Coupling Doris/Diode with the Poseidon-3 altimeter: a team effort in orbit

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Diode (Détermination Immédiate d'Orbite par Doris Embarqué, or Immediate Onboard Orbit Determination by Doris) is a suite of real-time onboard orbit determination programs which processes Doppler measurements acquired by a Doris receiver on a satellite.

Since its integration with Doris (on Spot4), Diode has been used with increasing regularity:
- by the Doris receiver, in particular to provide data which enable it to locate the receiver's tracking loop more efficiently,
- by external users (such as the satellite's AOCS, other payload instruments and their related ground segments), to determine the host satellite's precise orbit and provide time-tagging data.
Each flight opportunity requires a new Expression of Needs to be defined by the relevant project teams: for Jason-2 an innovative coupling with the Poseidon-3 altimeter was conceived.

In the framework of the Jason-2 project, Diode was commissioned to provide users with a 'Geodetic Bulletin', containing up-to-date information on the satellite's position: latitude, longitude and altitude, particularly in relation to the geoid. The Poseidon-3 altimeter will be able to use this information in two experimental operating modes, which each modify one of the altimeter's main operating phases. Like all radars, the altimeter must first find and lock onto its target (this is the Acquisition phase), so that it can then follow it (the Tracking phase).

First mode: Using altitude data from the Diode geodetic bulletin which is transmitted to the altimeter, this experimental mode should result in the predicted search range of the return echo being significantly narrowed. Accelerating the Acquisition phase in this way should enable Poseidon-3 to generate a larger quantity of useful data during Earth/Sea transitions, thus improving altimetry in coastal areas. In this mode, the useful signal will then be tracked in a conventional manner as for Poseidon-2.

Second mode: This experimental mode will modify the tracking loop. The target's predicted distance will be calculated directly by the altimeter, combining altitude data from Doris/Diode with the altitude from a pseudo Digital Terrain Model (DTM) of the track overflow by Jason-2, which is recorded in the altimeter's onboard memory. Depending on the quality of this pseudo DTM, the positioning accuracy of the return echo in the altimeter's receiving window will be of the order of a few meters. The combined use of Diode data and the altitude from the pseudo DTM will enable the position of the reception window to be controlled directly, which in turn will enable any target to be tracked independently of the type of return echo. This mode will therefore be very useful when tracking over areas of special interest, such as rivers and lakes (which are not always sufficiently covered by conventional altimeters).

However, it must be emphasised that these two **evaluation** modes are still undergoing study and development. We are very optimistic about their forthcoming validation, but in the

meantime the operating modes which were validated for Poseidon-2 remain effective for Poseidon-3.

Five versions of Diode are currently in orbit, totaling **more than 16 years of active flight experience**. Onboard orbit determination by Doris has become an operational reality, while testifying to excellent reliability and outstanding precision. The Cryosat project, a joint collaboration with Esa which failed during its launch in October 2005, was to be the first time Diode was used by a satellite's AOCS (it was to provide satellite positioning in the J2000 reference frame). Doris and Diode thus represent a successful satellite integration, mutually benefiting each other:
- As well as generating extremely precise measurements for a number of scientific applications (Diode's involvement was initially limited to enhancing availability by replacing the ground programming loop), the Doris receivers can now supply products of value to their host satellites.
- New products are currently being developed for future clients such as Pleiades and Jason-2, particularly the latter with a new feature which enables the altimeter's tracking loops to be programmed more accurately over particular surfaces.

This innovative Doris/Diode and Poseidon coupling should also prove to be a winner on all fronts, both by extending the altimeter's capability over coastal areas and inland waters, and by widening the range of payload opportunities, thereby contributing to an increase in the number of Doris instruments flying in various orbits. In return, this 'Doris constellation' will play a role in optimising the distribution of the network of beacons, leading to more effective management of the 'International Terrestrial Reference System' which is so vital to altimetry missions.

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