OSTST **2026**

DORIS/DIODE Real-Time orbit determination on-board Sentinel-6B

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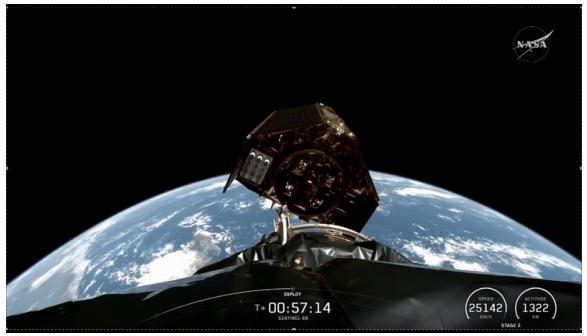
IN PARTNERSHIP WITH

Content

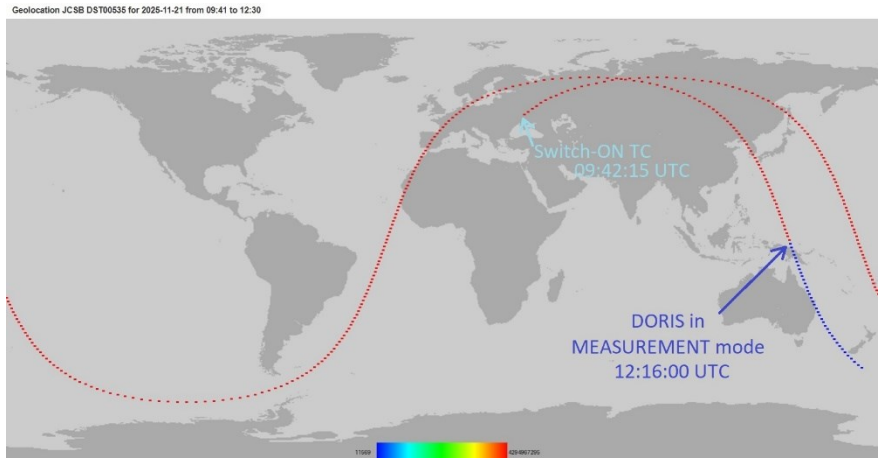
DORIS activation on-board Sentinel 6B

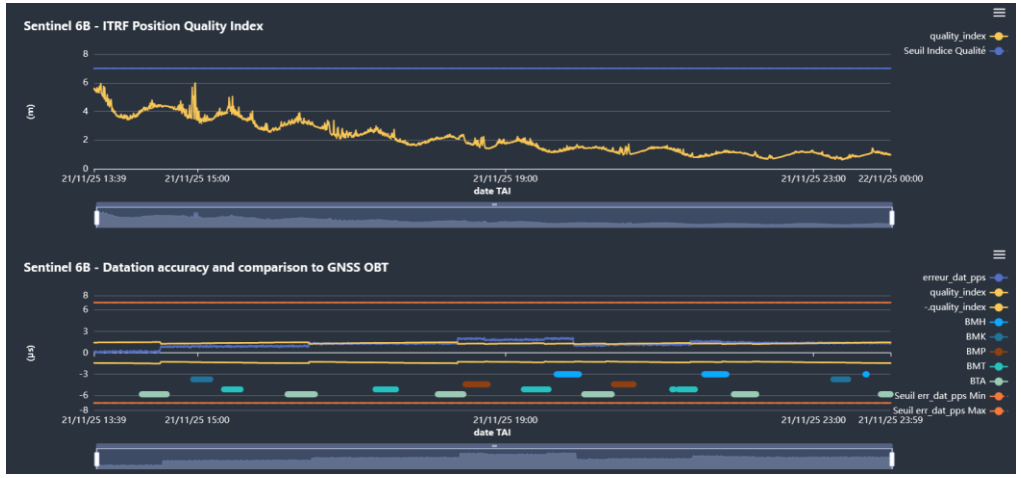


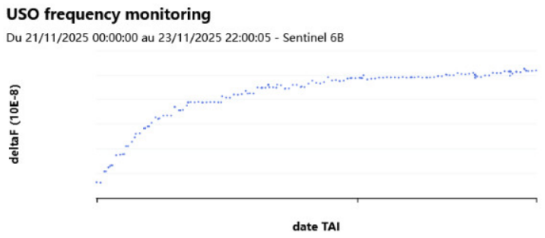
Sentinel 6B launched: November 17th, 2025

DORIS ON: November 21st, 2025, 9h42 UTC (Lost In Space)

Measurement mode and convergence reached in less than 2 orbits.



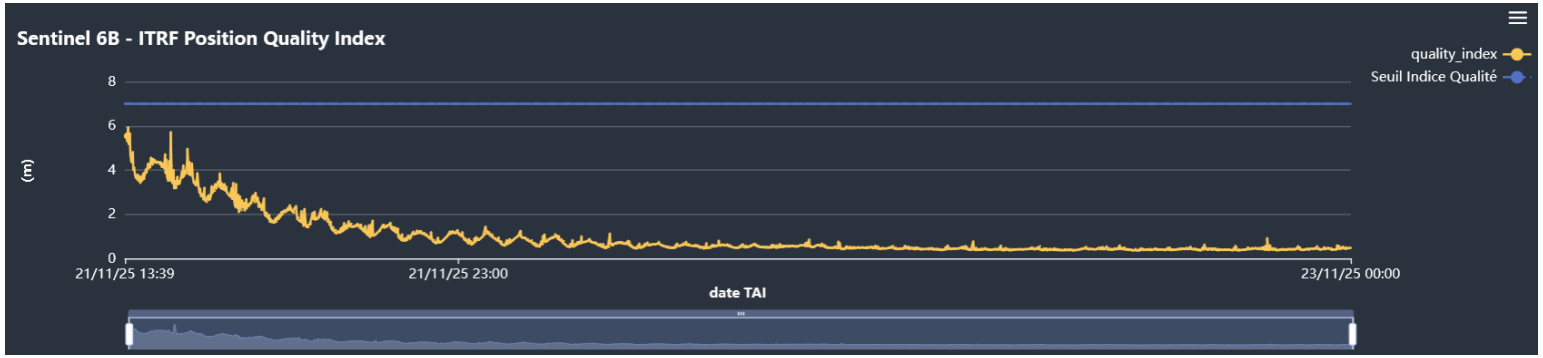




After 4H, still in USO warming period, the accuracy was already better than 6m in position and 3µs in time restitution.

DORIS/DIODE performances

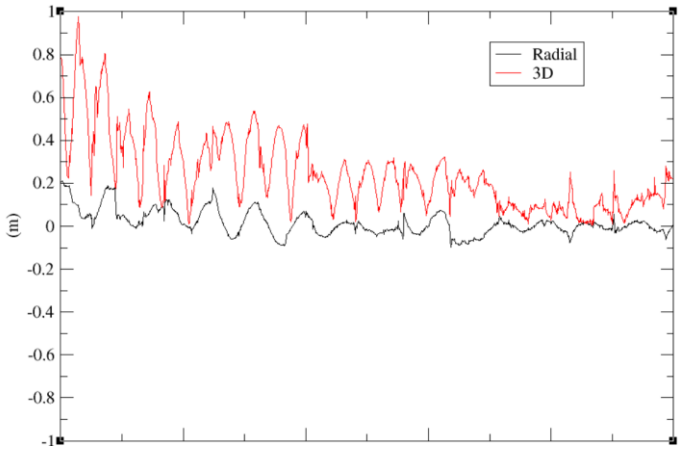
Looking at the Qualtity Index, full performances of the on-board navigator are reached in less than one day.
The QI is a self-estimation of its positioning error. It is the only error estimator available in real time.



Better than 1m after one day

Orbital error signal due to EOP estimation convergence

Comparison to CNES on-ground MOE



Requirements (ITRF reference frame):
5 cm RMS radial component
1m RMS 3D

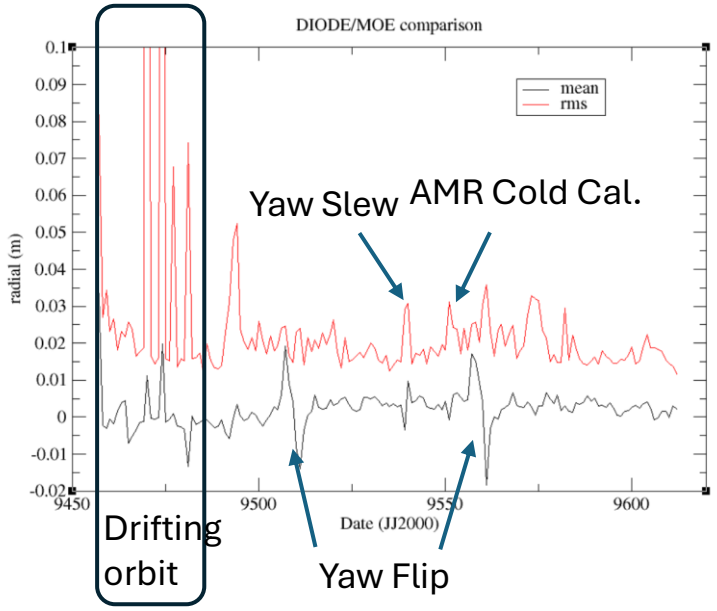
✓ Reached in one day

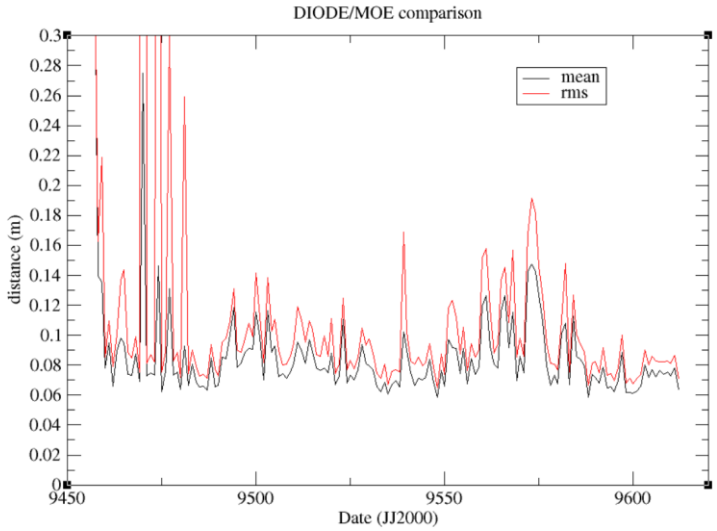
Time restitution accuracy: 5 µsec RMS

✓ Reached in 4H

DORIS/DIODE performances

Comparison to CNES on-ground MOE on a longer period (November 21st – May 1st)





Radial RMS: ~2cm with no bias

3D RMS: ~9cm

Requirements (ITRF reference frame):
5 cm RMS radial component
1m RMS 3D

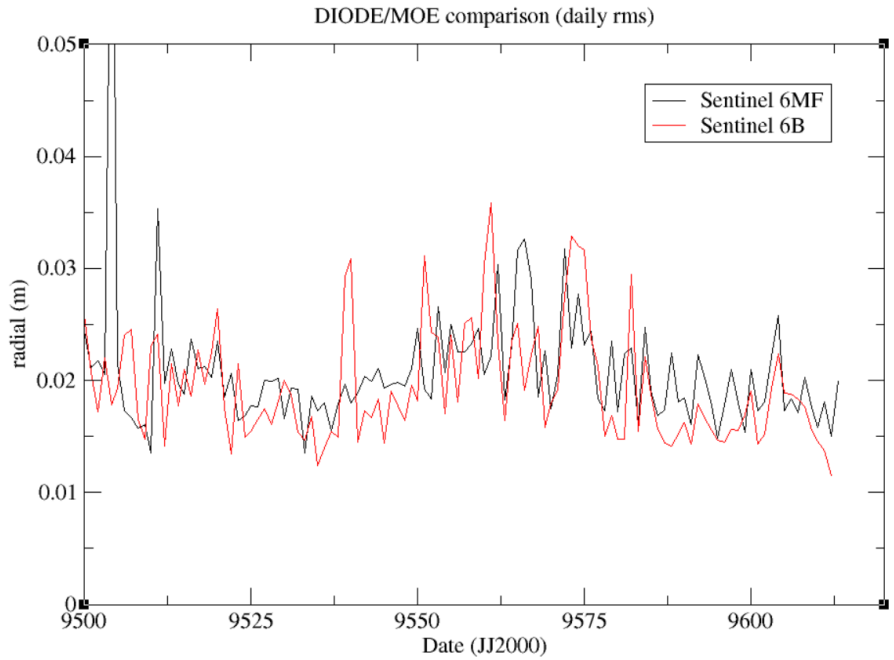
✓ Ok

Comparison with Sentinel-6MF

Same orbit: Sentinel-6MF is 30s ahead of Sentinel-6B
Same platform
Same DORIS DGXX-Sev type receiver with OBSW v5.05

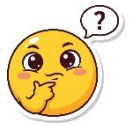
} Same performances?

Performances should be better for S-6MF due to Authorized Extrafine Regime, using more models and allowing to estimate frequencies drifts, EOP drifts and finally positioning more precisely.
Extrafine Regime is systematically inhibited at the beginning of life for all missions, while observing the USO stabilization and its behavior. It is still inhibited for Sentinel-6B.



Sentinel-6B shows better results, except during attitude maneuvers.

This was unexpected.



DIODE estimated parameters

DIODE is based on force models and a 32-parameter Kalman filter

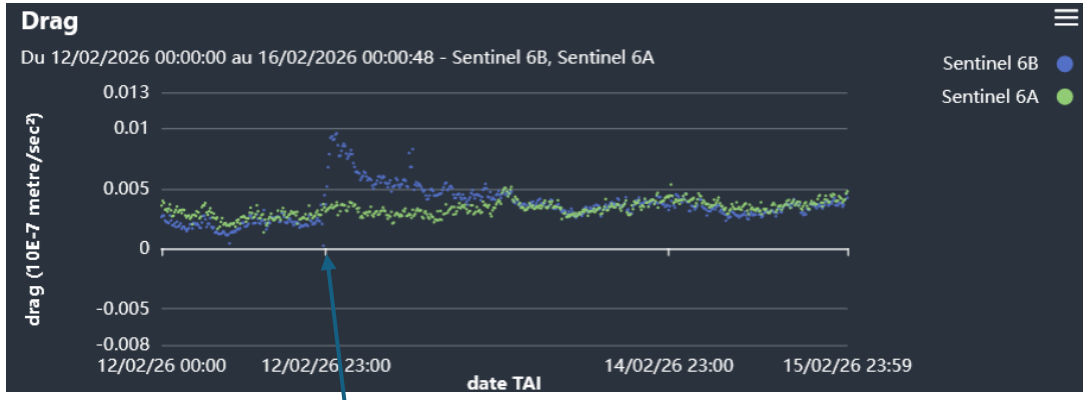
- Position, Velocity
- Drag
- Pole coordinates
- Empirical Hill parameters

} Global parameters

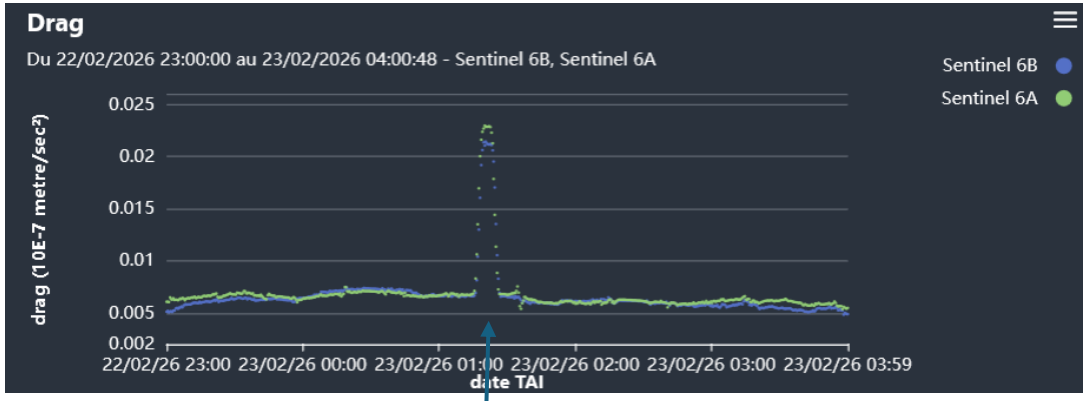
- Onboard frequency
- Beacons frequencies
- Beacons tropospheric bias

} Local parameters

Drag : very similar for both missions at the orbital period.



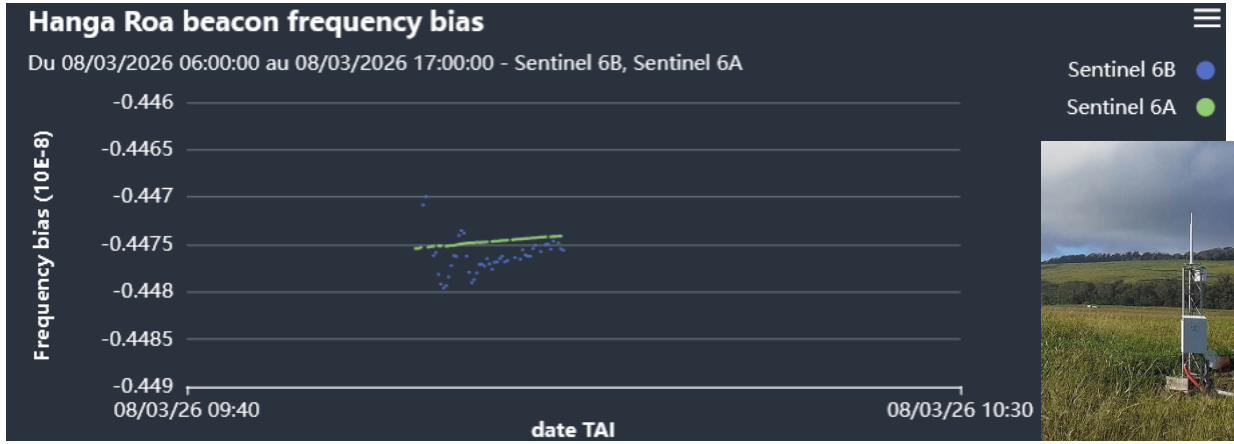
S6B Yaw Slew for POS-4 pointing

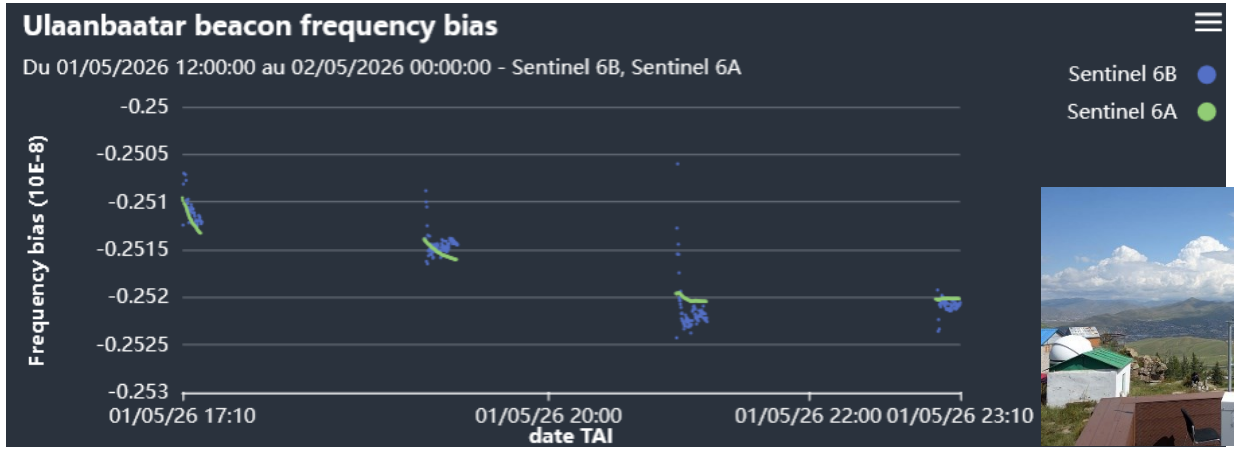


Both missions AMR Cold Cal.

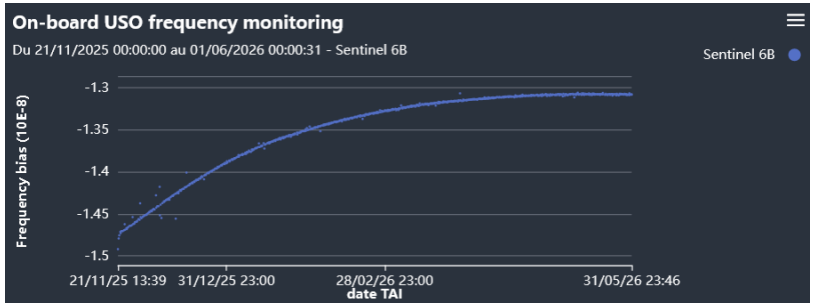
DIODE estimated parameters

Beacon USO frequency





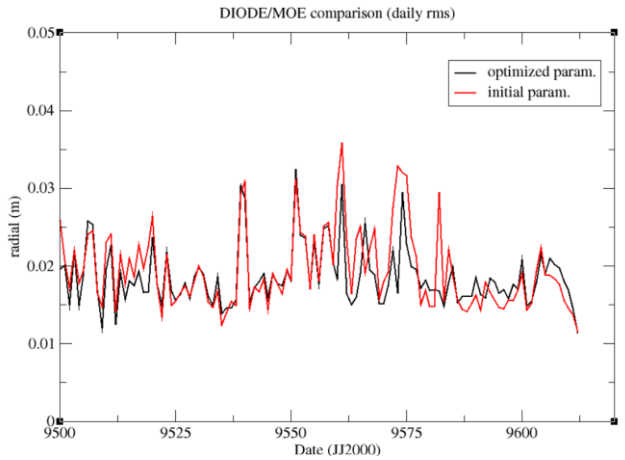
Smoothed solution for S-6MF due to the extrafine regime and estimation of the frequency drifts.

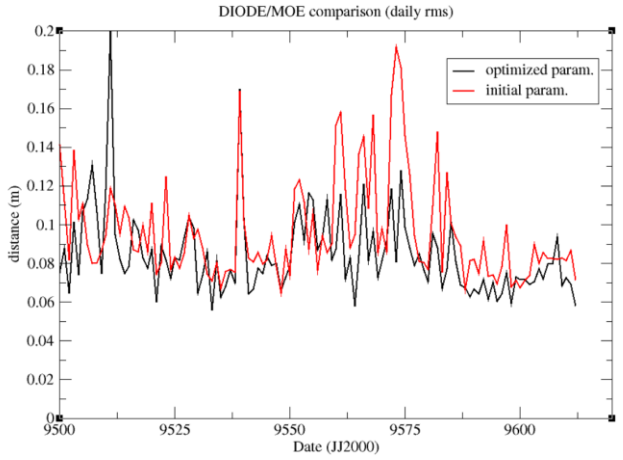


Sentinel-6B USO is stable enough to authorized the extrafine regime and benefits from it.

DIODE filter optimization

Tuning was optimized for previous DIODE version 5.02.
DIODE v5.05 showed 20% improvement w.r.t. v5.02, only due to refined models.
Satellite parameters for Sentinel-6B (Mass, Centre of Mass position) needed also to be adjusted to take into account the beginning of life maneuvers.



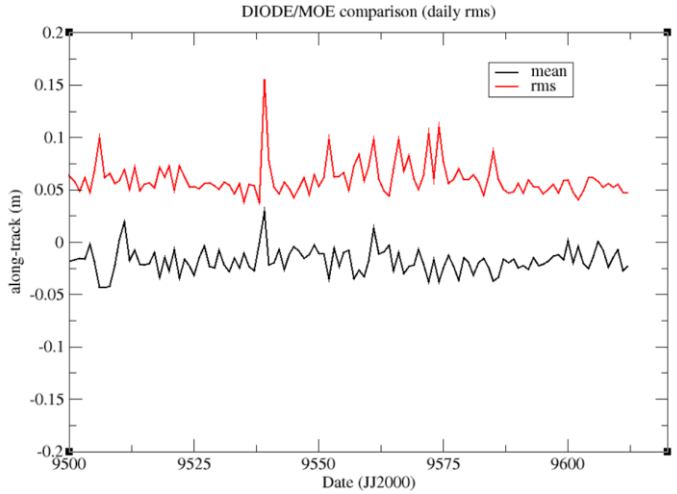


Statistics on the full period:

	MINIMUM	MAXIMUM	MEAN	ST DEV	RMS	**IMPROV**
	*********	*********	*********	*********	*********	*********
Radial	-0.299868	0.158098	0.003162	0.018673	**0.018939**	**10%**
Tangentiel	-0.885265	1.194992	-0.017518	0.060080	0.062582	**10%**
Normal	-0.278669	0.319734	0.003085	0.057417	0.057500	**20%**
Distance	0.001480	1.218220	0.073481	0.046710	0.087071	**13%**

DIODE filter optimization

Still a 1.4cm bias on the along-track component



It might be due to transit time delay (TTD) in the receiver.
A datation error of 1µs due to TTD is consistent with a 7mm error along-track.
A comparison between DORIS, GNSS and Laser orbits is needed to confirm the cause (in progress).
If confirmed, TTD can be updated on-board.

Importance of having multi-technical systems for calibration.

And for Sentinel-6MF, with the same optimized tuning, performances are improved by 10% and equivalent to Sentinel-6B:

	MINIMUM	MAXIMUM	MEAN	ST DEV	RMS	**IMPROV**
Radial	-0.702428	0.138586	0.001889	0.018979	0.019073	**10%**
Tangentiel	-1.022486	0.556431	-0.016559	0.059618	0.061875	**10%**
Normal	-0.469409	0.666622	0.001738	0.054613	0.054641	**10%**
Distance	0.001221	1.024431	0.072302	0.044162	0.084722	**10%**

Conclusion

DORIS on-board Sentinel-6B shows very good performances

- ~2cm on the radial component for a requirement of 5cm
- ~10cm in 3D for a requirement of 1m
- ~2µs on the time restitution for a requirement of 5µs

Geodetic packet is delivered on-board to the altimeter in real time with 100% availability.
Geodetic packet includes altitude and altitude variation rate essential to altimeter.

Performances are slightly better for Sentinel-6B than for Sentinel-6MF.

Tuning optimization is proposed to improve these performances on both missions

- It will be uploaded on board Sentinel-6MF during the orbit change at the end of 2026
- It will be uploaded on board Sentinel-6B this autumn
- ~10% of improvement is expected on both missions, with rms better than 2cm on the radial component

DORIS 10MHz USO delivery to the altimeter and GNSS is done with a stable frequency.