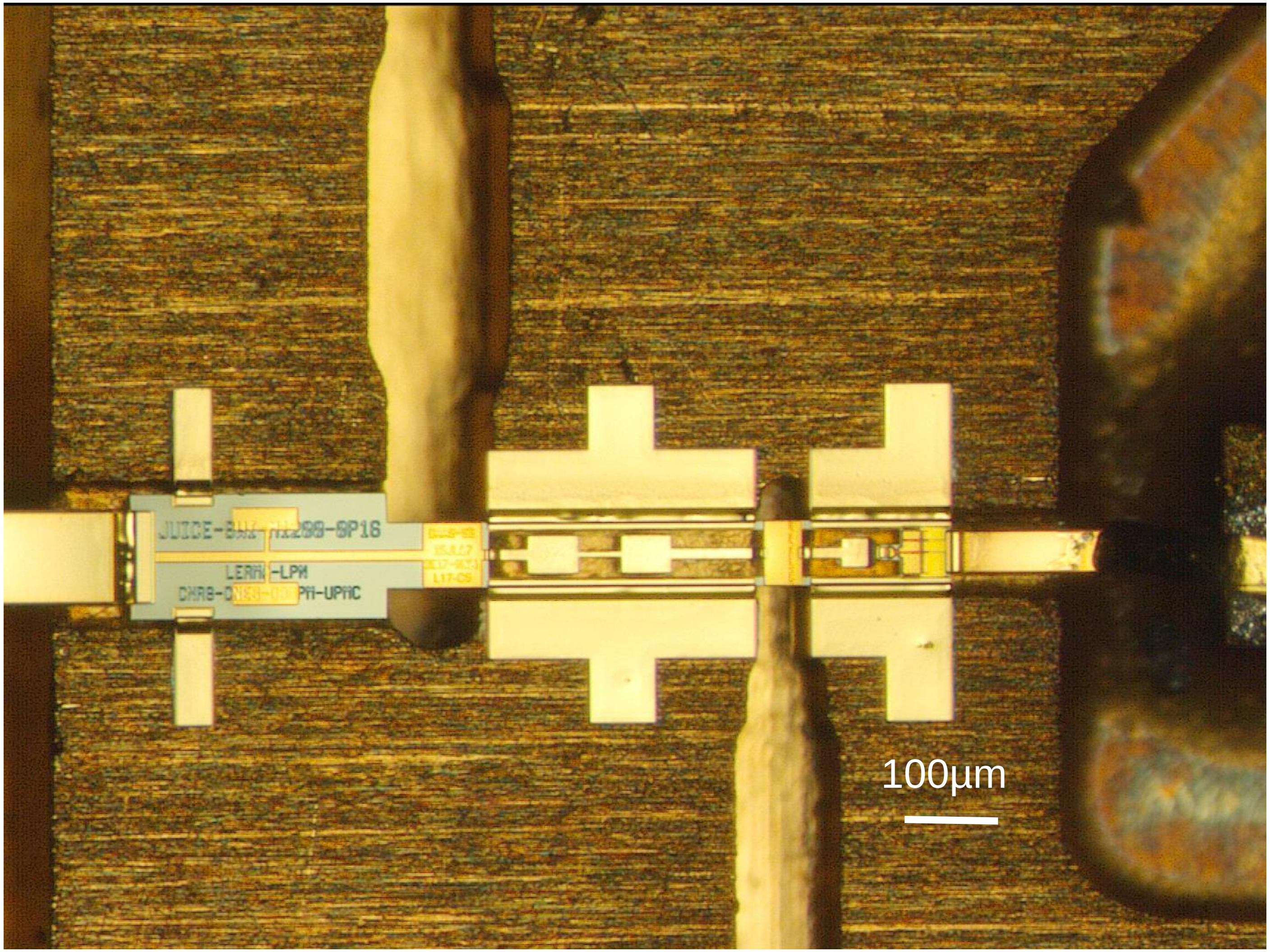
Instrumentation

JUICE-SWI : simplified 3D model front-end Oct 2016



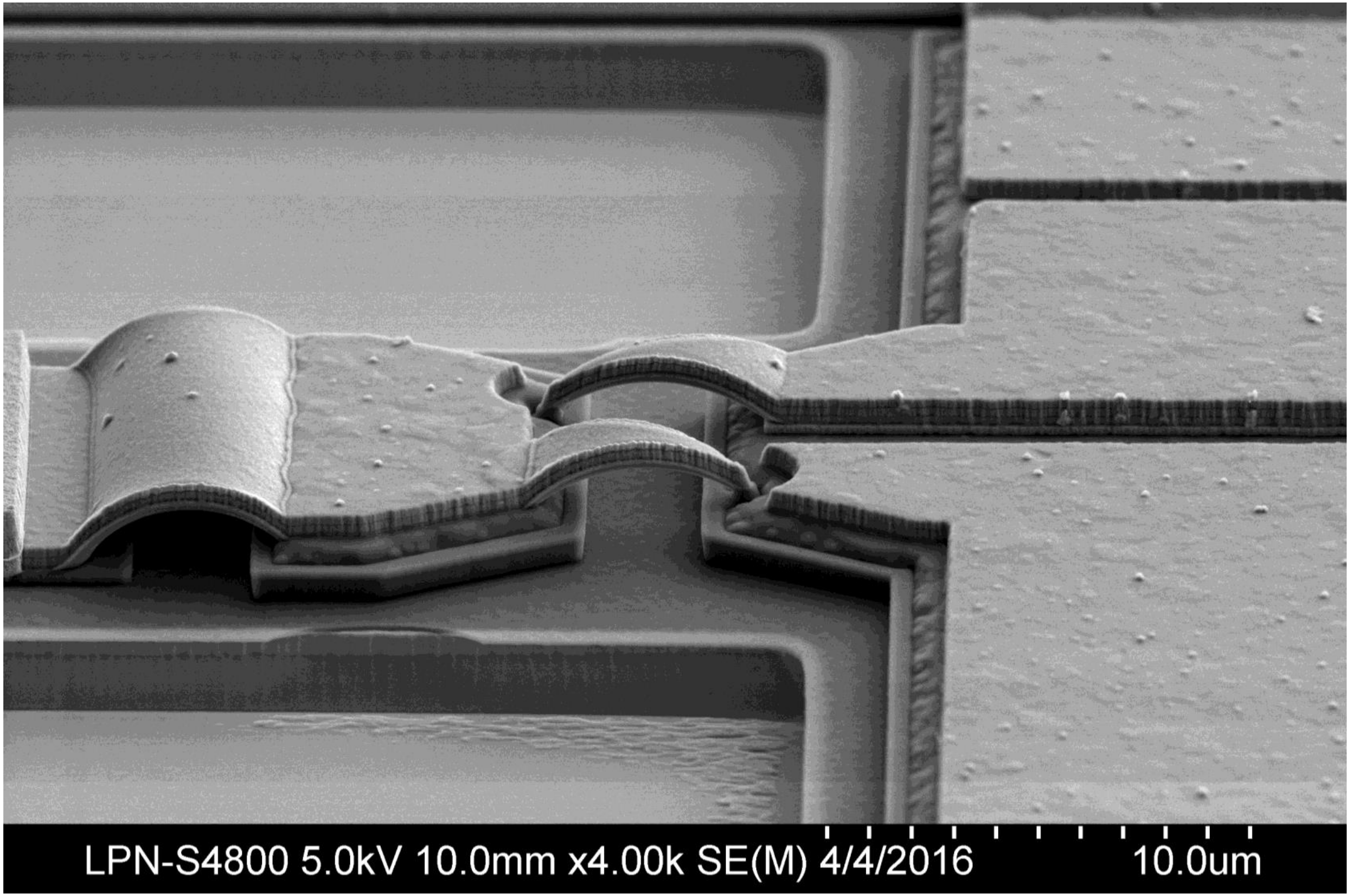
Instrumentation

JUICE-SWI : Schottky receiver at 1200 GHz



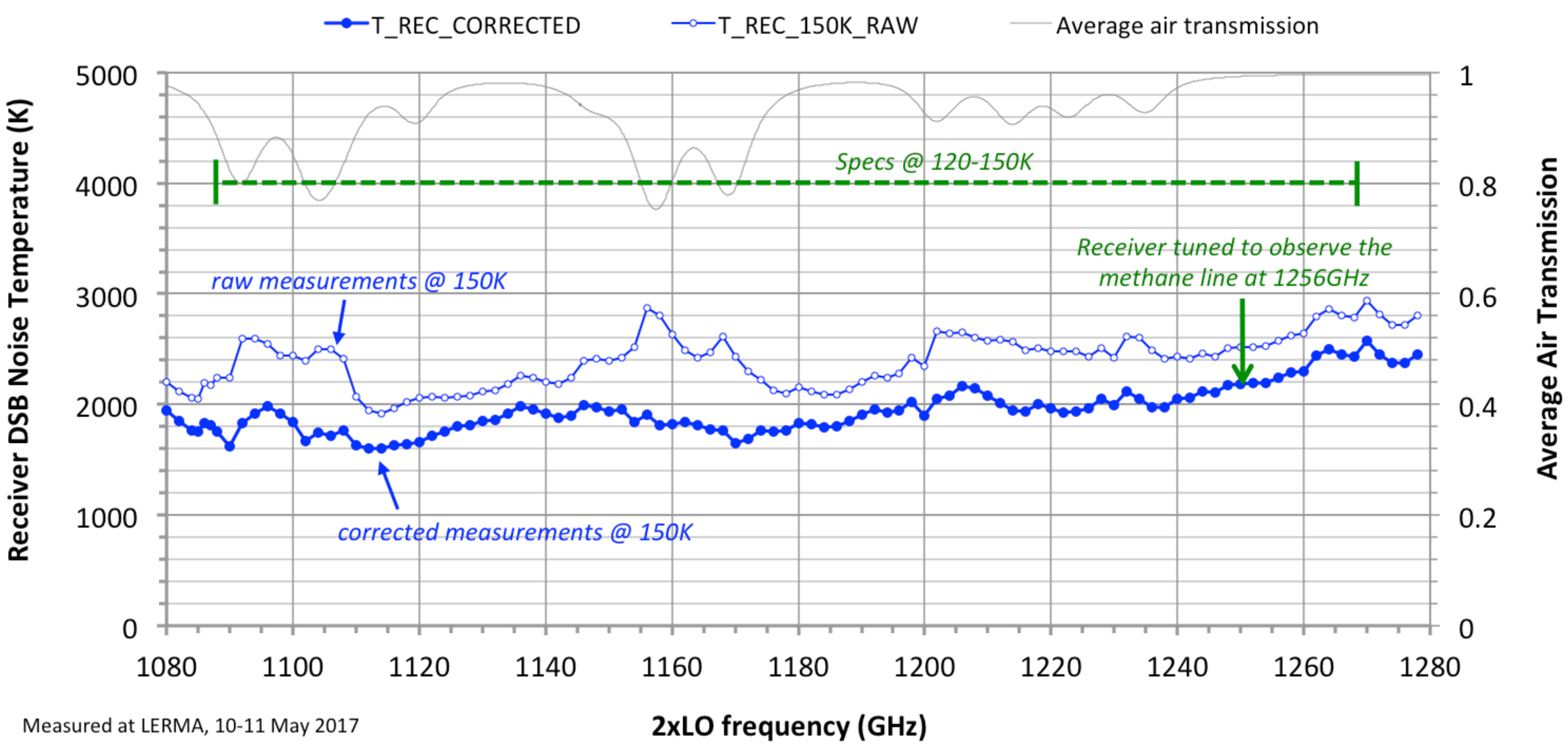
Instrumentation

JUICE-SWI : LERMA / C2N Schottky diode for the mixer at 1200 GHz



Instrumentation

JUICE-SWI : receiver sensitivity at 1200 GHz



Instrumentation

HSTDM : a millimeter receiver for the Chinese Space Station (CSS)

HSTDM : Heterodyne Instrument covering the frequency range 410 – 630 GHz

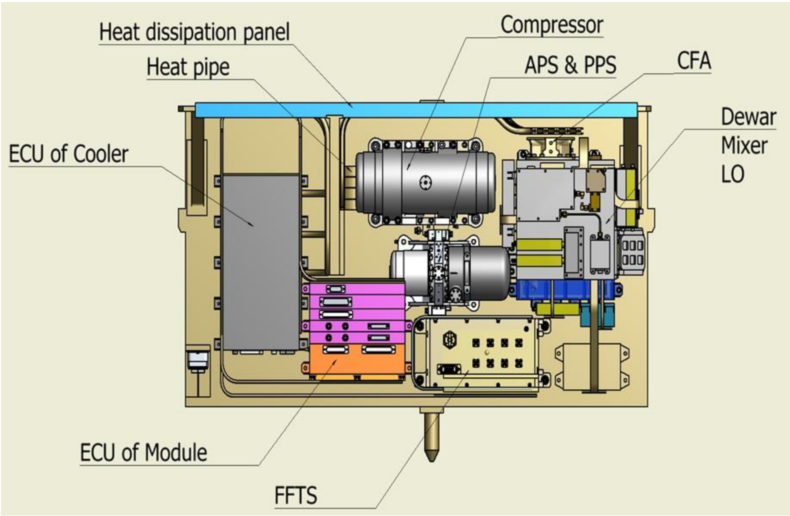
Mixer technology : SIS and Schottky Launch time : 2022

Objectives:

Scientific : Radio-astronomy and Earth atmosphere observations

Technical : Space Terahertz technology and cryogenic mechanical refrigeration

LERMA participation : supply of the Schottky receiver chain covering 510 – 630 GHz



All components layout of the HSTDM

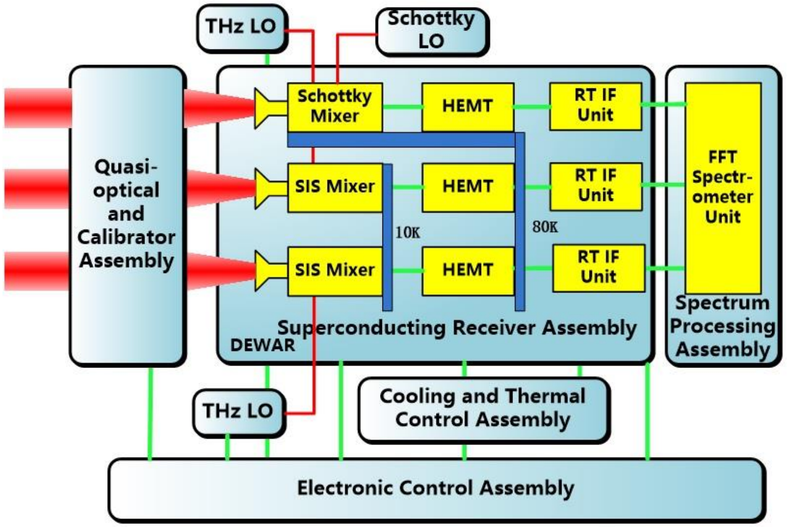


Diagram of the HSTDM

Instrumentation

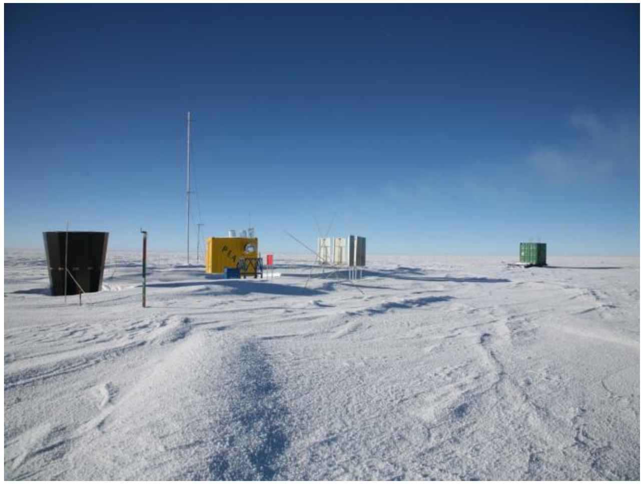
DATE 5 : 5 m THz telescope at Dome A

On the platform of the Chinese Center for Antarctic Astronomy

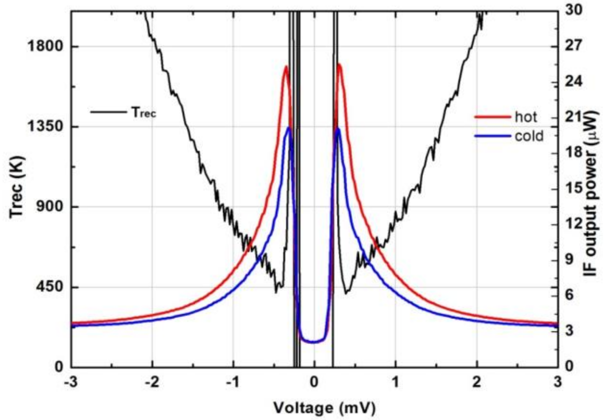
Mixer technology : SIS and HEB covering the frequency range of 850 – 1400 GHz

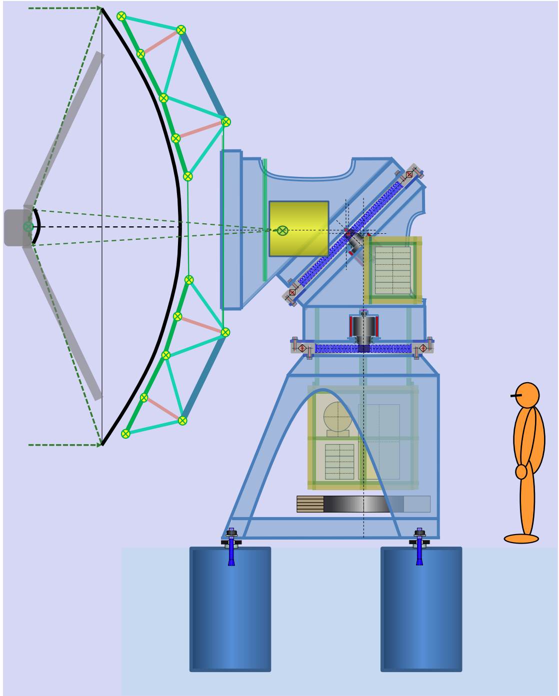
Construction phase : 2018-2022

LERMA participation : Collaboration for the HEB receiver and Local Oscilator



HEB mixer made at LERMA demonstrated state-of-the-art sensitivity: 450 K at 1.4 THz





Instrumentation

Far Infra Red mission of the future

Origins Space Telescope : NASA FIR Large Mission study for the 2020 US Decadal Survey
European study of a heterodyne instrument
=>LERMA coordination

FIRSPEX : ESA M5 Cosmic Vision, PI Oxford Univ
=> LERMA 1.9THz channel

MILLIMETRON : RAS/Roscosmos. Discussion

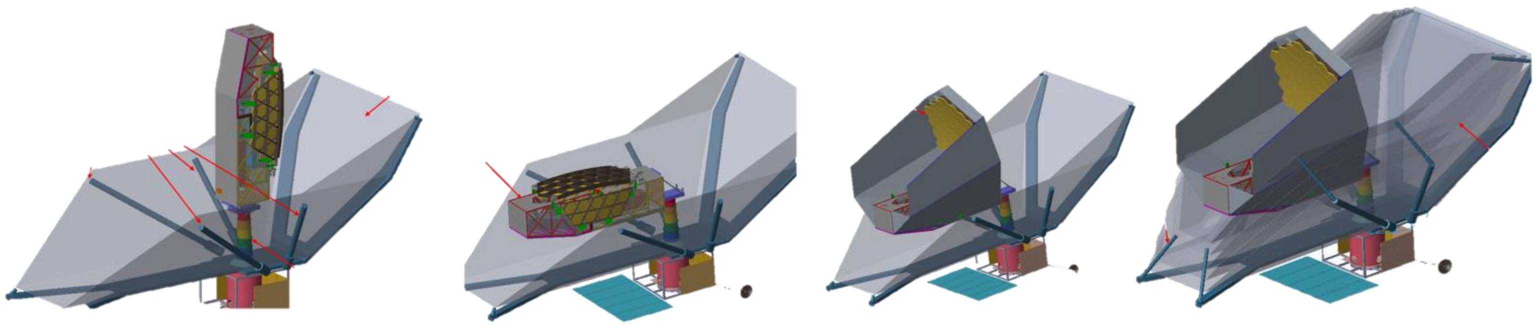
SOFIA : 500 GHz channel
=> LERMA contribution HIFI legacy mixers

GUSTO : NASA Long duration balloon (Phase A)
=>LERMA scientific contribution

Instrumentation

Far Infra Red mission of the future : Origins Space Telescope

Launch
~2035



Deploy lower booms
L+3 days

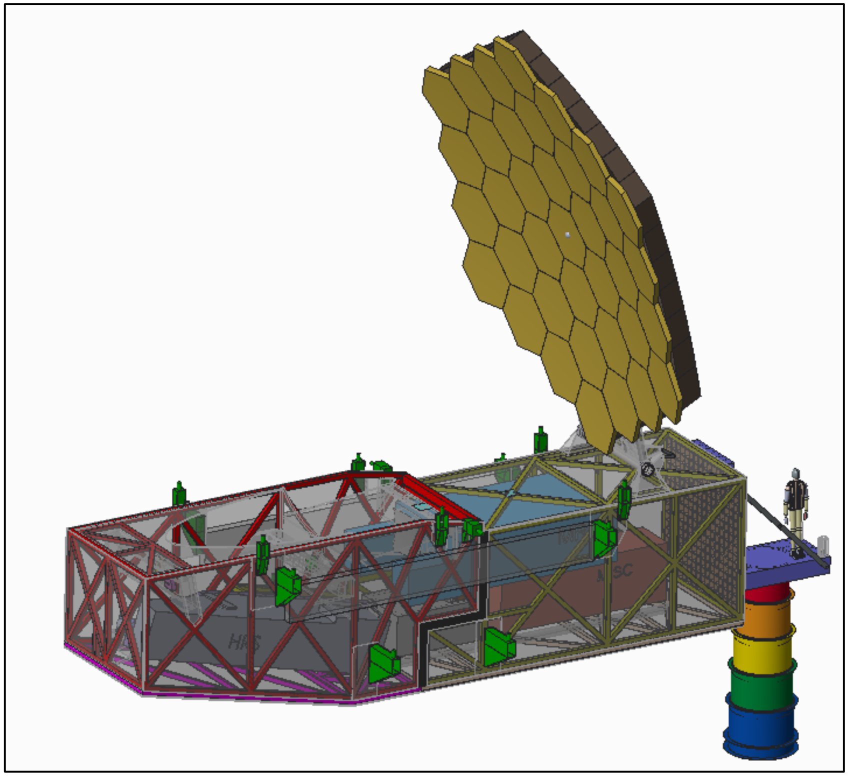
Deploy
telescope and
baffle

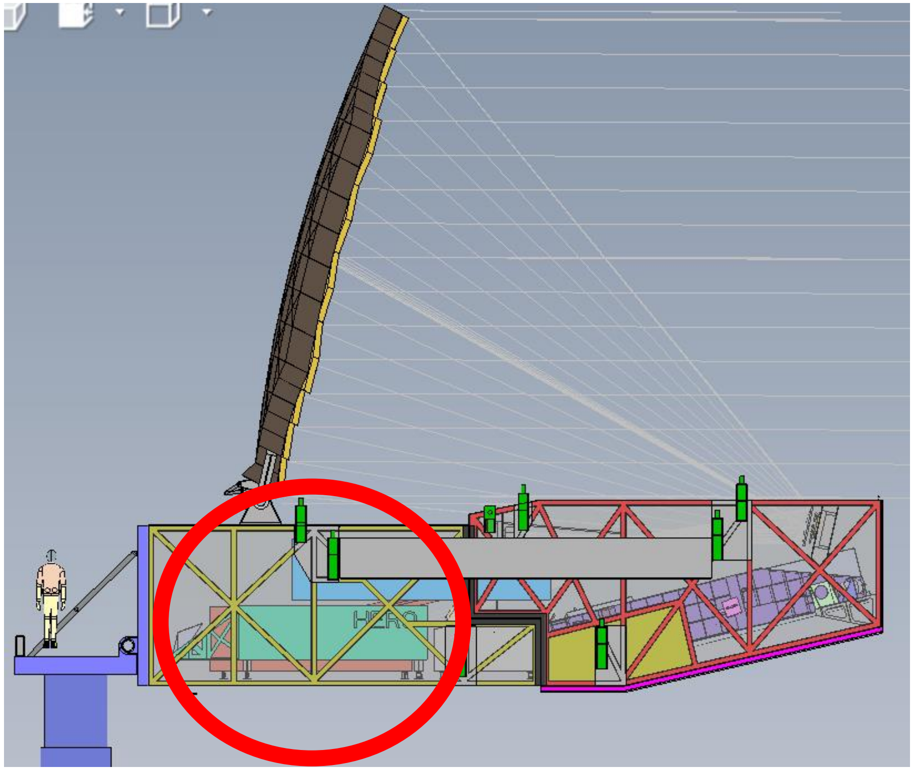
Deploy upper booms
L+ 20 days

Instrumentation

Far Infra Red mission of the future : Origins Space Telescope

Deployed antenna of 9.2 m



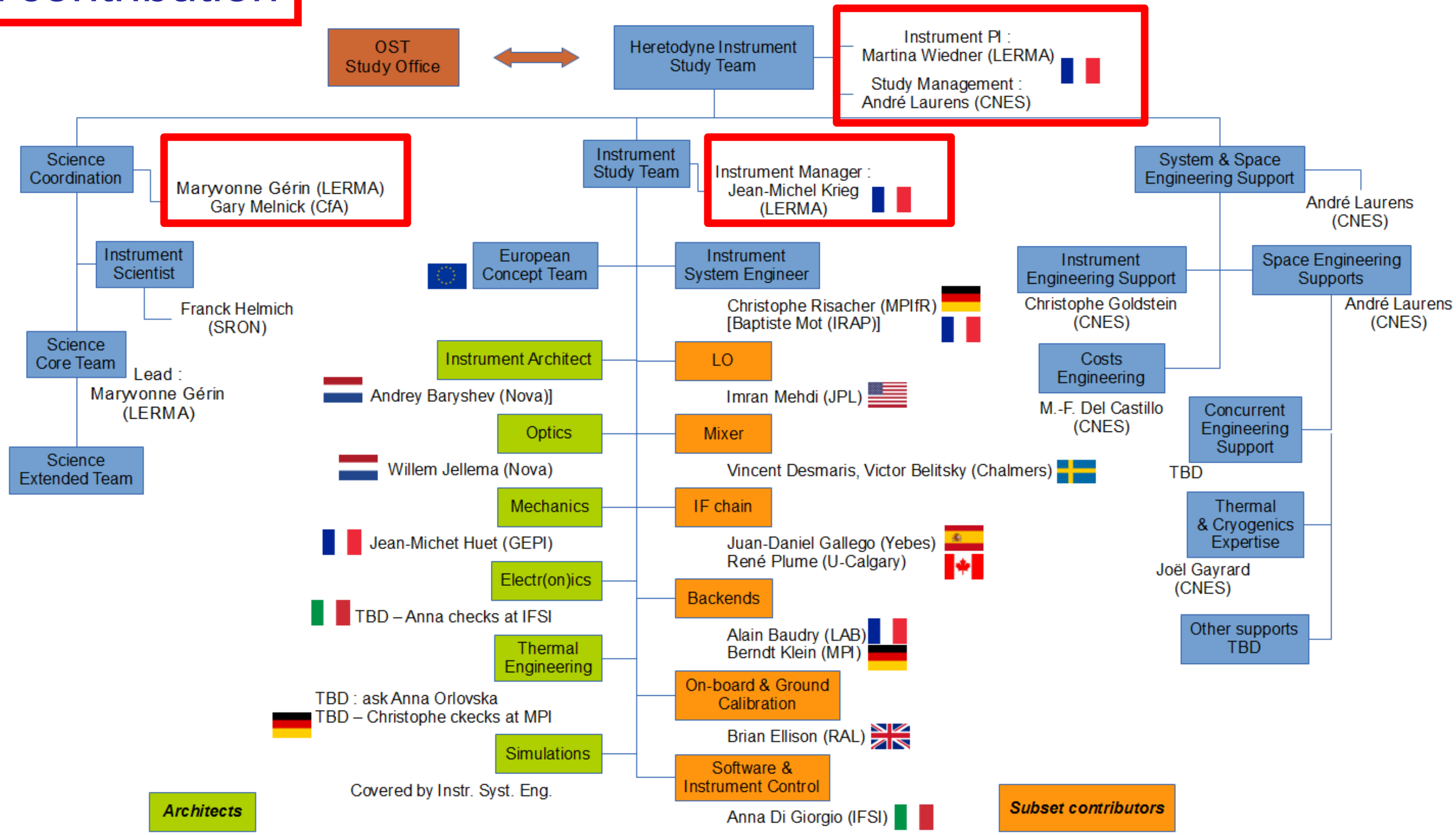


Instrumentation

Far Infra Red mission of the future : Origins Space Telescope

LERMA contribution

Team for HERO



Instrumentation

- LERMA in partnership with C2N (formerly LPN) have currently a leadership position in Europe for Schottky technology. The process is competitive with the US.

- Schottky developments also benefit the Earth observations, with the diodes considered as a reliable source of components at ESA for the Ice Cloud Imager on board MetOp-SG.

- Schottky and HEB expertise allows LERMA to position itself for future astrophysics, planetary and Earth observations, both from satellites, from aircraft and balloon, and from the ground.

- New national collaborations in preparation to strengthen the position of France in international consortia.

Remote Sensing

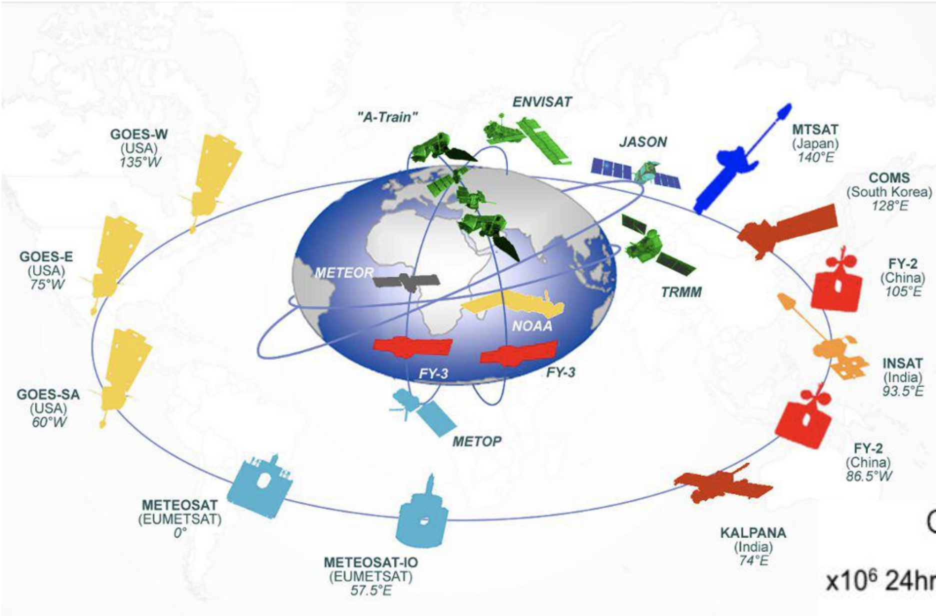
How to improve the quantification of key variables of the Earth water and energy cycle using multiple satellite observations?

The atmosphere, clouds, and precipitation from multi-satellites (e.g., project MetOp-SG)

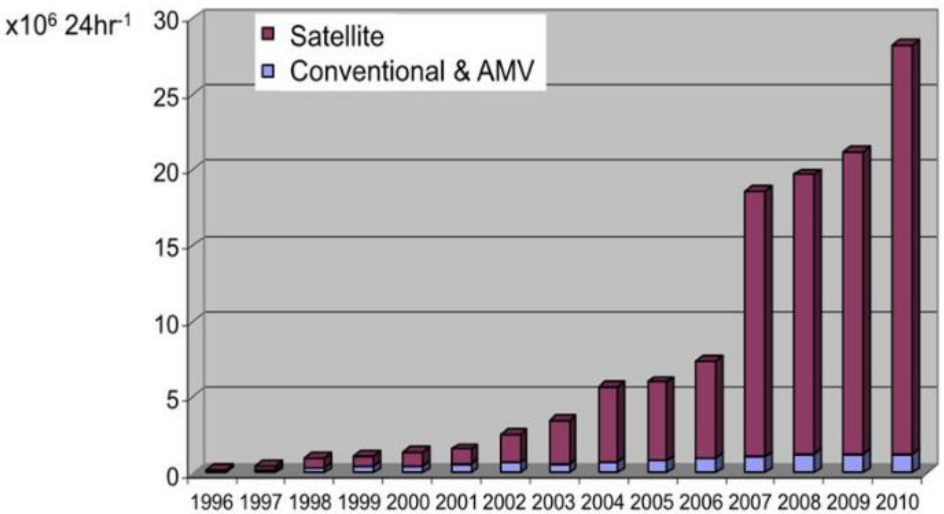
The continental surfaces (e.g., SWOT)

The ocean (e.g., MICROWAT)

Remote Sensing



Conventional and satellite data assimilated at ECMWF 1996-2010



Unit is millions of data values assimilated per 24 hour period

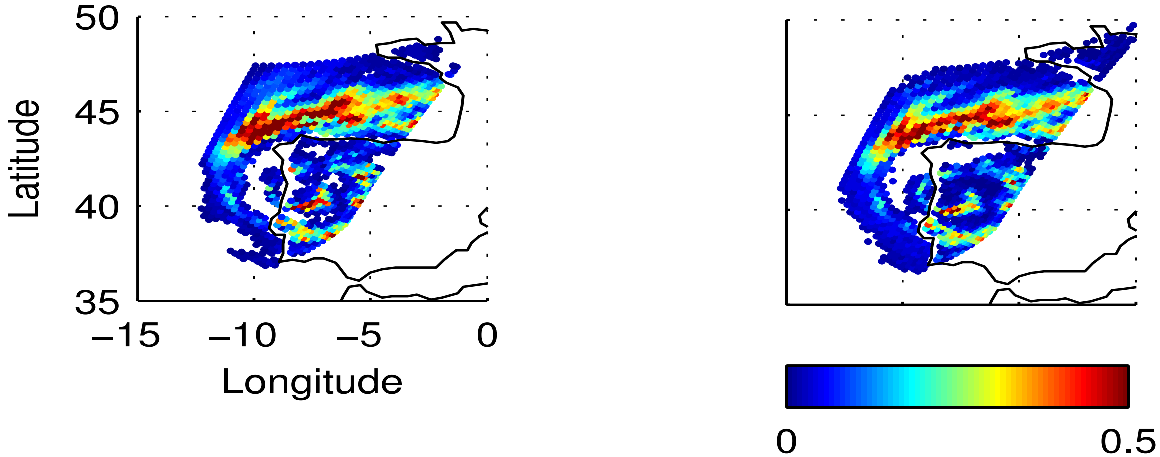
Remote Sensing

Observations and analysis of clouds and precipitation

- **Preparation of the Ice Cloud Imager (ICI) to fly on the next generation of European meteological satellite (MetOp-SG) to be launched in 2022.**
- **For the first time, observations between 200 and 700 GHz for the characterization of ice clouds. Development of the retrieval methodology.**

The integrated content of frozen water in kg/m²

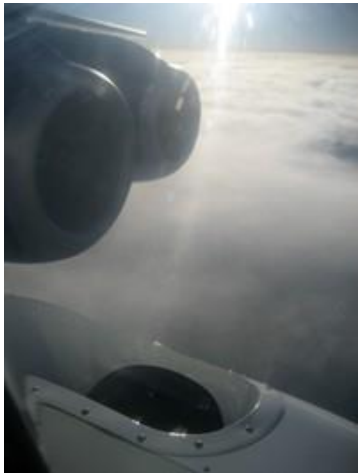
Target *Retrieval*



Remote Sensing

Observations and analysis of clouds and precipitation

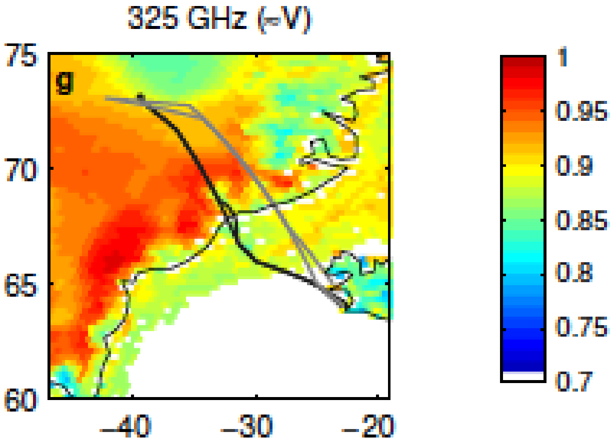
Exploitation of the ISMAR (International Sub-millimeter Airborne Radiometer) observations, on board the UK Met Office aircraft, the ICI demonstrator



Several flights over North Atlantique and Greenland

Analysis of the surface emissivity and the polarized scattering in clouds

Surface emissivity at 325 GHz over Greenland, evaluated with the ISMAR flights



Remote Sensing

Analysis of continental surfaces from multi-satellites

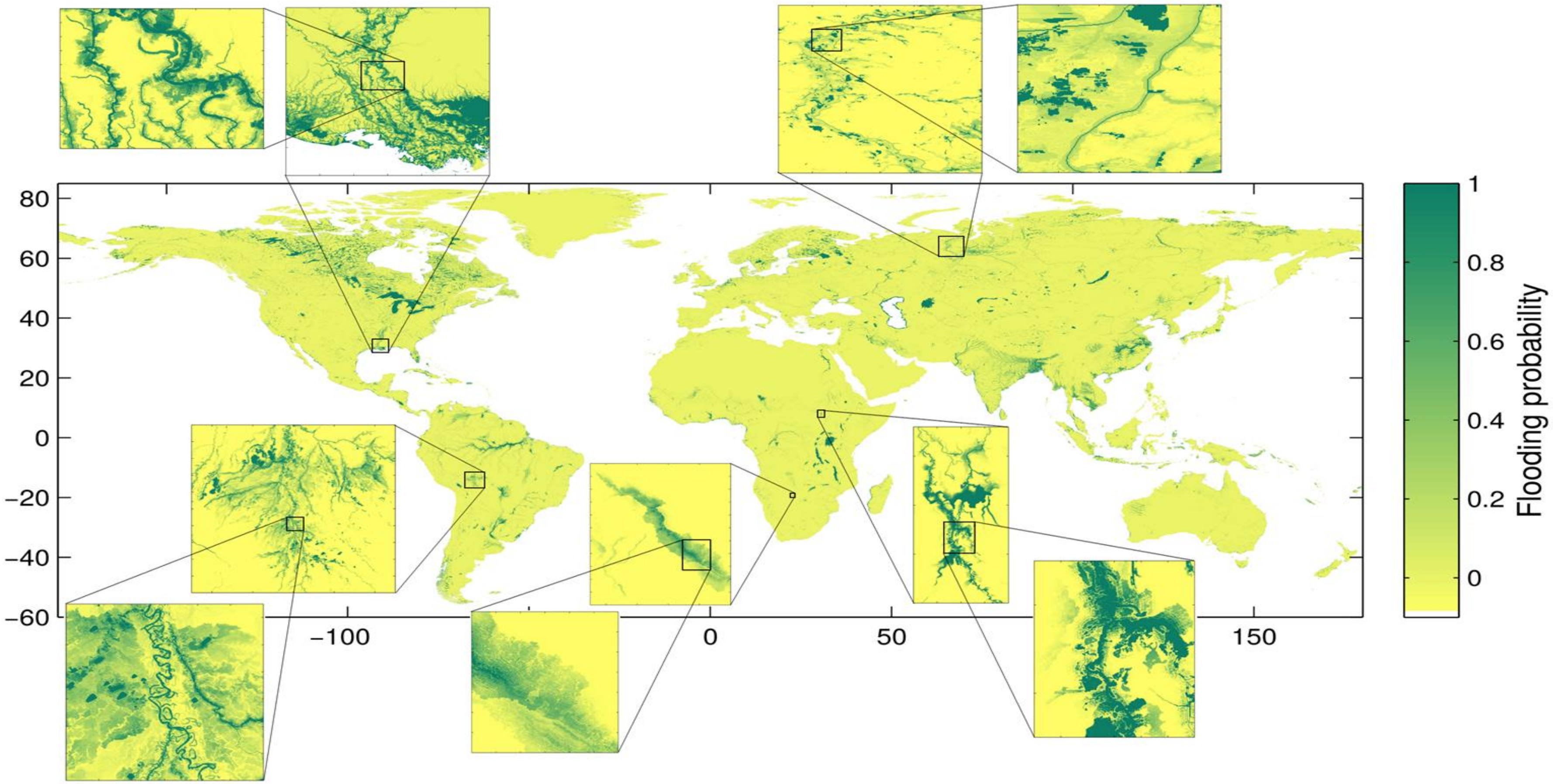
Production and analysis of long time series of surface water extent and dynamics, since 1978 up to current time, for climate studies and flood warning

Development of methods to measure surface water extent and dynamics with high spatial resolution at global scale, from existing satellite observation and topography information

Preparation of the NASA/CNES SWOT mission (Surface Water Ocean Topography)

Remote Sensing

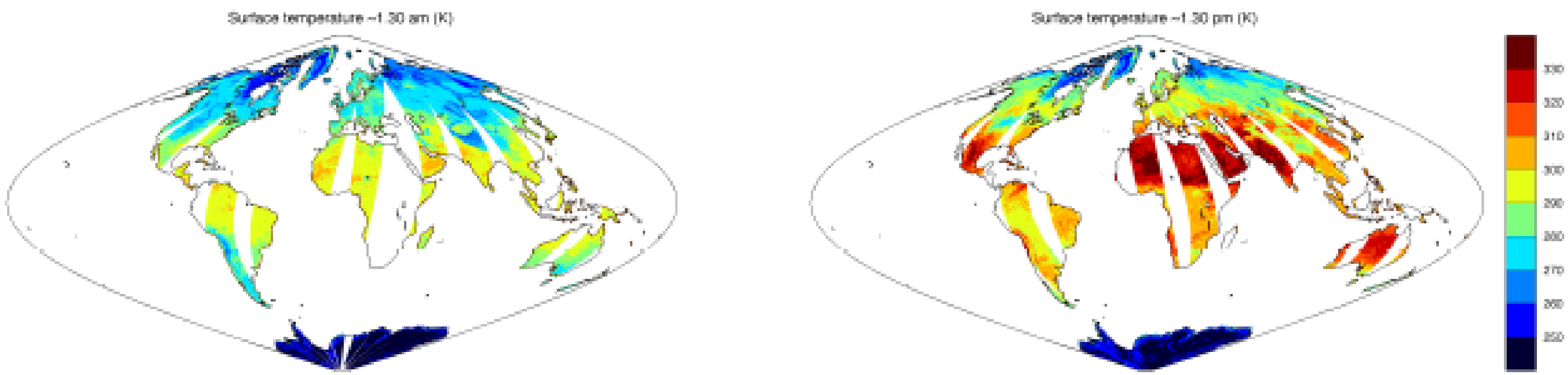
Analysis of continental surfaces from multi-satellites



Remote Sensing

Analysis of continental surfaces from multi-satellites

- **The Land Surface Temperature is now an official 'Essential Climate Variable'.**
- **Development of an innovative methodology to estimate this parameter systematically fom microwave satellite observations, to complement the infrared estimation that are hampered by the cloud. Requires reliable surface emissivity calculation.**
- **Global coverage over 40 years to be produced and analyzed.**



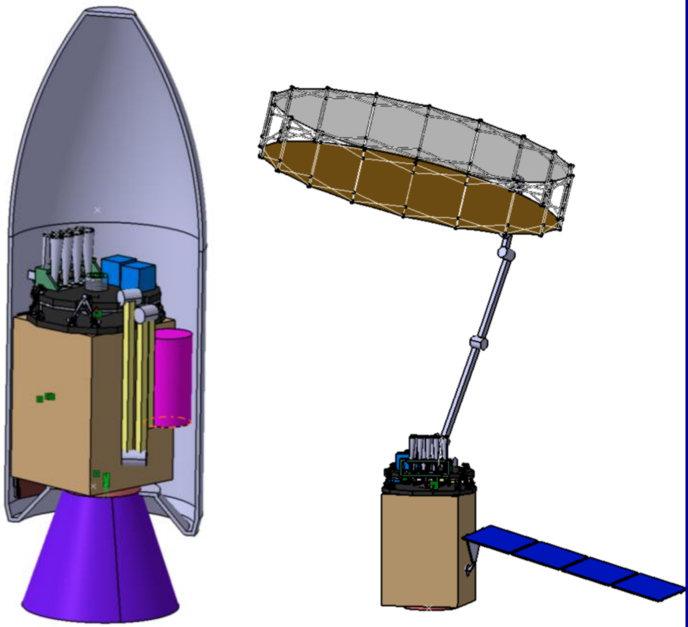
Roughly three times more coverage with microwaves than with infrared observations

Remote Sensing

Development of a new microwave mission for the estimation of the Sea Surface Temperature and Sea Ice Concentration: MICROWAT

- **To complement the infrared measurements, development of a new microwave mission (1.4, 6 and 10 GHz) with a 5 m antenna, for Sea surface Temperature, Sea Ice Concentration, and Salinity measurement.**
- **European consortium led by LERMA**
  Industrial team: Airbus EADS

To be submitted to the ESA Earth Explorer call 10 and to ESA Sentinel mission



Remote Sensing

- **A group derived from the instrumentation activity, working primarily with microwave to sub-millimeter observations**

- **Tight connection with the community in Ile de France (IPSL), in France (e.g., LEGOS, Meteo-France), and internationally (e.g., UK Met Office, University of Cologne (Germany), University of Columbia (USA), USTH (Vietnam)…)**

- **A start-up derived from the activity of that group (Estellus)**

- **Strong involvement in several satellite mission projects with CNES, ESA, NASA (ICI/MWI on board MetOp-SG, CFOSAT, MICROWAT, SWOT)**