RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

DORIS ON GENESIS
TECHNICAL STATUS

FRANÇOIS DIDELOT & THE DORIS PROJECT TEAM (CNES)

WORKSHOP IDS
MONTPELLIER
SEPTEMBER 4TH AND 5TH 2024

DORIS

IDS
INTERNATIONAL DORIS SERVICE

CONTEXT

GENESIS mission milestones

Jan. 2023 => Procurement proposal

Feb. 2024 => 1st GENESIS Science WS at ESOC

Mar. 2024 => Signature of contract with OHB-I (76.6M€) without DORIS

=> ESA/CNES exchanges for the procurement of one DORIS equipment qualified for GENESIS

Sept./Oct. 2024 => System Requirements Review (SRR)

DORIS on GENESIS: what's new since last IDS WS (Nov. 2023) ?

- Way forward:
  - CNES simulations (DORIS test facilities) to assess the DGXX-S behaviour at a GENESIS orbit to confirm the faisability of relevant measurements
  - CNES investigations of other sources of instruments
  - Consider an adaptation of the mission organization

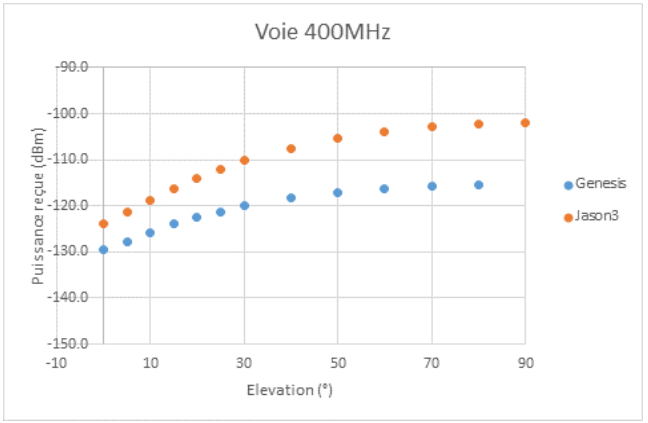
IDS AWG November 28th – 29th 2023, IGN Saint-Mandé

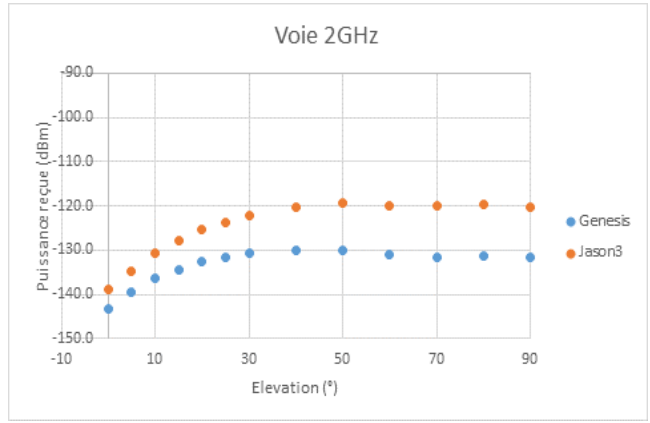
Simulation / measurements campaign on DORIS EGSE (end 2023)

Instrument provider found

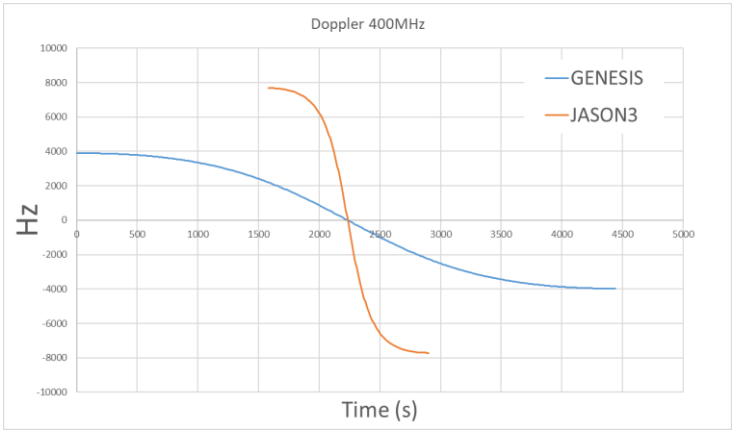
Much progress made, way forward identified

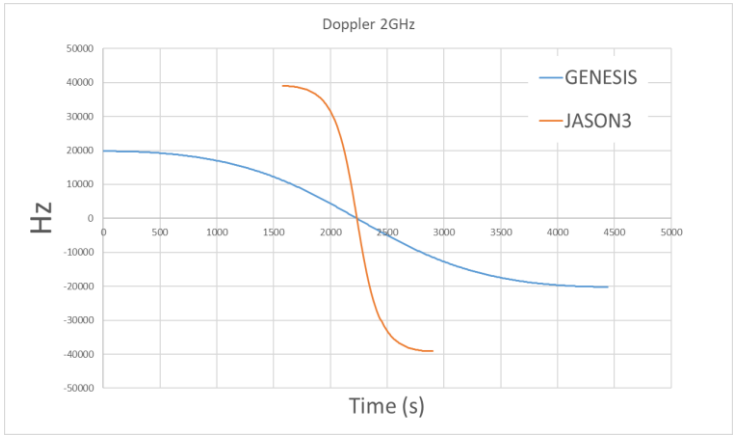
DORIS AT 6000KM: MAIN CHANGES





- ❖ Link budget
- ❖ Doppler shifts
  - « flattened » compared to LEO but still discernible
- ❖ Duration of passes



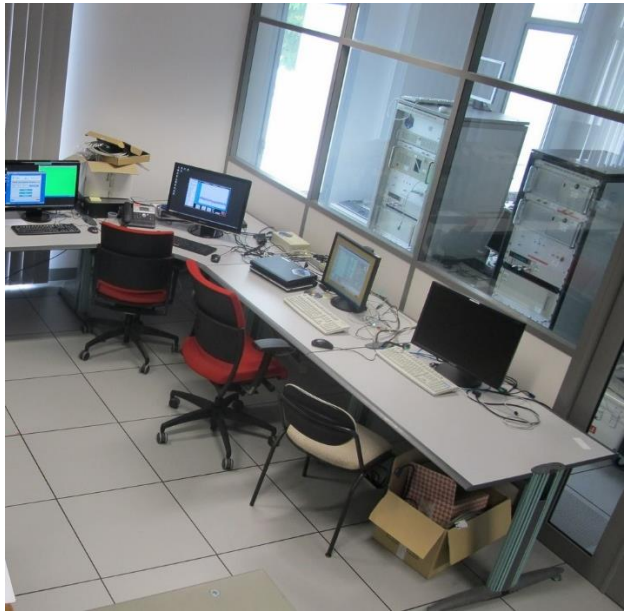


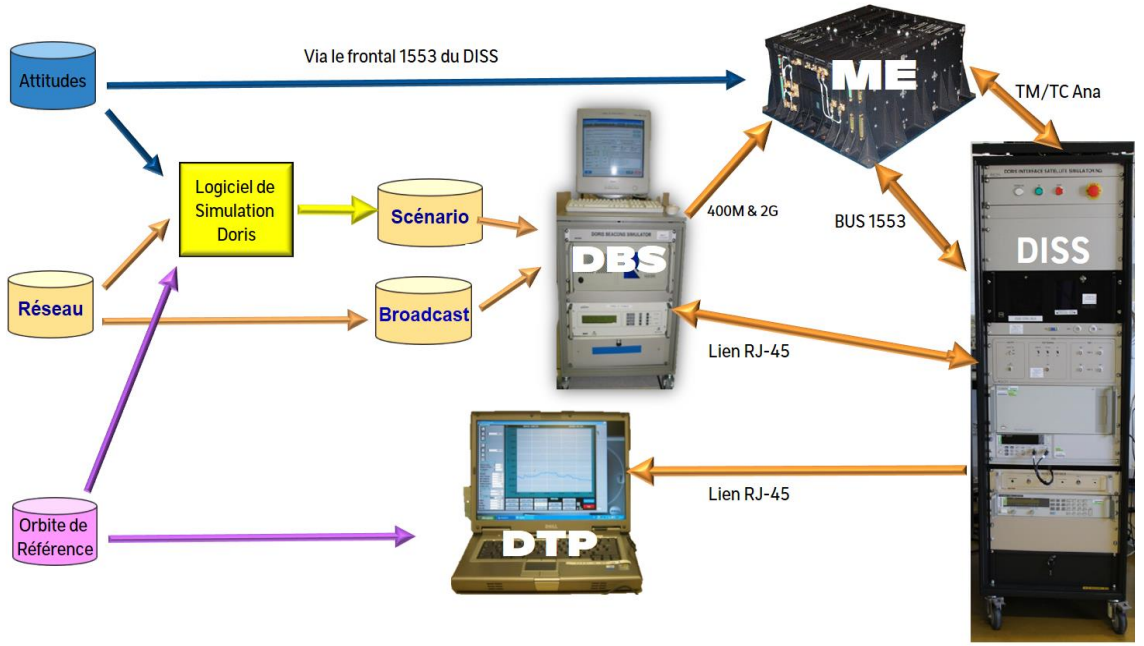
- ❖ Visibility of more beacons ➔ more internal jamming (Doppler crossings)
- ❖ Co-visibility of Master Beacons
- ❖ Sensitivity to radiations,…, different orbital perturbations

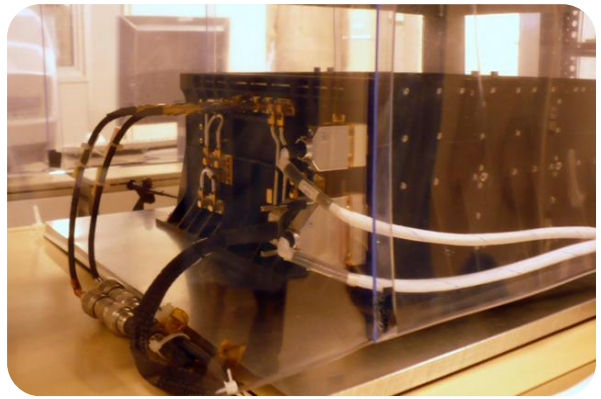
Tests of DORIS DGXX-S on GENESIS orbit

DORIS Testing Facilities

❖ EGSE used to validate OBSW and hardware evolutions & perform AIT tests







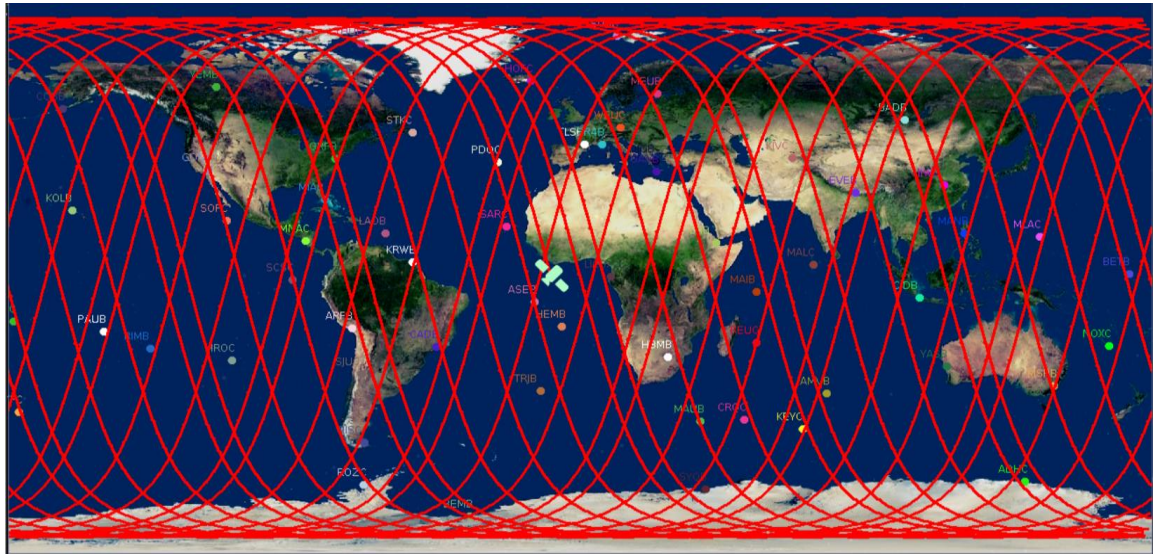
❖ Limitations:

- number of beacon signals to be generated simultaneously
- Master Beacons signals simulated on 1st DBS channel only

Tests of DORIS DGXX-S on GENESIS orbit

GENESIS Test Context

- ❖ Reference orbit: circular, semi-major axis of 12378 km, inclination 95.5°
- ❖ Electric model of instrument used: DGXX-S
- ❖ DORIS OBSW: V5.02 *(designed for LEO)*
- ❖ Network of beacons: 60 stations
- ❖ Test scenario of 5 days
- ❖ UT programing modes: 2 tested
- ❖ DIODE on-board conf: minor adaptations



Tests of DORIS DGXX-S on GENESIS orbit:

RESULTS

- ❖ Focus on the last test run in « UT designation by DAS-N »
- ❖ OBSW computing time measured: nominal results
- ❖ Self-initialization of the DORIS instrument: OK

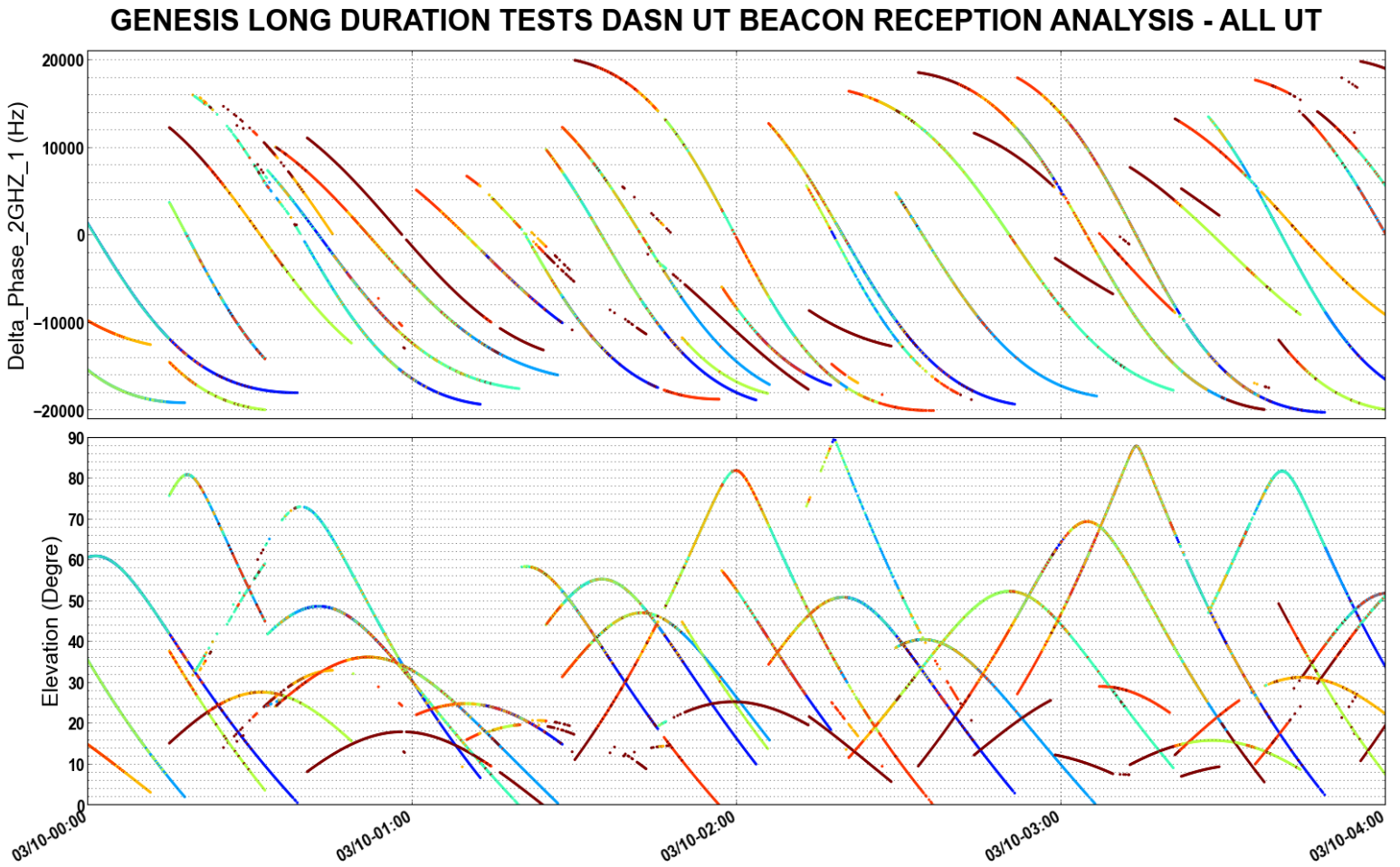
Tests of DORIS DGXX-S on GENESIS orbit

Doppler measurements

❖ Good observability of passes over the beacons

❖ Several UT used for each pass
(due to DAS-N programing mode)

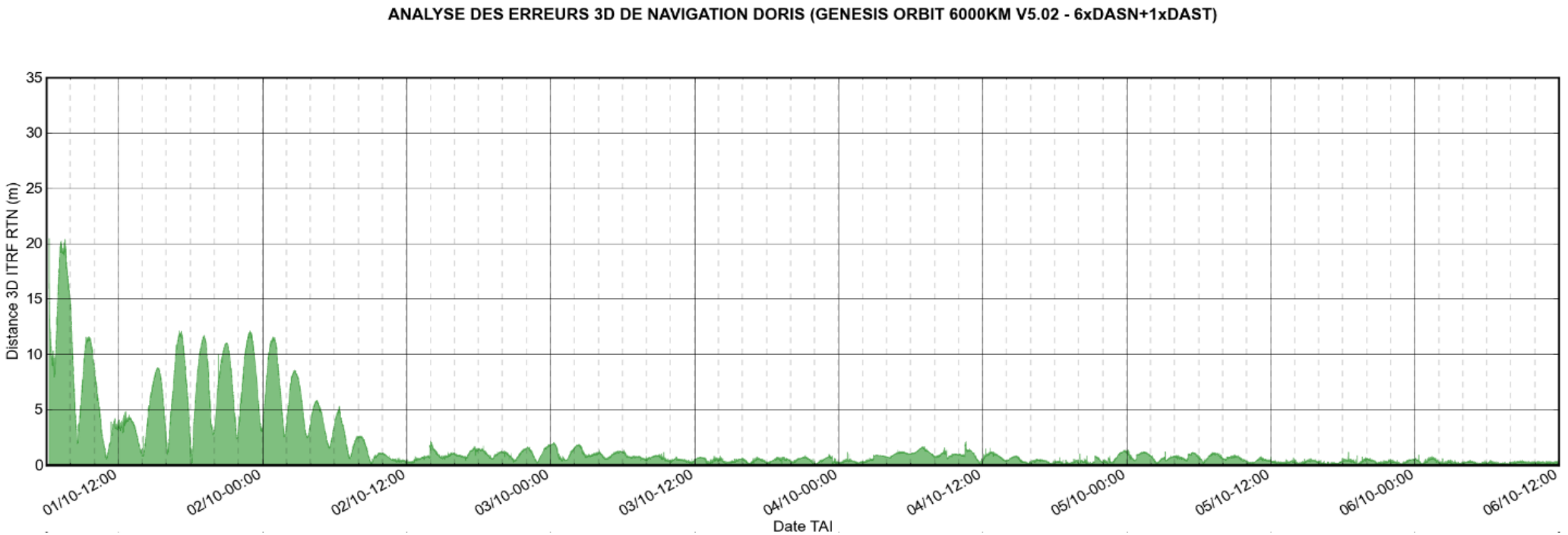
❖ Measurements done at low elevations <10 degrees



Tests of DORIS DGXX-S on GENESIS orbit

DIODE navigation performances

❖ Convergence towards sub-metric level of accuracy in 3D
(~0.7m RMS on the period starting on 02/10 12:00)

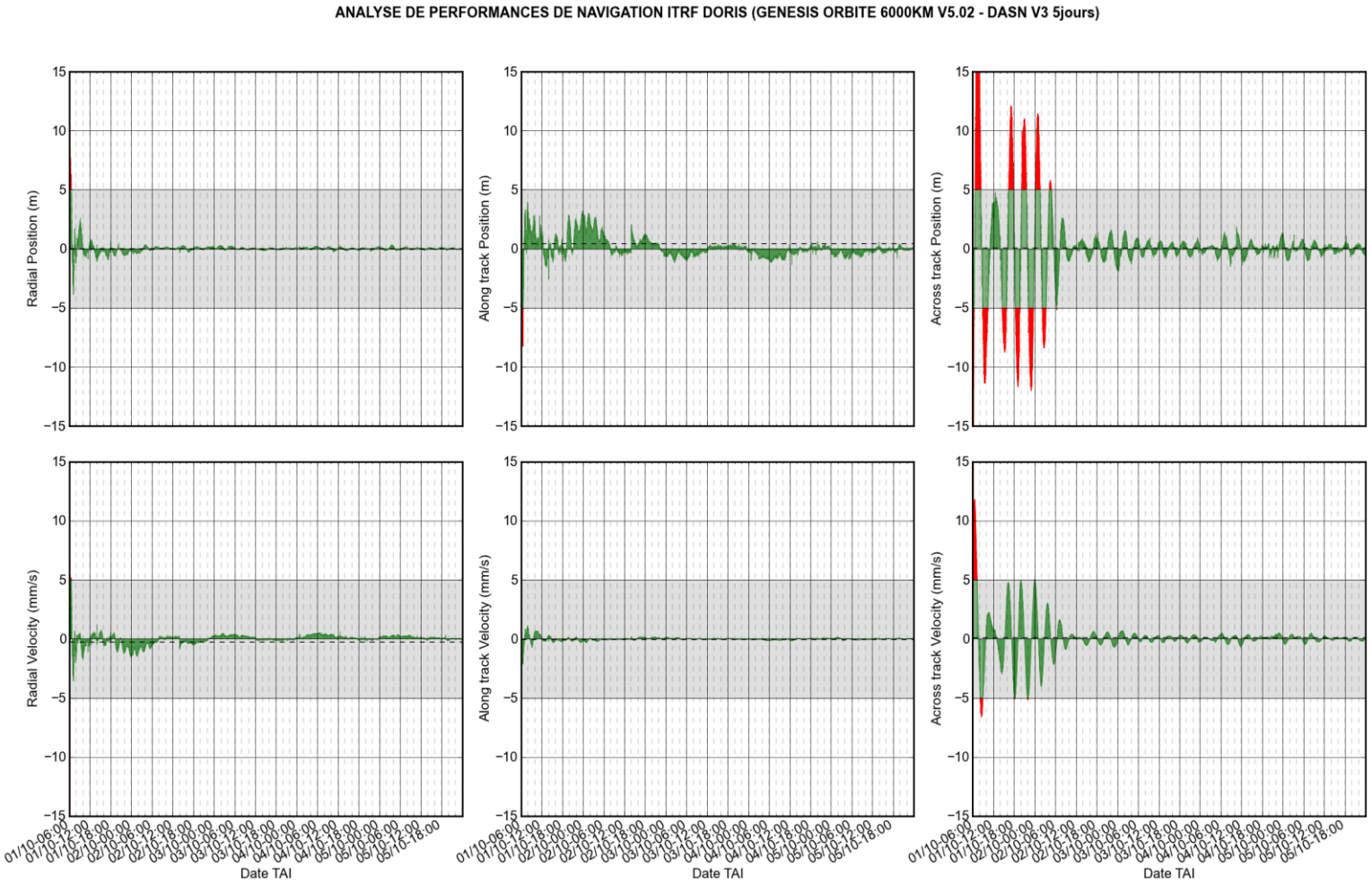


Tests of DORIS DGXX-S on GENESIS orbit

DIODE navigation performances

Radial, along-track, across-track

Beginning of the scenario

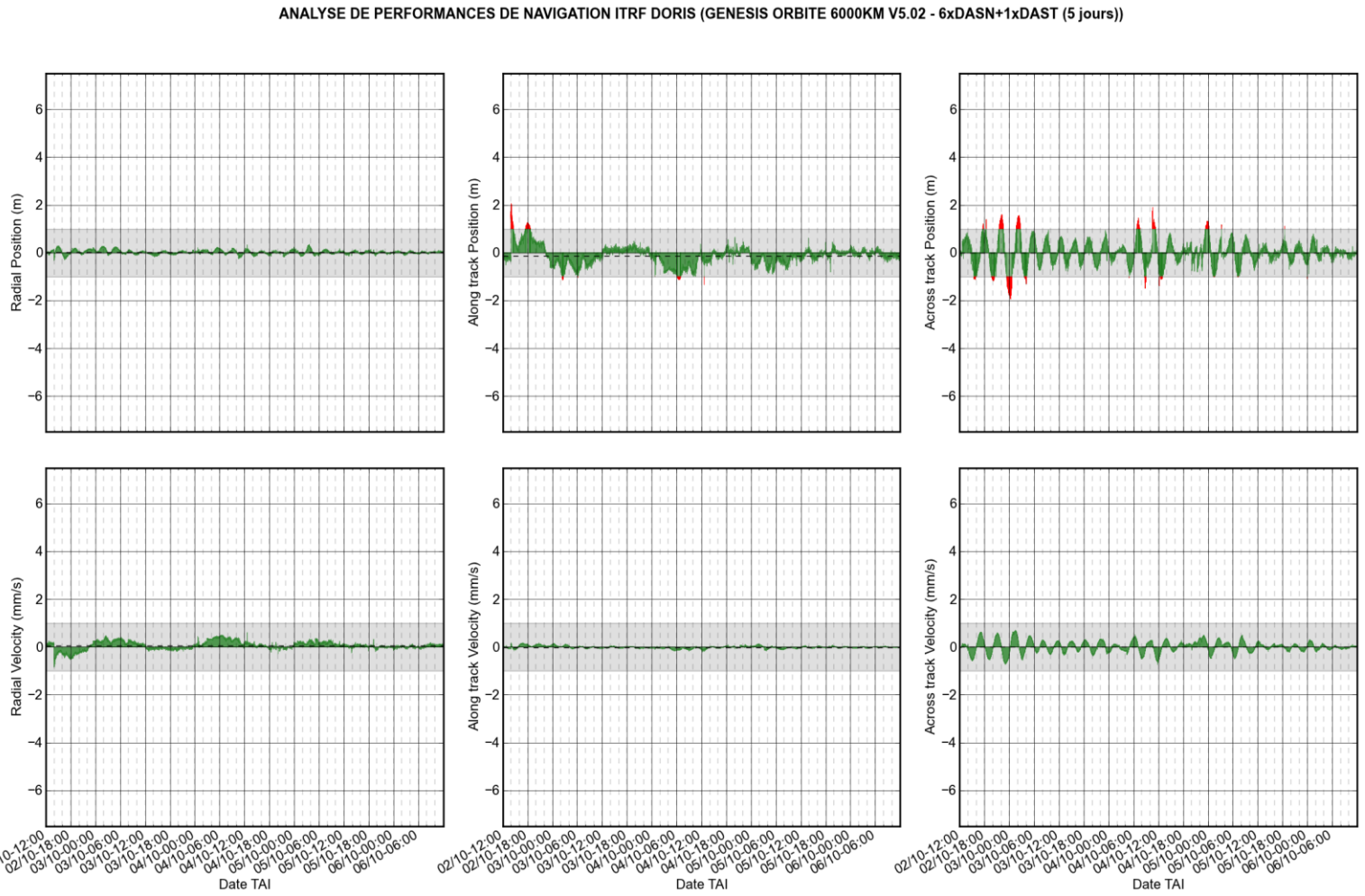


Tests of DORIS DGXX-S on GENESIS orbit

DIODE navigation performances

Radial, along-track, across-track

End of the scenario (zoomed in)



- ❖ **Interesting results given the lack of adaptations for MEO**
- ❖ **But not necessarily representative of the software tools to be used to compute GENESIS products**

Synthesis of the tests performed in dec.2023

- **DORIS DGXX-S instrument should be functionally operational at the GENESIS orbit**
- Ability of the receiver to initialize and perform Doppler measurements was confirmed
- Doppler variations are slightly flattened at 6000 km compared to LEO altitudes, but still remain distinctive enough to be exploited for orbit determination purposes
- DIODE navigator was able to process the measurements and to deliver a real-time orbit of sub-metric precision in 3D despite the lack of adaptations of DORIS and DIODE OBSW to the MEO orbit

The relevance of DORIS on-board GENESIS was confirmed

DORIS instrument soon back in GENESIS baseline

NEXT CHALLENGES

GENESIS SRR preparation

=> Confirmation of **essential technical inputs**:

- the **orbit** parameters
- the standard of **on-board common clock (USO)**
- **platform** specifications
- **environmental** data / hypothesis

=> Contractually, consolidation of:

- System requirements
- Instrument requirements
- PA and ECSS requirement

…and of our « Statements of Compliance » wrt all these req.

NEXT CHALLENGES

GENESIS SRR preparation

Few examples concerning the DORIS instrument:

- Reception band specification TBC
- Link budget (sensibility of the instrument) TBC
- Performances (orbitography accuracy, time-tagging, etc) specifications TBC
- Compliance to radiative environment hypothesis TBC

⇒ Review all requirements applicable to DORIS

⇒ Assess compliance and detail the open points and the strategy to investigate them

⇒ First of all: clarify the modalities of WG-4 contribution with ESA project management

NEXT CHALLENGES

Performances studies to be continued

- Simulation studies by CNES orbitography experts
- Update of EGSE to enable the simulation of 12 beacons simultaneously

⇒ New set of measurements more representative of collisions

Phase A studies

- In coordination with the instrument provider to adapt the DORIS receiver as much as possible to GENESIS orbit
- Assess the necessity to shift the frequency of (some) beacons
- Adapt DIODE navigator to optimize the designation algorithm

Other long-term actions in parallel

- Connection of some DORIS beacons to atomic clocks (frequency reference)
- Interconnections of DORIS beacon and GNSS receivers

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

THANK YOU FOR YOUR ATTENTION

WORKSHOP IDS
MONTPELLIER
SEPTEMBER 4TH AND 5TH 2024

DORIS

IDS
INTERNATIONAL DORIS SERVICE