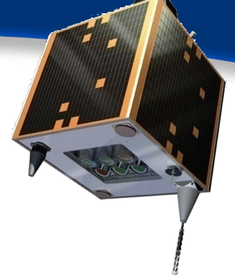
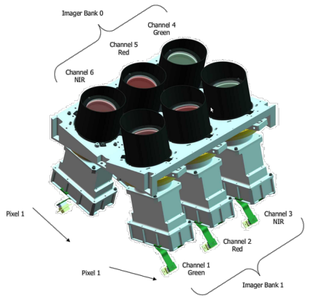
Deimos-1
Absolute Calibration and Data Validation



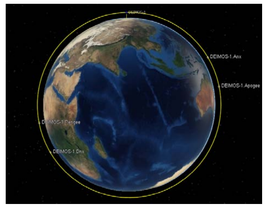
Sensor Specs

- SLIM-6-22 dual-bank linear pushbroom CCD
- 3 cameras per bank, matching Landsat's NIR, R, G channels
- 22 m GSD
- 300 km swath per bank
- ~ 14,400 detectors per camera
- Each detector is considered a radiometer and has to be characterized



Orbit and Imaging Parameters

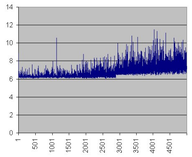
- **Launch**: July 29th, 2009
- **Expected operational lifetime**: 7 years
- **Orbit**: Sun-synchronous frozen @ ~650 km
  Eccentricity and LTAN designed for 10-yr stability
- **Line period**: minimum GSD along the track (GSD is almost constant over one orbit)



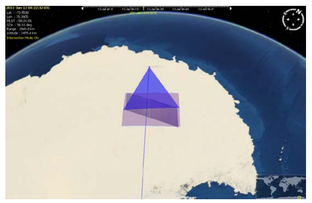
- **Pre-quantization radiometric parameters:** integration times and analog gains
- **Integration times**: chosen for a proper tradeoff between noise and MTF along the track
- **Analog gains**: fixed in nominal operation, with tradeoff between the expected saturation level, the quantization noise and the contrast
- **Digital gains**: On-board post-quantization rescale from 14 to 8 or 10 bits, based on planned observation
- The Deimos-1 **PlanEO Mission Planning System** evaluates the Sun-Zenith Angle and ground type among other parameters and suggests a set of digital gains and of integration times for each capture to be planned. The calculations are optimized to obtain the richest radiometric data for each terrain type.

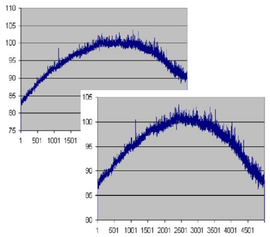
Relative Calibration

- Post-launch commissioning campaign
- **Step 1:** Assess background signal for each detector and estimate noise.
- Full swath images over the Pacific, at night, avoiding natural and artificial light sources.
- The background signal is different for each detector.
- The signal is sensitive to a number of imaging parameters, which shall be optimized and fixed.

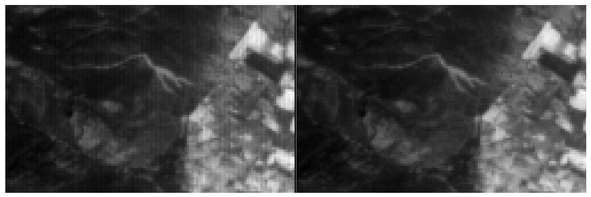


- **Step 2**: Assess the signal over a bright target.
- With a 300km-wide swath per bank, a large and uniform area is required.
- CEOS Landnet site Dome-C (Antarctica) chosen.
- Two effects are visible, in addition to the difference in response for each detector:
  - **Vignetting:** Intrinsic to the camera. Compensated by calibration coefficients.
  - **Asymmetry:** The snow has a significant BRDF effect, and the ground is view under a changing solar angle across the track.
- The asymmetry disappears in the lower graph, which comes from a Dome-C image taken with the platform properly yawed. The upper one was generated using an image captured with the platform in its nominal orientation.



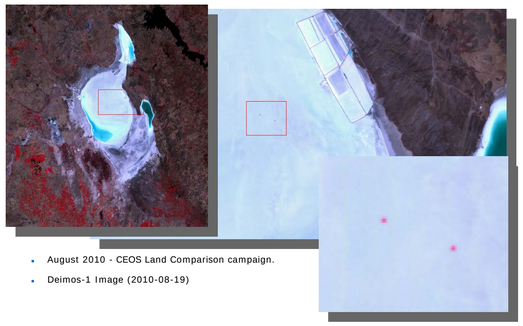


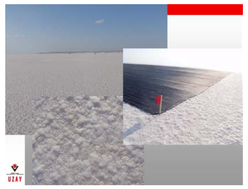
- **Step 3**: Once the external effect of the BRDF are removed, we can characterize each detector with a gain and a bias, equalize their response, and consider the full array of detectors as a single one.



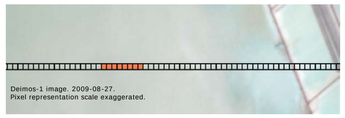
Absolute Calibration

- Vicarious calibration using images of Tuz Gölü (Turkey), a CEOS Landnet site, coordinated with TÜBİTAK.
- TÜBİTAK took ground and atmospheric measurements, generating atmospherically corrected TOA radiance at the time of the satellite overpasses.
- TOA (Top of Atmosphere) radiance values were calculated using 6S (Second Simulation of a Satellite Signal in the Solar Spectrum) radiative transfer code .





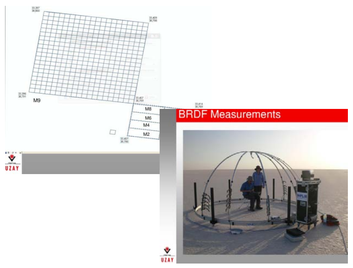
- With all linear arrays of detectors equalized, we need only a small sample which spans a few pixels to obtain the absolute calibration parameters for each band. These parameters will be extensible to the whole array.



Cross-Calibration

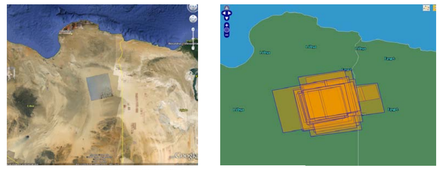
- August 2010 - CEOS Land Comparison campaign.
- Location: Tuz Gölü salt lake. Carried out by TÜBITAK.

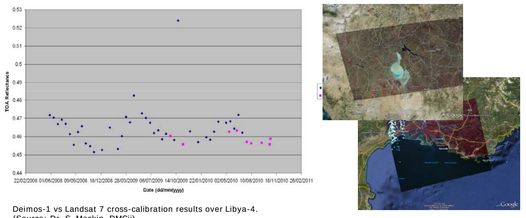
Institution	Optical sensor
CMA	FY3A/VIRR
CNES	SPOT4
	SPOT5
DMCII	Beijing1
	Deimos1
	UK-DMC2
ESA	ENVISAT/MERIS
	ENVISAT/AATSR
JAXA	ALOS/AVNIR-1
	ALOS/AVNIR-2
NASA	EO1/ Hyperion (primary) and ALI
	Terra/MODIS
USGS	Landsat5
	Landsat7
GISTDA	THEOS
DLR	RAPIDEYE_2
	RAPIDEYE_3
	RAPIDEYE_4
	RAPIDEYE_5



Validation & Monitoring

- Libya 4 CEOS pseudo-invariant site.
- Two acquisitions per month.
- Monitoring:
  - Trend
  - Landsat 7 cross-calibration
  - Other DMC platforms cross-calibration
- Outputs are used as inputs to tune the calibration parameters. This periodic acquisition is both a calibration and a validation technique.
- The trend monitoring gives us information about the sensors degradation. If a sensible deviation were found, a new calibration campaign would be scheduled.
- Additional validation checks are performed over La Crau (France) and Tuz Gölü (Turkey)

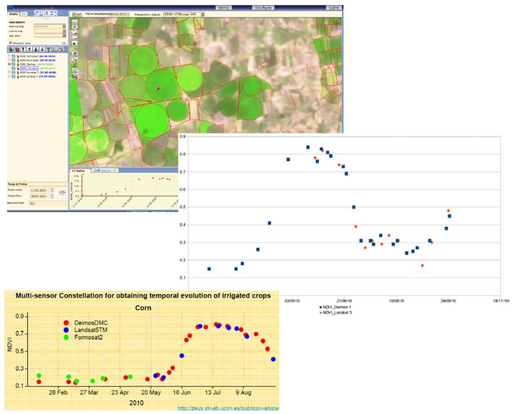




Deimos-1 vs Landsat 7 cross-calibration results over Libya-4.
(Source: Dr. S. Mackin, DMCii)

Customer Validation

- Cross-validation with Landsat and Spot-5
- Very good correlation with both sensors



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DEIMOS Imaging S.L.
an ELECNOR company
Boecillo, Spain
www.deimos-imaging.com