DORIS WG4 Status

Guilhem Moreaux

2026/03/12

WG4 DORIS

- **Last visio meeting on 2026/02/09.**

- **25 members including experts on the DORIS receiver/beacon, DORIS ground network, DORIS data management, DORIS data processing (POD, IDS ACs).**

- **Work Packages**
  - DORIS network
  - DORIS receiver/Genesis clock
  - DORIS data/metadata
  - DORIS simulations
  - DORIS POD
  - DORIS contribution to TRF

WG4 Members

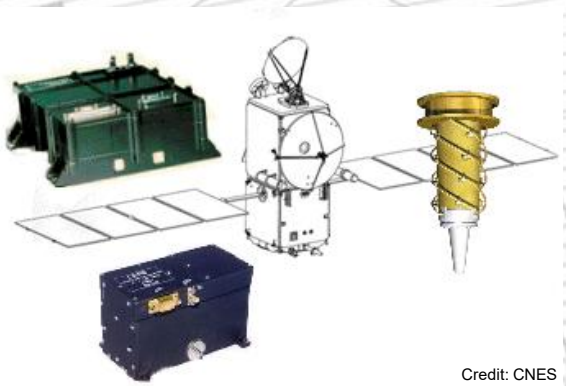
- Hanane Ait-Lakbir (GET)
- Jean-Christophe Berton (ESA)
- Hugues Capdeville (CLS)
- Jean-Pierre Chauveau (CLS)
- Alexandre Couhert (CNES)
- François Didelot (CNES)
- Gaia Fusco (ESA)
- Sara Gidlund (ESA)
- Isabelle Hernandez (CNES)
- Frank Lemoine (NASA)
- Jean-Michel Lemoine (CNES)
- Cécile Manfredi (CNES)
- Flavien Mercier (CNES)
- Guilhem Moreaux (CLS)
- John Moyard (CNES)
- Samuel Nahmani (IGN-IPGP)
- Michiel Otten (PosiTim UG)
- Felix Perosanz (CNES)
- Arnaud Pollet (IGN-IPGP)
- Jérôme Saunier (IGN)
- Erik Schoenemann (ESA)
- Patrick Schreiner (GFZ)
- Laurent Soudarin (CNES)
- Petr Štěpánek (GOP)
- Pierre Waller (ESA)

The Genesis DORIS Receiver

- **The DORIS instrument onboard Genesis is derived from the latest DGXX-S generation on board of LEO altimetric Sentinel-3 and Sentinel-6 satellites.**

- **On Genesis, the clock will be outside the DORIS box and will be provided by ESA/OHB.**

- **The DGXX-S receivers were designed:**
  - **for an altitude between 700 and 1400km.**
  - **to track up to 7 beacons simultaneously.**
  - **to be equipped with a Rakon internal USO.**



Credit: CNES

2026 WG4 Main Studies

- **Impact of the Genesis USO on the DORIS products.**

- **Selection strategy of the seven beacons.**
  - **More than 20 beacons in visibility at 6.000km.**
  - **Priority to stations co-located with GNSS/SLR/VLBI instruments?**
  - **Priority to stations at older sites?**
  - **Priority to stations with connections to atomic clocks?**
  - **Priority to stations with clock connections to GNSS?**
  - **…**

Such studies will be based on simulations of DORIS observations which rely on the Genesis

- **Orbit.**
- **Satellite attitude.**
- **Sensitivity of the USO to temperature, proton fluxes.**
- **DORIS receiver power supply in Earth shadow.**

Genesis & Proton Fluxes

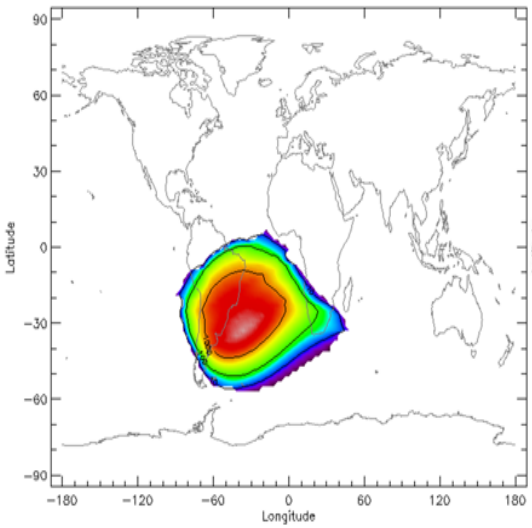
TUM Contribution

❑ SAA Proton Flux

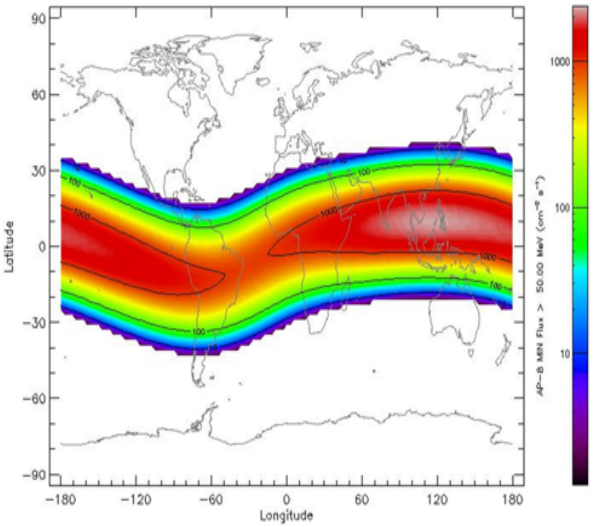
- Trapped protons in the Van Allen Belts affect the frequency of the onboard Ultra Stable Oscillator (USO).
- SPENVIS (SPace ENVironment Information System) is an integrated platform developed by ESA to model the space environment based on a set of models.
- Flux of trapped protons with energies above 50 MeV are displayed in the left figure for the height of the Sentinel-3 orbit based on the SPENVIS AP-8 model.
- The frequency variations of the USO can be compared with the modelled proton flux from SPENVIS and with the proton flux measured by the MEPED (Medium Energy Proton and Electron Detector) on MetOp.

❑ Proton Flux at Genesis Orbit

- The Genesis-1 satellite will fly a DORIS receiver and is equipped with an USO.
- The right figure shows the expected flux of trapped protons with energies above 50 MeV for the orbit height 6000 km of Genesis.
- The USO will be affected two times per revolution by the protons in the Van Allen Belts
- Appropriate shielding of the USO as well as continuous monitoring of the USO frequency using GNSS measurements is essential for the successful analysis of Genesis DORIS tracking data.



Flux of trapped protons (E > 50 MeV) at height of Sentinel 3



Flux of trapped protons (E > 50 MeV) at height of Genesis orbit

From Mezerette et al., 2026, Progress on DORIS Clock Correction Strategies from the IDS Working Group. IAG International Symposium on Reference Frames for Applications in Geosciences (REFAG2026), Munich 2-4, 2026.

Depending on the USO shielding, connection with GNSS may be of great help in the DORIS data processing.

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DORIS-GENESIS ACTIVITIES PROGRESS UPDATE

12/03/2026

GENESIS WS 2026 - BRUXELLES

DIFFUSION LIMITEE DORIS

01 Summary of Major Achievements

DORIS PDR Board meeting held on November, 26 2025

DORIS PDR is considered successfully closed. A few actions have been identified together with their due date but are not blocking the PDR.

Procurement of hardware parts launched (receiver – Thales-DMS) including PCBs

Contract signed with **Thales-DMS on November 27, 2025**

KOM held on December 17, 2025

Contract signature with Thales-AEC on December 22, 2025

KOM held on January 29, 2026

02 Future Outlook

EQSR with Thales-DMS (receiver) planned by end of , 2026

EQSR with Thales-AEC (antenna) planned on March 30, 2026

De-risking test follow-up (with GENESIS more representative context)

MO Safran: Discussion on mid term stability test results and DORIS error budget vs USO in February, 2026

Genesis on-board reference clock = Safran MO master crystal oscillator

Frequency measurements in thermal vacuum chamber provided by SAFRAN *(related action from WG4 meeting#1)*

- 1st analysis from CNES shows that:
  - Short-term performances are within DORIS specifications (~ as RK-410)
  - Mid-term specifications are not met in thermal variations, on 900sec/4000sec) even if fairly good at 20°C (stable temp)
- Actions taken to:
  - Consolidate the results and impact on instrument performances
  - Clarify thermal regulation strategy and improve if possible

- Impact on orbit/positioning performances >>> Dedicated subworking group to:
  - ⇒ consider potential work-around: characterization of temperature sensitivity of the USO prior to launch & use of temperature TM + adapted approach of frequency adjustment (frequency drift adjustment + taking benefit of greater observability by Time Beacons + …)
  - ⇒ give consecutive recommendations (eg. accuracy of temperature sensor on the USO, …)

Functional & perfo tests on DORIS test facilities

Series of tests in late 2025 (already mentioned at WG-4 meeting#2) to test:

- the 12 bacons signals simulator
- the impact of Master Beacons covisibility

⇒ Rather good immunity from internal interferences (collisions) if delta power > 3dB

⇒ No show-stopper related to MB covisibility

❖ Strategy to collect DORIS measurements >>> Dedicated subworking group

⇒ potential tuning on-board processes when/if possible (ex: to maximize amount of data on both channels, etc)

⇒ designation (of beacons to be tracked) strategy:

⇒ Form of passes => length, symetry, use of unchained measurements, etc…

⇒ sub-network to be prioritized ? => geodetic fundamental sites (4 techniques) ? sites with good frequency reference ? sites with common DORIS/GNSS on-ground clock ?

Support for instrument calibration needs

Discussions initiated in view of the WS Splinter dedicated to Calibration

Focus on Antenna “Center of Phase”

⇒Discussions of measurements processes (with support from CNS experts)

⇒Clarification of accuracy needed