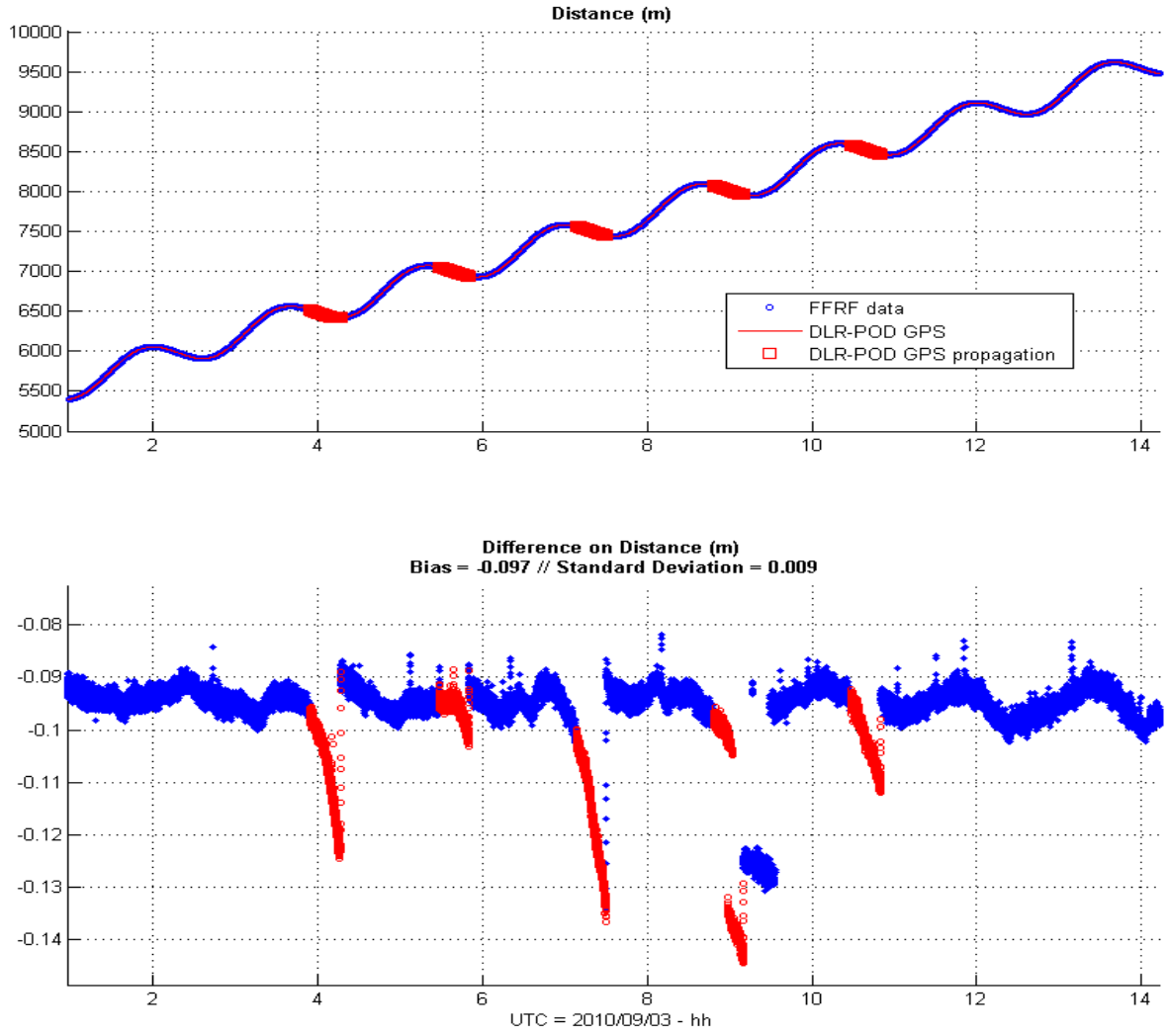
FFRF commissioning: approaching the ultimate performance

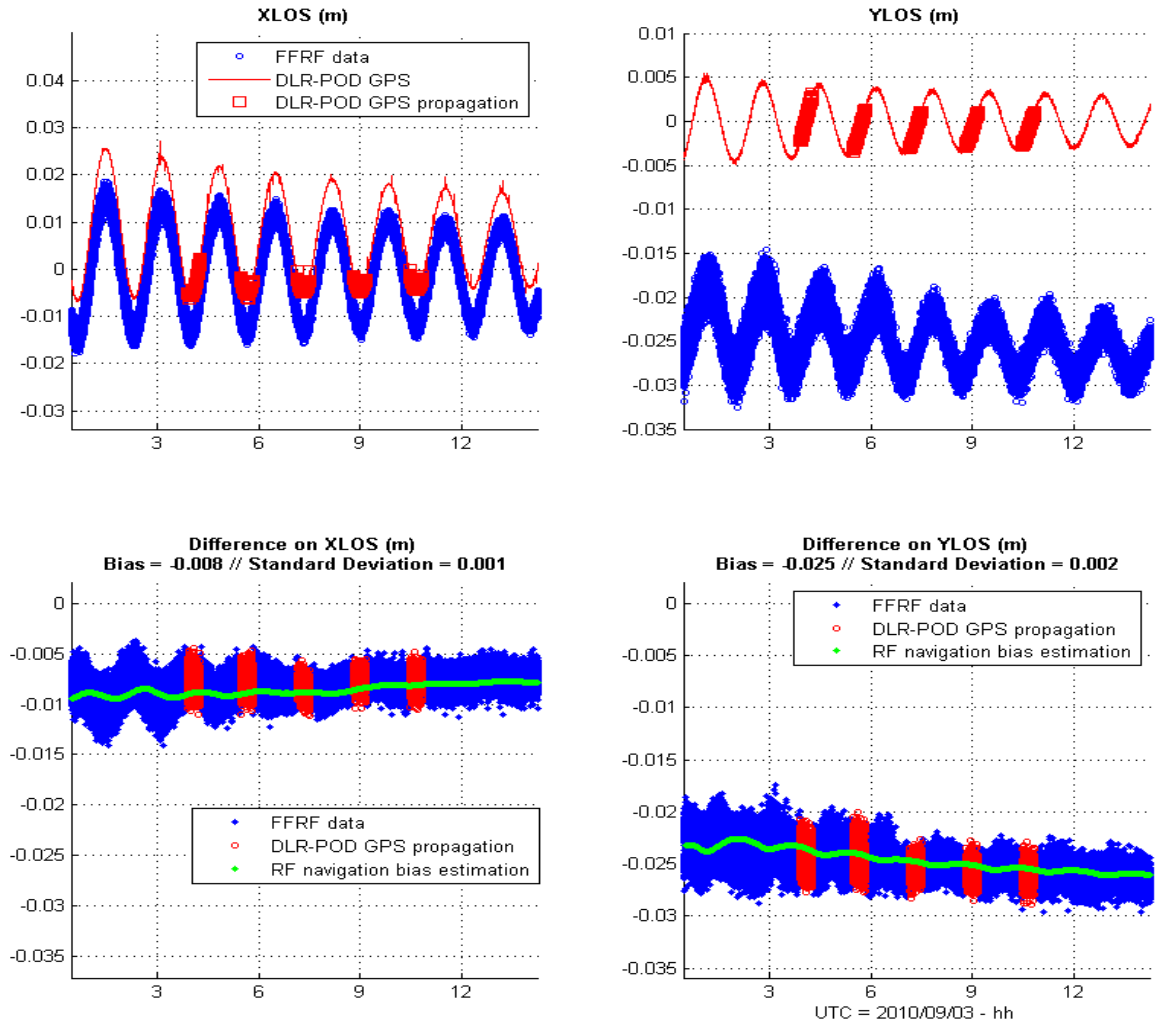
Since the start of the FFRF commissioning one week ago, the subsystem has been put through a series of functional tests and has proven quite resistant to different contingency scenarios (link breakdown, power switching, etc.). Thanks to the AFF variable trajectory and high reactivity from the SSC operations team, we have also been able to test the instrument for different inter satellite configurations (various relative distances, velocities, pointing and antenna selection on TANGO). This also worked very well.

The last five days have been spent in a stable navigation mode, as to allow testing of the long-term stability and performance of the FFRF as well as the CNES navigation filter which is part of the PRISMA onboard software. The results can be seen in the enclosed figures.

The first figure below shows the FFRF fine distance measurement over a 14 hour period starting a little after midnight on September 3rd, when MANGO moves away from TANGO on a corkscrew trajectory. The results are compared with the GPS POD (Precise Orbit Determination) data provided by DLR., and show good stability and a very good performance with a mean bias of about 10 cm, and a noise level smaller than 1 cm (STD) outside the SAA (South Atlantic Anomaly where the GPS is OFF – marked in red). The bias variations are due to internal instrument artifacts (temperature and AGC variations) and multi path effects that will hopefully be corrected through instrument calibrations, which are yet to be performed.

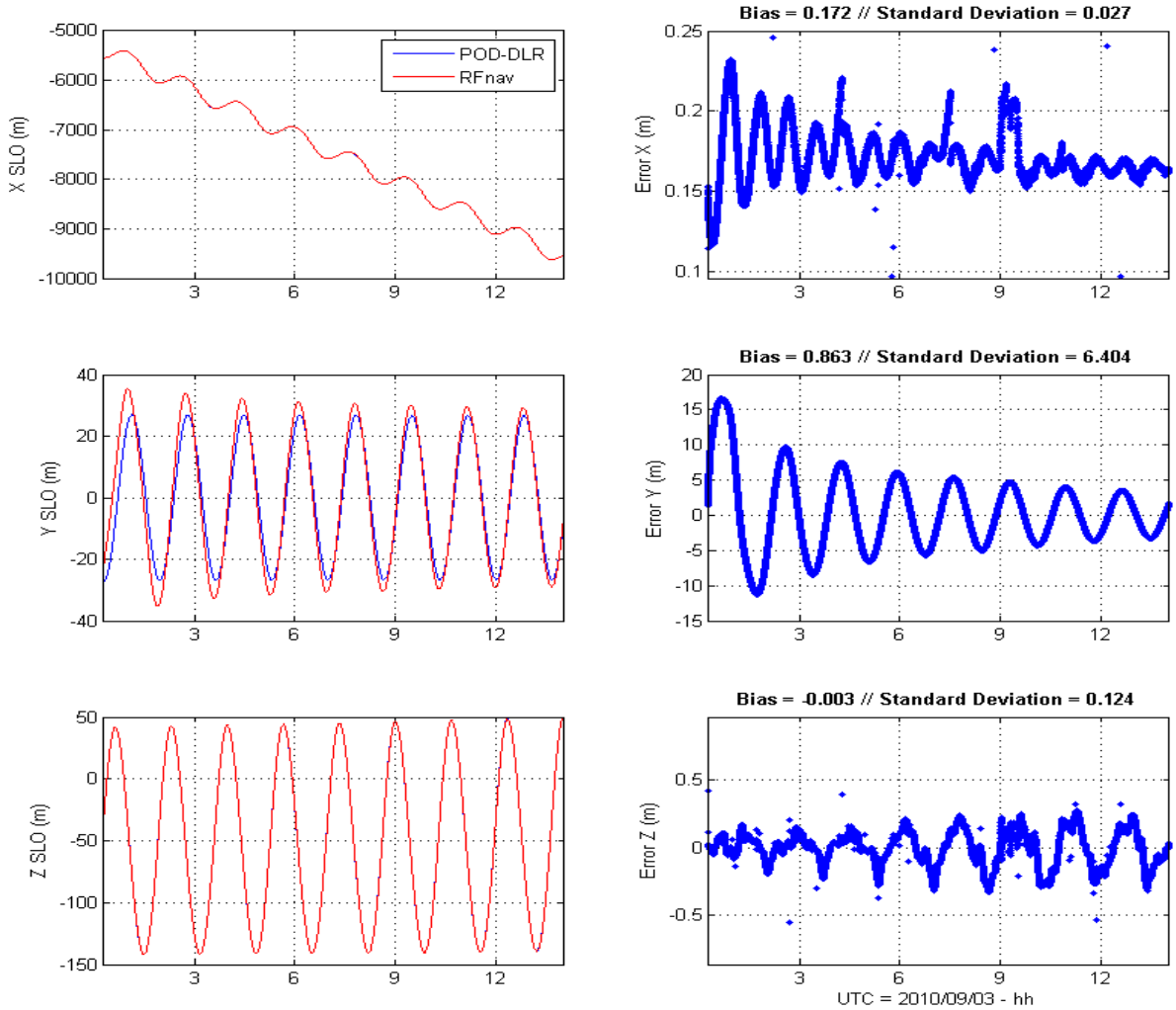


The next figure gives the precision for the same time interval of the line of sight (LOS) measurements, which represent the direction of TANGO with respect to the MANGO satellite. In this particular case, with MANGO flying behind and pointing towards TANGO, the XLOS measurement match with the in plane component and the YLOS measurement coincide with the across plane component of the vector pointing towards TARGET. The results are encouraging with less than 0,01 m (< 0,6 °) bias for XLOS (orbit plane angle) and less than 0,025 m (< 1,5 °) for YLOS (across plane angle). These biases are well estimated by the CNES on board navigation filter (green curve), and can thus be corrected for, leaving only the noise which is less than 0,2° on both axes!



The good performance of the CNES onboard navigation filter is confirmed in the last figure, which shows the first real-time estimation of the relative position of MANGO with respect to TANGO. The position noise is less than 3 cm along track (X) and less than 12 cm in nadir direction (Z), compared with the GPS. The relatively poor cross-track (Y) precision of 6,4 m is unsatisfactory, but is expected to improve significantly once the filter parameters have been tuned.

Note that the position error is decreasing on the along track (X) and cross track (Y) coordinates as a result of the convergence of the filter following a delta-v maneuver (engine burn) before the start of the given time period.



The FFRF and CNES navigation filter commissioning continues this week, with several new interesting scenarios and configurations (close range, attitude variations, etc.).