



# Preparatory steps for a permanent infrastructure in West Crete to calibrate Sentinel-3, Cryosat-2 and Jason missions with a prototype microwave transponder

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## Abstract

To extend and strengthen Gavdos operations, three Cal/Val facilities have been developed at several other locations, all on the mainland of West Crete. At first, the RDK1 site has been established in the Central-West Crete, along the Jason No. 109 ascending track, while it serves as extension and validation of the Gavdos Cal/Val procedures. Secondly, in the South-West Crete, the CRS1 site has been created for the calibration of the Chinese HY-2 satellite. Finally, a site, called 'CDN2', located on a triple cross-over of the Jason, Sentinel-3A (orbit 14) & 3B (orbit 335) and AltiKa satellites, has already been identified, tested, and selected for altimeter calibration. Also, observations from tide gauges and other dedicated scientific sensors (i.e., GPS-Glonass-EGNOS-BeiDou receivers, meteorological, DORIS, SLR, etc.) installed at various Cal/Val facilities over the broader Crete/Gavdos region, will be used to provide a time series of absolute calibration values and drifts for the Sentinel-3 altimeter and radiometer. A new prototype microwave transponder has been developed and delivered in 2011 to serve as an alternative and independent technique for calibration of, mainly, European altimetric missions. Characterization of the transponder itself has been conducted at the Compact Payload Test Range facilities in the European Space Agency, in 2012. The operational capabilities of the microwave transponder have been already tested employing the Cryosat-2 satellite on TUC campus.

This work will present the preparatory steps taken, and the procedures to be followed for the establishment of a permanent calibration site for Sentinel-3 in the south west of Crete using the developed transponder. Calibration of both Sentinel-3A and Sentinel-3B as well as Jason satellites (and possibly AltiKa) will be performed with this ground infrastructure.

## 1. The operational Gavdos/Crete Cal/Val facilities



Fig.1: Ground tracks of Jason & SARAL



Fig.2: The Cal/Val facilities in Gavdos/ Crete.

Three facilities are fully operational for the calibration of satellite altimetry missions (Jason-2, SARAL/AltiKa, Cryosat-2 & HY-2). The absolute bias is estimated by:

$$\text{Bias} = \text{SLA}(k) - \text{SLA}(k_0)$$

SLA(k) is the sea level anomaly as measured by the altimeter, and SLA(k<sub>0</sub>) is the sea level anomaly as measured by in-situ instruments. Local geoid and mean dynamic topography models are used as reference surfaces for estimating altimeter bias at specific calibrating regions, south of Gavdos and west Crete.

## 2. Transponder Calibration site for Sentinel-3



Fig.3: Altimetry missions over CDN2: S3A = red, S3B = blue, Jason-2 = yellow

The CDN2 site in central west Crete will be the dedicated external calibration site for the calibration of the surface topography element of Sentinel-3 mission.

Cross calibration between several altimeter missions (Sentinel-3A, Sentinel-3B, and Jason-2) will improve the quality of Sentinel-3 operations.

CDN2 Characteristics/ Specifications:

- Lat= N 35°20'43.76", Long= E23°46'34.62", H=984m;
- 100m east of S3A, 300m west of S3B & under Jason ground tracks;
- Protected from strong winds;
- Metallic infrastructures will be avoided to deter unwanted signal interference;
- Main Instruments: transponder, GNSS receiver, meteorological sensors;
- Additional Instruments: microwave radiometer, mobile SLR unit @ TUC Campus;
- Hybrid power supply system with solar panels, wind generators, batteries;
- Communication with central facility via GPRS and satellite links.

## 3. Transponder Status



Fig.4: The procedure for transponder calibration (left) and the TUC's transponder (right).

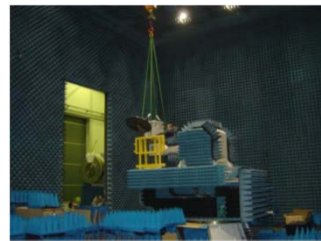


Fig.5: The transponder's characterization procedures @ CPRT facilities at ESTEC/ESA.

## 4. Cryosat-2 Transponder Calibration Results

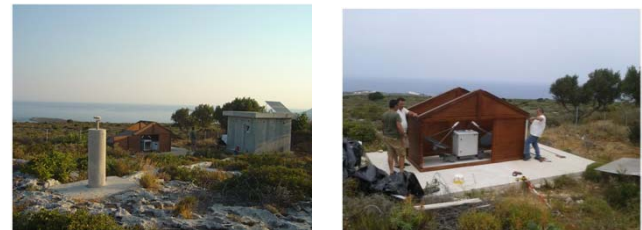


Fig.6: Transponder at the SLR2 site on TUC Campus, Crete, Greece for Cryosat-2 calibration.

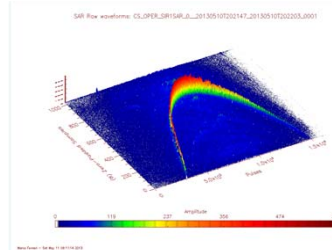


Fig.7: Cryosat-2 SAR raw waveforms using the transponder, on 10-May-2013 .

## 5. Conclusions & Future Plans

- The Gavdos/Crete Cal/Val facilities are fully operational;
- Calibration is carried out for Jason-2 (No. 018 & 109), SARAL/AltiKa (No. 100 & 571), Sentinel-3A (No. 14), Sentinel-3B (No. 335) using sea surface and transponder techniques;
- The "CDN2" site will be fully operational in 2014 to support the Sentinel-3 commissioning phase;
- The "CDN2" will be used for S3A, S3B, Jason-2, and Cryosat-2 calibration;
- The transponder has been effectively used for Cryosat-2 calibration;
- Preliminary Cryosat-2 calibration values have been determined as: B = 0.638m (from FBR data), and B = 0.745m (from stack data);
- Cryosat-2 transponder calibrations are on-going.

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