

DORIS

DAYS
2021

November 16, 17 and 18

November 17th

Session 2 – Presentation 4

Why use DORIS on a satellite mission?

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DORIS ATTRACTIONS

- In real-time

- ✓ On board real time orbit determination ($<1\text{m}$), especially radial component, for payload driving and products location, platform navigation or ground operations
- ✓ On-board time tagging w.r.t TAI time scale at microsecond level
- ✓ On-board frequency reference thanks to stability and precise (10^{-12}) monitoring of its Ultra-Stable Oscillator (USO)

- Medium (or longer) term latency

- ✓ Precise ($< 1\text{cm}$) Orbit Determination for altimetry on ground processing
- ✓ Precise positioning of ground beacons (DORIS is one of the IERS technique)
 - earth pole motion
 - tectonic
 - Geocenter
 - ITRF contribution
- ✓ Models improvement : gravity field, geoid

DORIS ATTRACTIONS : BENEFITS FOR ALTIMETRY

- Very precise radial component : from DIODE navigator orbits
- Precise datation

⇒ **crucial data for altimetry**

- ✓ used for NRT and GDR products : meteorology, hurricane forecasts, climate change studies...
- ✓ RINEX files production used for ionospheric studies

Recommendations from POD (OSTST 2018)

“Recognizing the achievements of the precise orbit determination on the Jason series and Sentinel 3A-3B series of missions of reliably verifying the radial orbit accuracy of 8 – 10 mm RMS, the OSTST recommends that future altimeter and oceanographic missions embark three independent POD instruments (DORIS [Doppler Orbitography and Radiopositioning Integrated by Satellite], GNSS [Global Navigation Satellite Systems], and a SLR [Satellite Laser Ranging] Retroreflector) to allow independent verification of orbit accuracy for the calculation of key climate and ocean variables, including but not limited to, sea surface height and mean sea level.”

⇒ High complementarity with other technics

SENTINEL6 / JASON-CS : good example with DORIS on-board

Continuity with its predecessors : Topex/Poseidon,
Jason1-2-3
Reference mission
Demonstrate the POD centrimetric for other scientific
missions
⇒ DORIS is mandatory on board

For the altimeter :

- DIODE orbit used for mode change, in real time
- Frequency of 10MHz



HOW DORIS IS USED?

- Today's DORIS is onboard of LEO satellites, between 700km and 1350km.
- The DORIS system was designed to work with these altitudes
 - power emitting by beacons
 - budget link
 - visibility of beacons, and so, number of measurements
 - Doppler collisions
- Taking into account missions feedback on SAA effect

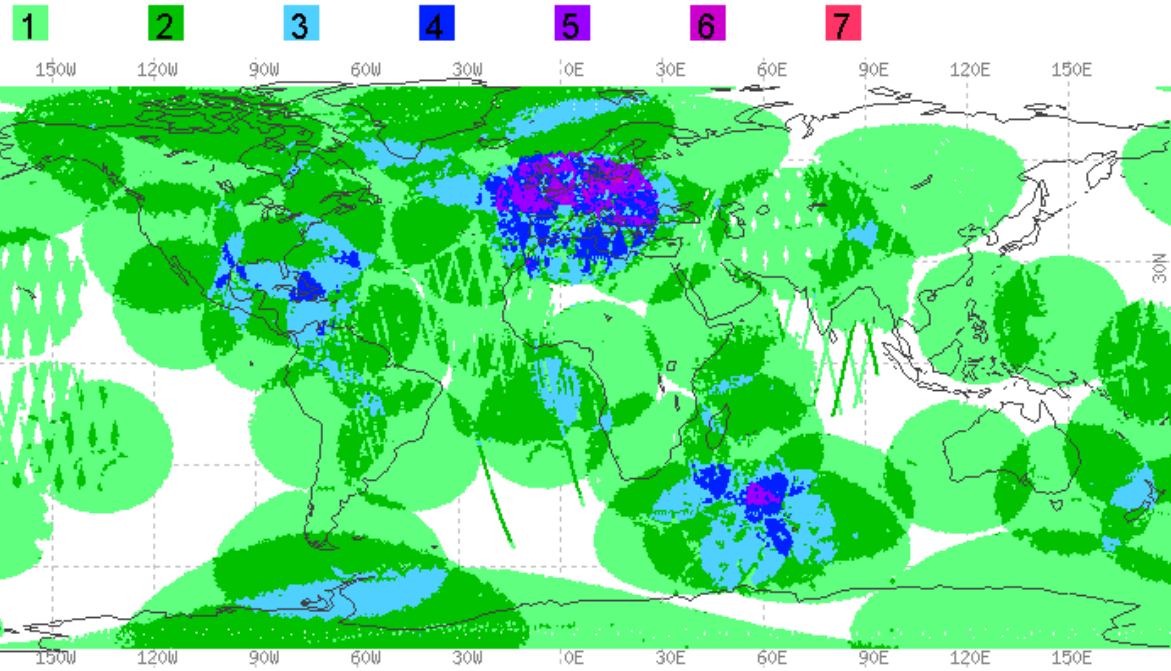
Different altitudes

Coverage of SENTINEL3B orbit by the DORIS network

Period processed : from 18/09/2021 to 15/10/2021

Coverage rate : 77,52%

Nb of measurements received by OBSW at each sequence :



Sentinel3B orbit : 814km

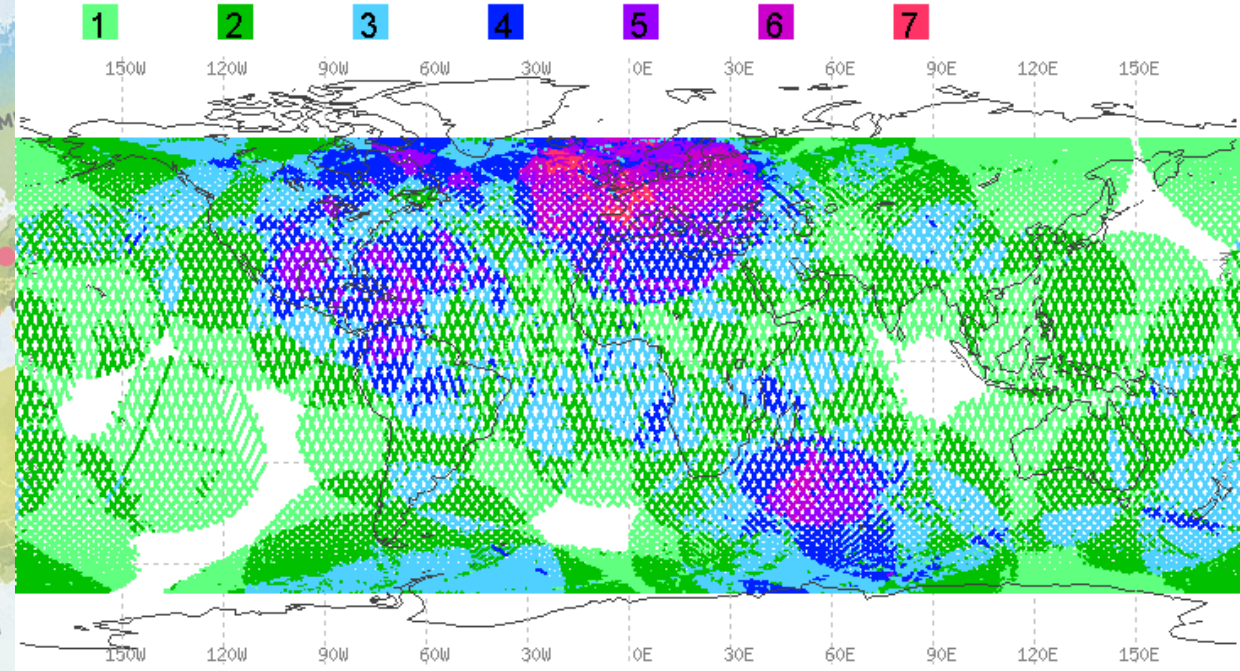
Fewer measurements and few Doppler collision

Coverage of JASON3 orbit by the DORIS network

Period processed : from 05/10/2021 to 15/10/2021

Coverage rate : 94,07%

Nb of measurements received by OBSW at each sequence :



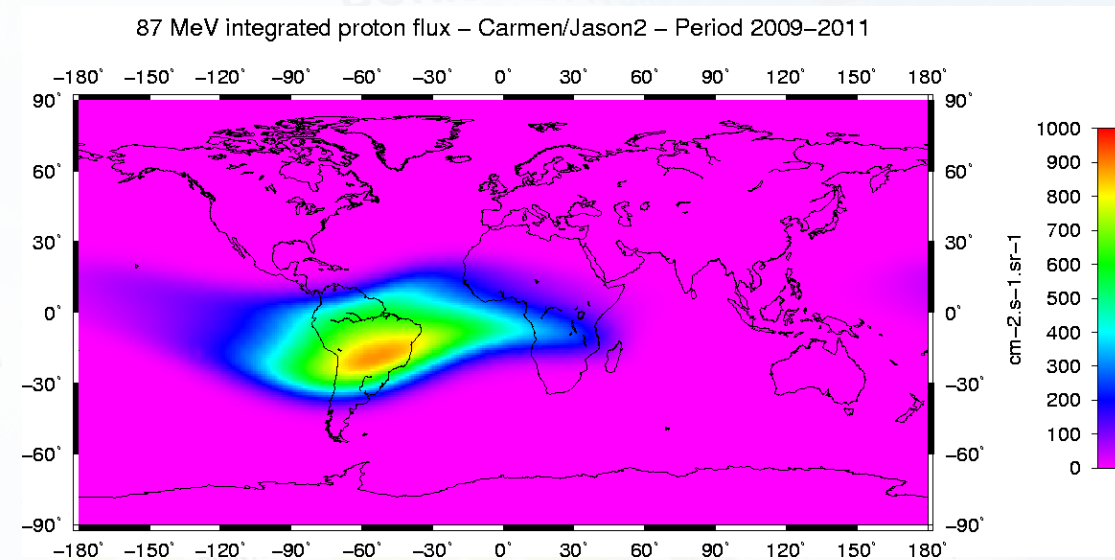
Jason3 orbit : 1336km

More measurements and more Doppler collision

SAA effect : statement

Definition :

Zone in the South Atlantic where radiations are higher



Consequences on DORIS performances :

The quartz used in USO is very sensitive with radiations

⇒ frequency glitch

⇒ troubles in stations coordinates, for stations in the SAA zone

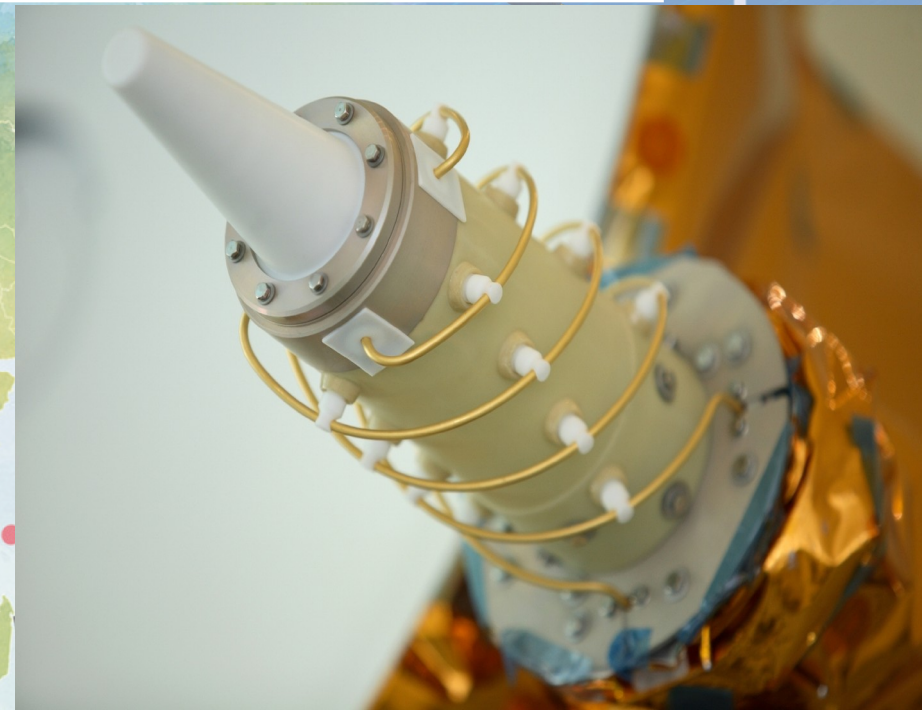
SAA effect : attempted treatment

- Pre-irradiation of the USO quartz with high level dose : low sensitivity with radiations
- R&T Study on-going to try to understand and minimize the impact of radiations on quartz performances
- From Jason3 mission : GNSS and DORIS are connected to follow the USO frequency

THE CURRENT INSTRUMENT



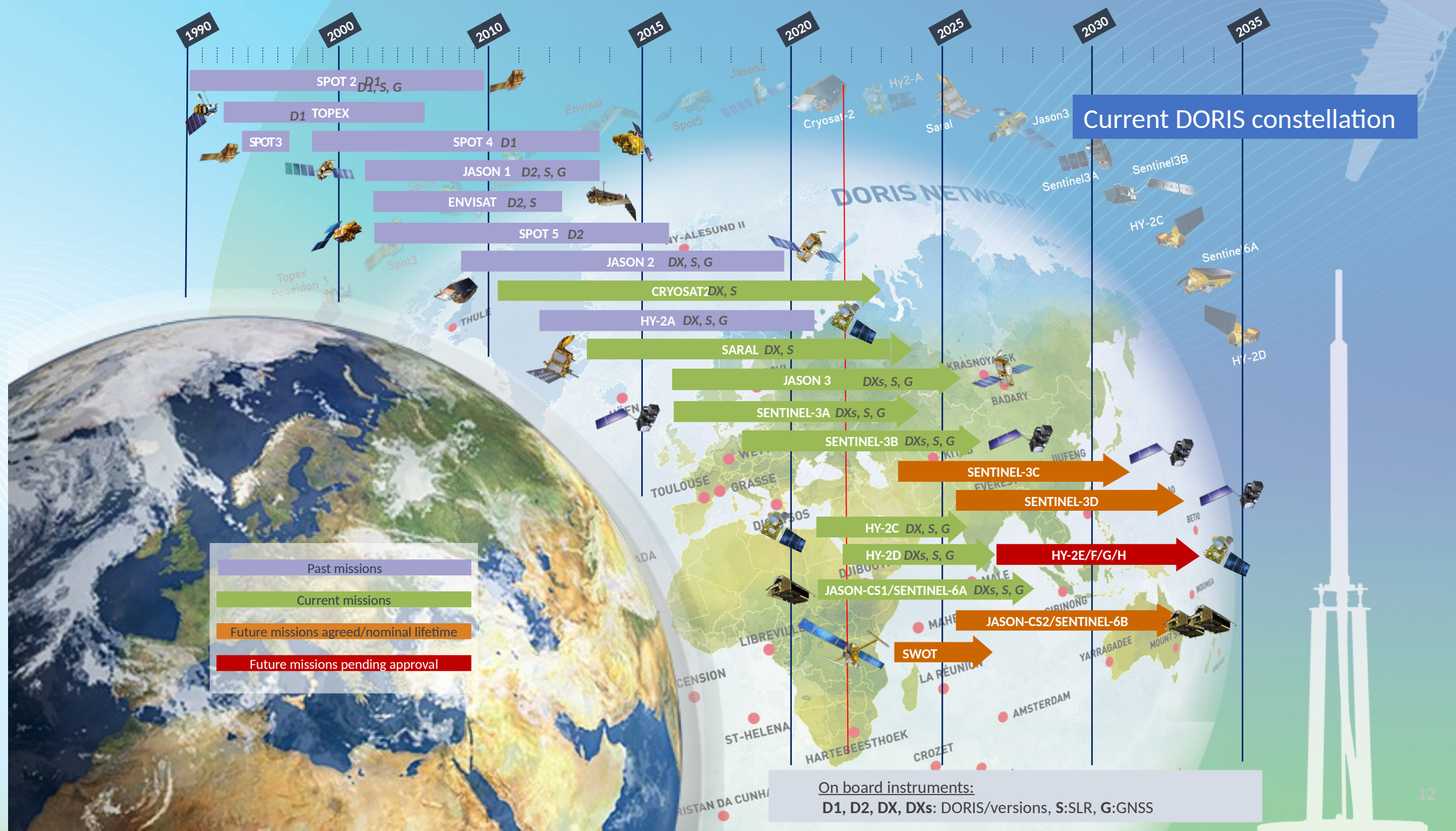
DORIS Redundant Box (DRB, or BDR in french)
2 chains inside
17kg, around 400x400x180mm
7 Treatment Unit to track 7 beacons



Bi-frequency antenna

New generation instrument

- T-DMS instrument : studies ongoing on the 5th generation (DGXX-S generation heritage)
 - Use of new generation components
 - Line of thinking about a DORIS instrument with an only chain
 - ⇒ Reduce the volume, reduce the recurrent cost while keeping performance and reliability
- A new combined DORIS/GNSS receiver (R&T study from 2019) : for new missions, with lower performances
 - GNSS and DORIS functions on a Zynq-based miniaturized platform
 - Take benefits of GNSS and DORIS systems for POD
 - ⇒ Miniaturized instrument for new mission with small platform, with lower performance



LONG TERM VISION

- **Chinese altimetry missions HY2 : HY2E-F (G?)**

NSOAS confirmed the program follow-on, and the approved budget for 2 instruments

⇒ pending for order to T-DMS, end of 2021 or beginning of 2022

- **ESA altimetry missions**

- CRISTAL, ice study

- Pending for mission confirmation with DORIS on board (Nov 2021)

- Launch 2027 (TBC)

- Sentinel3 Topography NG, pending for mission confirmation with DORIS on board

- Launch 2029 (TBC)

- Sentinel6 FO : Sentinel6C, with DORIS on board for service continuity

- Launch 2029 (TBC)

Key points

- Thanks to DIODE navigator, DORIS gives a very precise orbit
- DORIS has a strong complementarity with the other localization technics
- A full constellation today : we wish new missions for the future