Towards centimetre orbits in real time with DORIS/DIODE

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- The DIODE function (DORIS Immediate Orbit DEtermination) which computes in real time the position and the velocity of the satellite is embedded in the On board software of the current DORIS instruments.
- The DIODE Function has been developped by CNES with support of the COFRAMI Company.
- The first issue is flying as a passenger on board DORIS/SPOT4 (French Observation satellite) since 1998. This first issue provides a satellite position in real time with an accuracy of a few meters.
- After this first successful experiment, The DIODE Function has been fully integrated in the on board Software. Enhanced versions of DIODE are flying on board ENVISAT(ESA Environment monitoring satellite), Jason-1 (NASA/CNES Altimetry satellite), and SPOT5, reaching a one meter accuracy RMS in 3D w.r.t. the International Reference Frame.
- More recently, new improvements have been implemented in order to meet the Jason-2 real time orbit requirement :

  < 10 cm rms on the Radial component
- Different improved issues have been developed and tested on ground from 2002 to 2006 using real DORIS measurement gathered from Jason1 as an entry for DIODE. The validated POE(1 cm level) is used as a reference. This is shown by fig 1 here below.

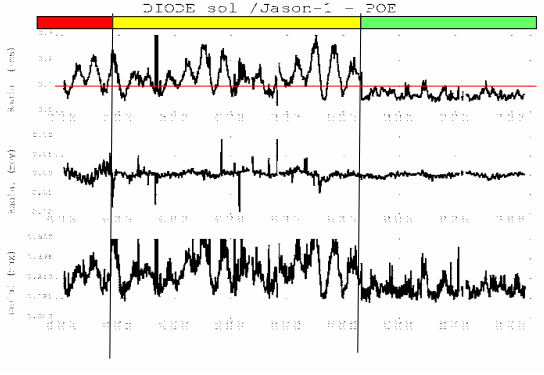
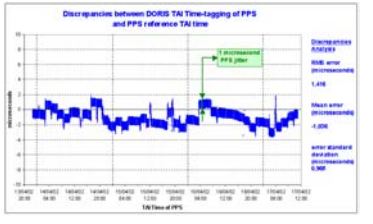


Fig 1
Improvements on DIODE versions 2002-2006

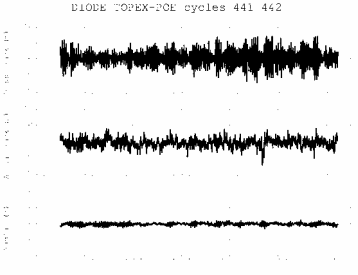
- The major improvement step has been obtained (see green area in Fig1) by correcting the thermo optical characteristics of the satellite. However the performance is limited due to sensitivity of the DORIS/Jason-1 USOs to radiations in South Atlantic Anomaly.
- As the orbit accuracy depends also of the measurements datation (along track error), the performance of the on board datation w.r.t. International Atomic Time scale shall be checked. This is regularly done on board Jason-1 thanks to the availability of a pps slaved on GPS time. The comparison given on Fig 2 here after gives an accuracy of 1 to 2 microseconds leading in a maximum along track error of 1.4cm which is acceptable for real time orbit.

Fig 2
Datation w.r.t. TAI on board Jason-1
(1 microsecond pps jitter is related to pps itself and not to DORIS datation process)



- Finally the performance of the DIODE current issue has been evaluated by using DORIS/TOPEX measurements (to walk around the sensitivity of the Jason1 USOs to radiation in SAA). The results are shown in Fig 3 and table 1 here after

Fig 3



Discrepancies DIODE / POE (mm)	Minimum	Maximum	Mean	Standard Deviation
Radial	**-154**	**122**	**-6**	**44**
Tangential	-801	406	-73	137
Normal	-783	754	11	252
3-D Error	8	832	266	138
Radial velocity	-0.34	0.67	0.007	0.12
Tangential velocity	-0.12	0.12	0.00	0.04
Normal velocity	-0.80	0.69	0.00	0.23
3-D velocity error	0.001	0.82	0.24	0.13

Table1 : DIODE current issue results

As a conclusion we can say that the error on the radial component of Jason-2 orbit should be below 5cm assuming :

*** the satellite is properly modelised**

*** the sensitivity of the USOs to radiations is well decreased (see poster about the current "DGXX" DORIS instrument)**