Deimos-2 Radiometric Calibration and Cross-calibration with Dubaisat-2

Jorge Gil, Alfredo Romo, Cristina Moclan, Fabrizio Pirondini
(Elecnor Deimos Imaging)

Diego Lozano
(Elecnor Deimos Space)

Enrique Gonzalez, Jesus Quirce
(Elecnor Deimos Satellite Systems)

ELECNOR DEIMOS, Spain

JACIE 2014
13th Annual Civil Commercial Imagery Evaluation Workshop
Louisville, KY - March 26-28, 2014

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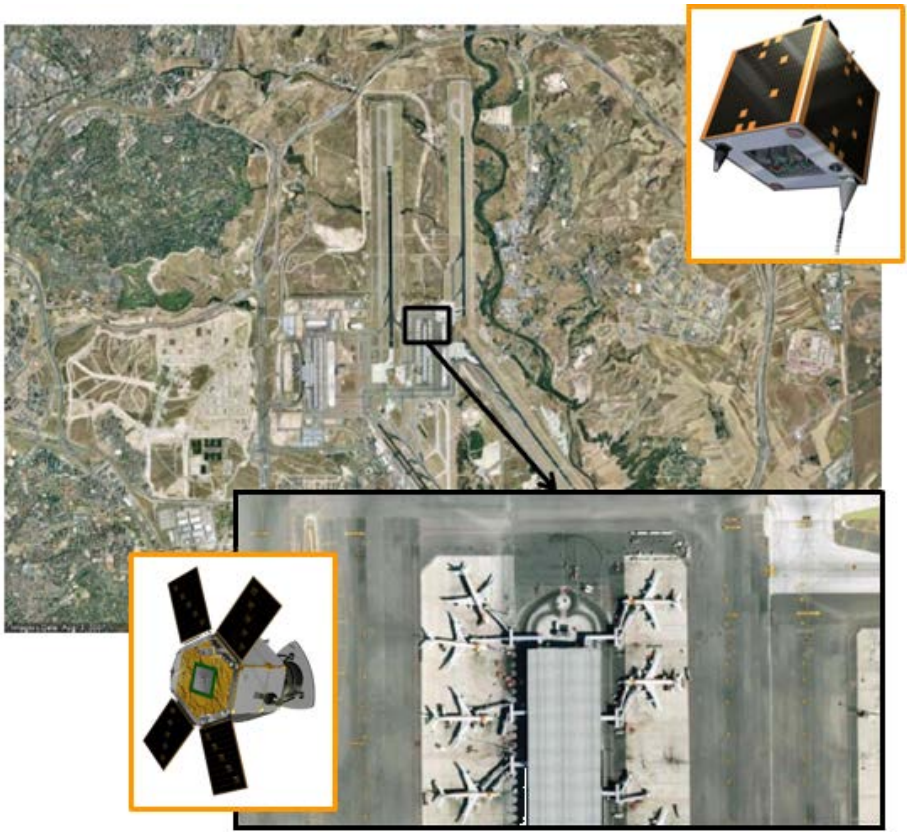
Contents

- The DEIMOS-2 Earth Observation System
- DEIMOS-2 radiometric characterization and calibration
- Cross-calibration with Dubaisat-2
- The calval4EO suite

1 The DEIMOS-2 Earth Observation System

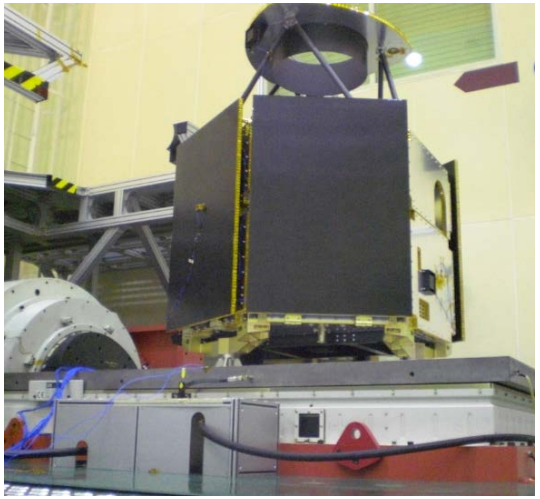
DEIMOS-2 EO System

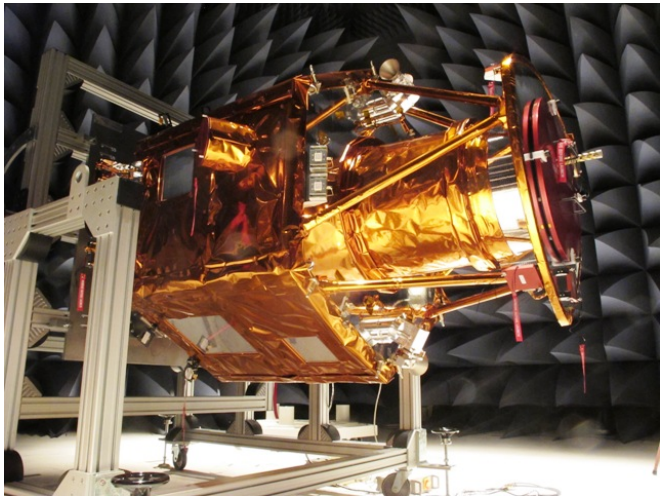
- **DEIMOS-1** (22m GSD, 3-band, 650 km swath), owned by ELECNOR DEIMOS, is the first Spanish Earth Observation satellite, launched in 2009
- ELECNOR DEIMOS' EO system will be upgraded in **2014** with the launch of a new satellite, the **DEIMOS-2**
- DEIMOS-2 will be a **multispectral optical** satellite with **very high resolution (75 cm Pan-sharp)**.
- The DEIMOS-2 end-to-end system has been designed to provide a **cost-effective** and **highly responsive** service to cope with the increasing need of **fast access to very-high resolution imagery**
- Designed and built by ELECNOR DEIMOS in cooperation with SATREC-i (South Korea). It has been integrated and tested in the new **ELECNOR DEIMOS Satellite Systems**' premises in Puertollano (Spain)

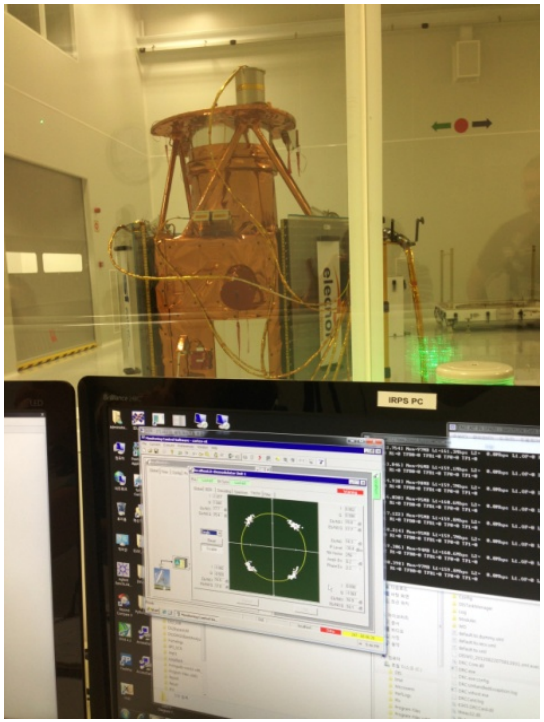


DEIMOS-2 EO System

- Built by ELECNOR DEIMOS in collaboration with SATREC-i (South Korea).
- Proven design with **significant heritage** (Dubaisat-1, -2)
- Nominal lifetime **>7 years**
- Mass: 310 Kg
- **Agile platform** (±45º across-track)
- High-performance AOCS for pointing accuracy & stability
- Xenon gas engines for orbit maintenance







DEIMOS-2 EO System

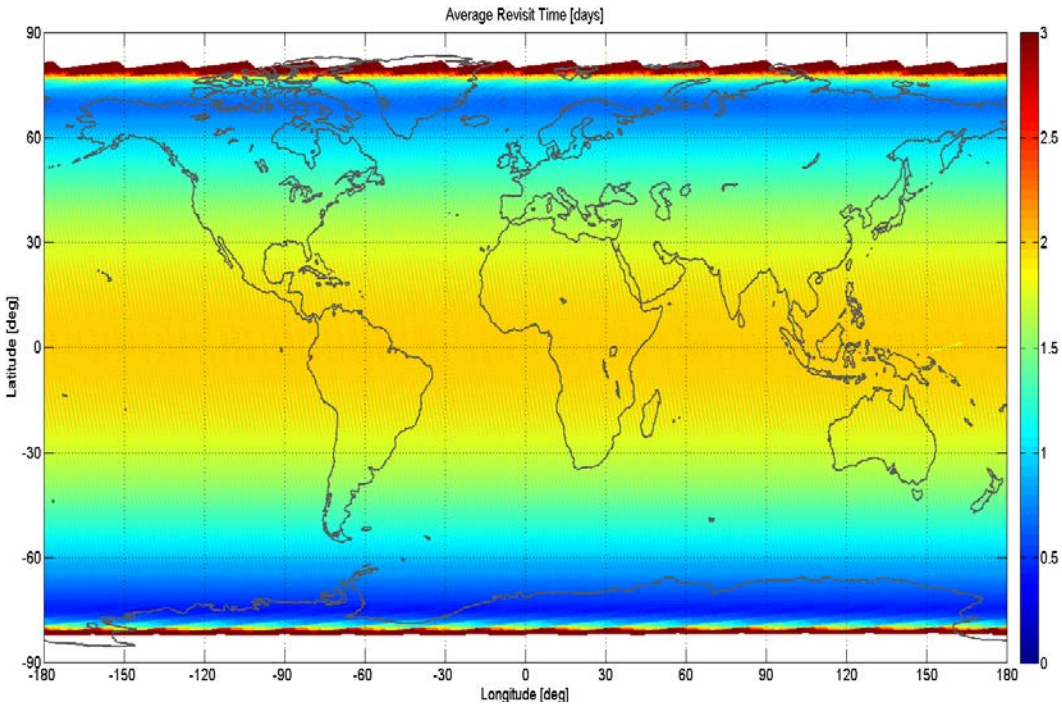
- **Orbit type**: Sun-synchronous, LTAN 10:30, ~620 km nominal altitude
- **Orbit determination**: via GPS, with metric accuracy
- **Orbit information** availability to users: with telemetry and on-ground POD

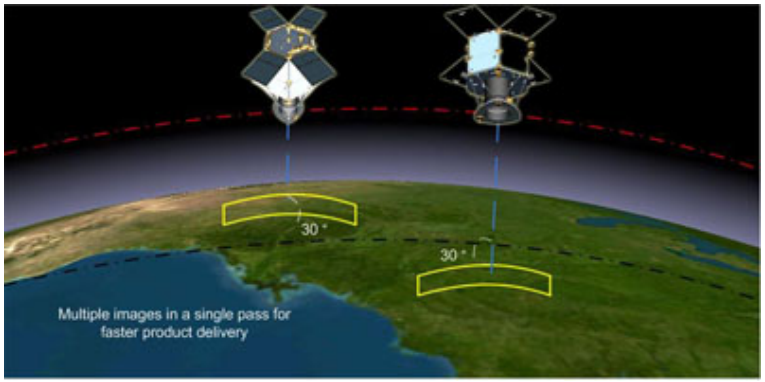
- **Viewing angle**: nominal ±30º, emergency ±45º
- **Geolocation accuracy**: ~100 m without GCPs

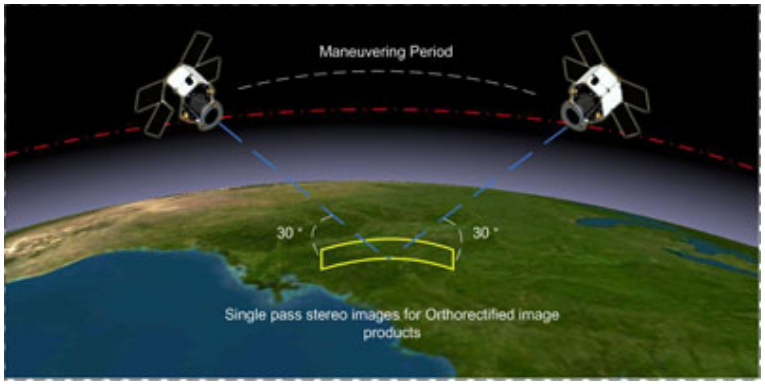
- **OBDH**:
- On-board recording (256 Gb, equivalent to 1,400km-long strip)
- Image data lossless compression, encryption, CCSDS encoding during transmission
- Solid state X band transmitter, with 160 Mbps download rate
- ±90°one-axis steerable X-band antenna

DEIMOS-2 EO System

- **System Capacity**: Up to 150,000 Km^2/day
- Global average revisit time: 2 days (±45º ACT)
- Average revisit time at 45º Lat: 1 day (±45º ACT)



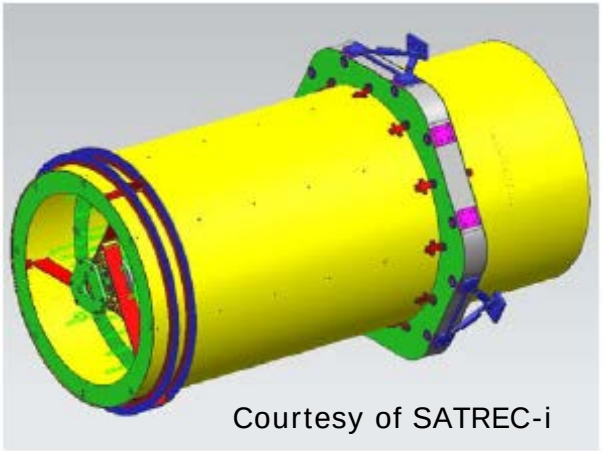


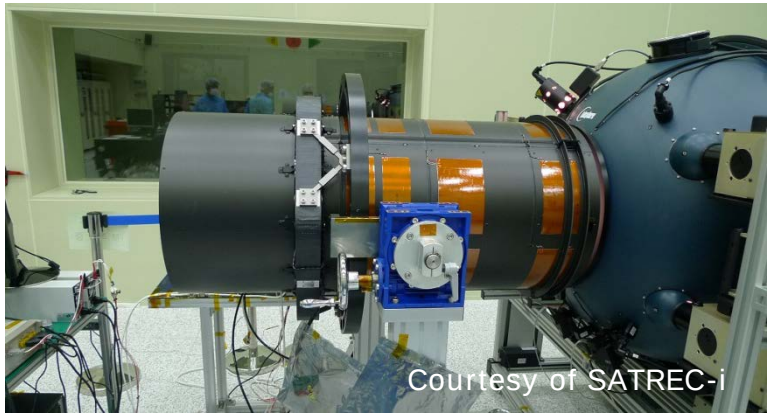


DEIMOS-2 EO System

HiRAIS Payload

- Pan/Multispectral high-res camera (GSD: Sub-meter Pan, 4xPAN res MS)
- **Main image product: 75-cm pan-sharpened**
- 40-cm Korsch 4-mirror telescope (5.75 m focal length, 1.2º FoV)
- **Pan** (450-900 nm) **+ 4 bands** (R,G,B, NIR)
- **12 km swath** (24 km in wide area mode)
- Capacity for stereo-pair acquisitions
- Radiometric resolution 10 bits
- TDI sensor:
  - PAN : 6, 12, 24, 48
  - Blue, Green : 4, 8, 16
  - Red, NIR : 2, 4, 8


Courtesy of SATREC-i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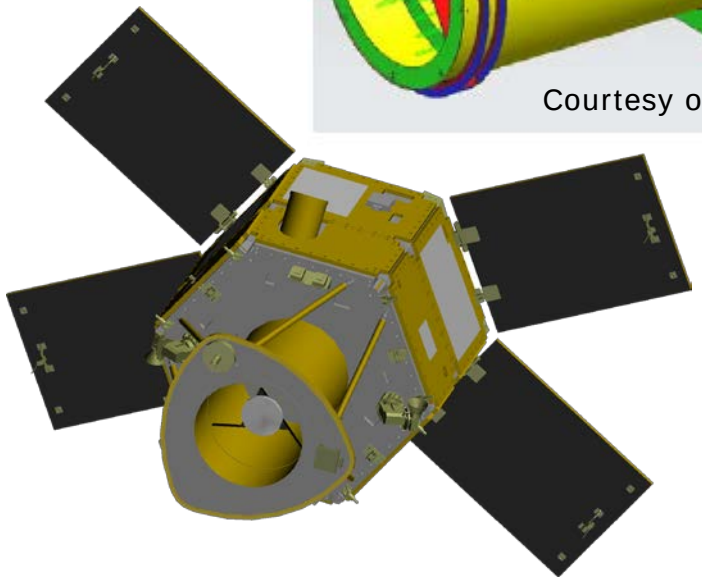
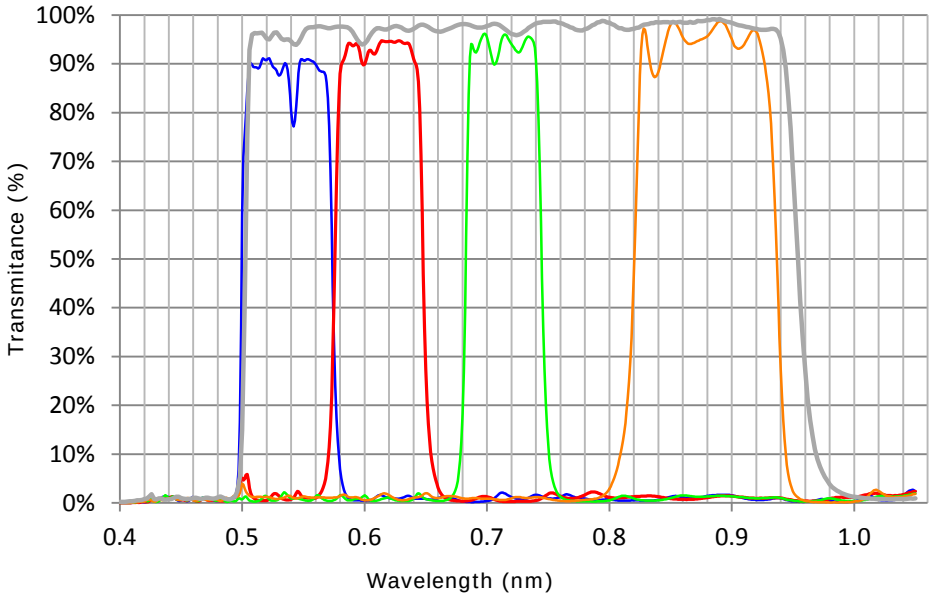
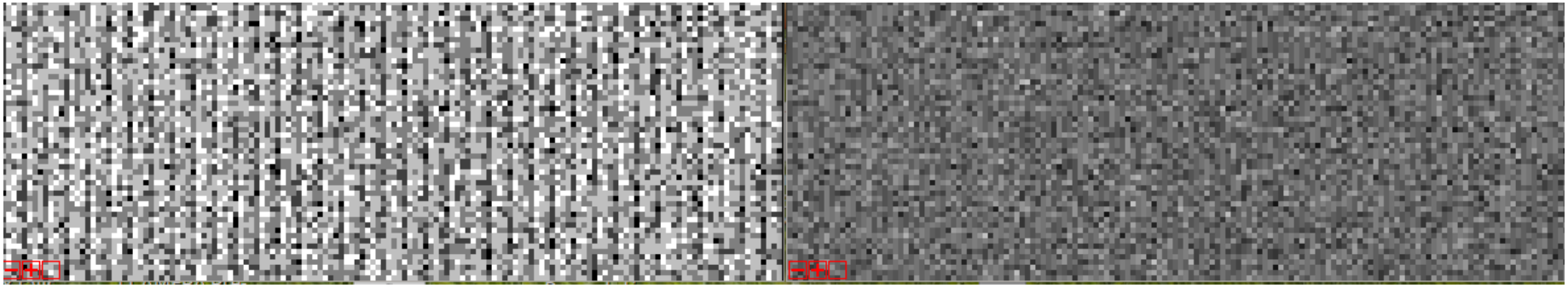


2 Deimos-2 radiometric characterization and calibration

Deimos-2 pre-launch radiometric characterization

- Spectral transmissivity profiles
- Dark Signal
- Pixel response non uniformity
- Signal-to-noise ratio
- Pixel saturation levels
- MTF

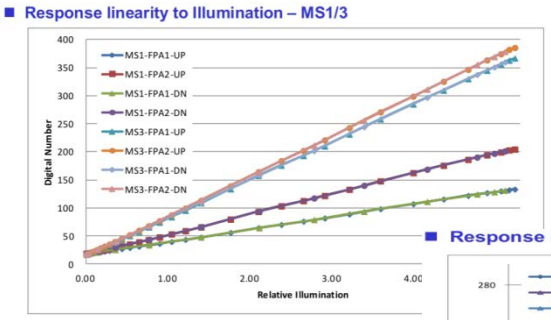


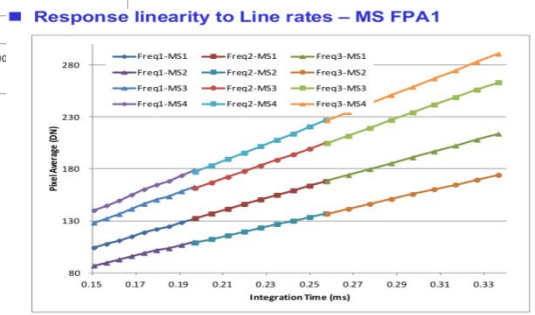


PRNU correction. PAN band

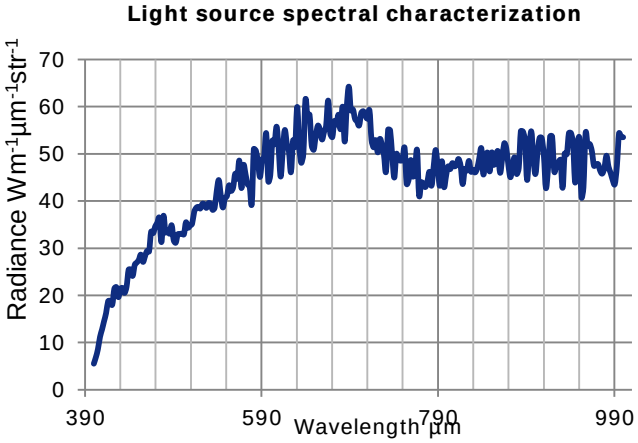
Deimos-2 pre-launch radiometric characterization

- PRNU correction requires measurements in different conditions. Relative scale
  - Illumination
  - TDI mode
  - Line rate
  - Gain





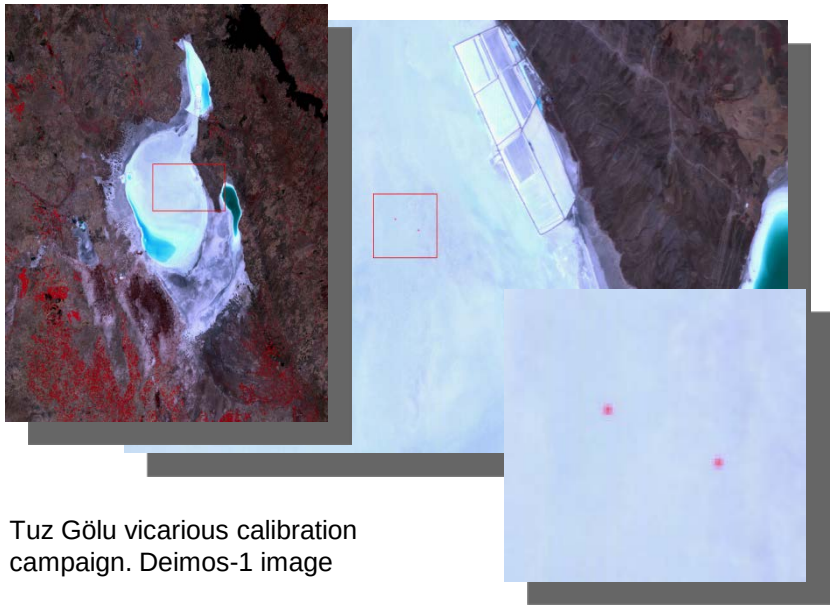
- Absolute characterization
  1. Light source characterization
  2. Correct PRNU
  3. Analyze system behavior
  4. Radiometry in absolute scale



Deimos-2 post-launch calibration

- Follow CEOS CAL/VAL recommendations and sites
- PRNU measurements and sensor trending using uniform and high reflectivity Pseudo Invariant Calibration Sites (PICS)
  - Dome-C close to winter solstice
  - Greenland close to summer solstice
  - Dark signal measurements using night images over the north pacific, where light sources (natural or anthropogenic) are unlikely.
- Absolute calibration will be achieved through vicarious measurements

Deimos-1 image of Libya-4



Tuz Gölu vicarious calibration campaign. Deimos-1 image

3 Cross-calibration with Dubaisat-2

Cross calibration with Dubaisat-2

Dubaisat-2

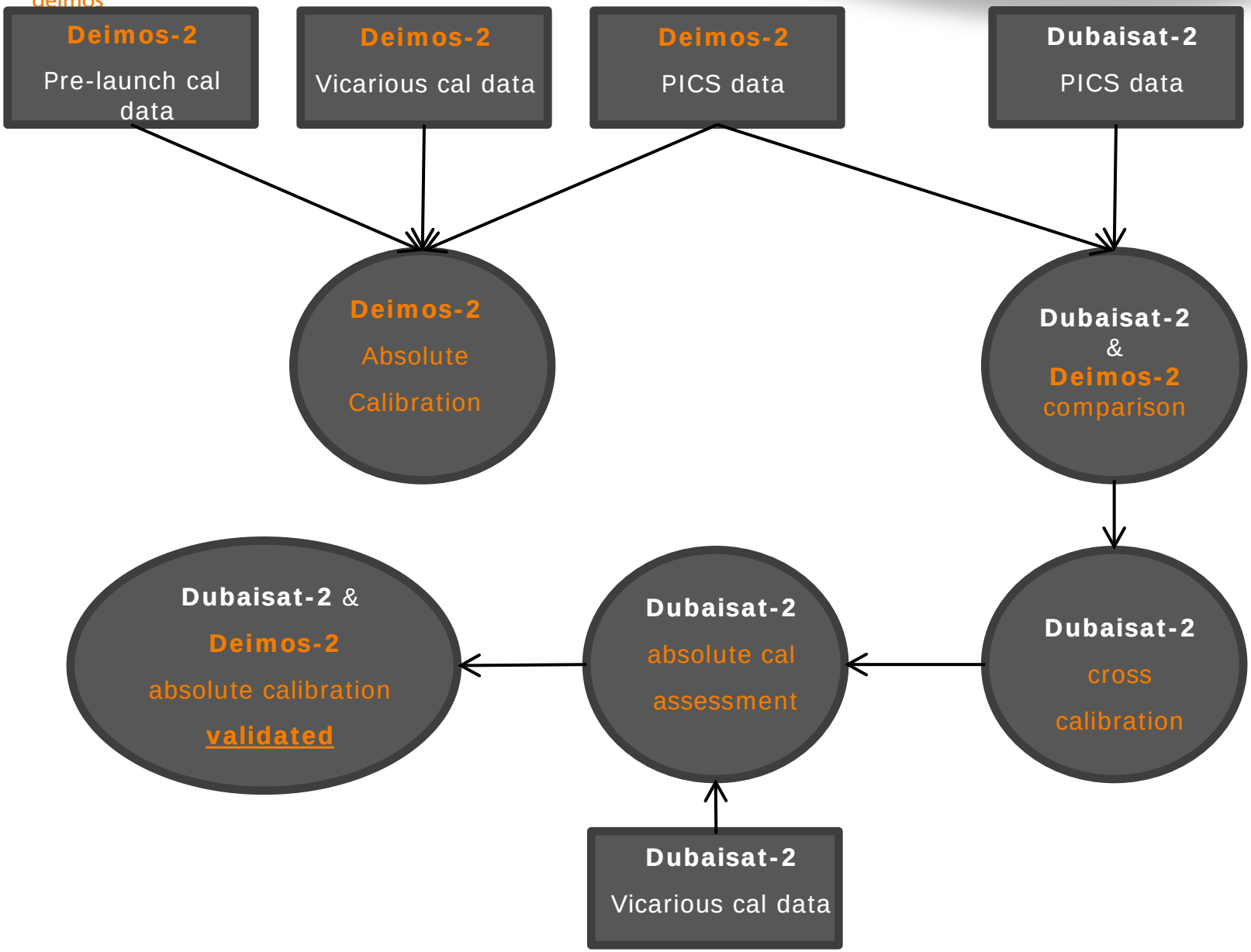
- Developed by EIAST, the Emirates Institution for Advanced Science and Technology (United Arab Emirates) and Satrec Initiative (South Korea)
- Dubaisat-2 is an almost exact Deimos-2 twin
- Owned and operated by EIAST
- Launched in November 2013
- Currently completing its commissioning phase

Cross calibration with Dubaisat-2

Workflow

- Deimos-2 absolutely calibrated data will be used as reference
- Data acquired on LNES for sensor trending will be used to cross-compare with Dubaisat-2
- Cross calibration coefficients will be generated for Dubaisat-2 based on the data comparison
- Vicarious validation campaign for the absolute calibrated Dubaisat-2
- If the validation campaign is successful, both sensors will be considered absolutely calibrated and validated

Cross calibration with Dubaisat-2



4 The calval4EO Suite

- **ELECNOR DEIMOS' Ground Segments** for optical Earth Observation missions, including DEIMOS-2 Ground Segment, are based on the new **gs4EO®** suite of products

- **State-of-the-art products** , the result of more than a decade of work for the European Space Agency, especially evolved for supporting small Earth Observation missions

- Designed to work together, but can also be used as independent applications

- ELECNOR DEIMOS is reusing many of them in on-going projects for ESA and the Spanish government, as well as in ELECNOR DEIMOS' own DEIMOS-1 mission

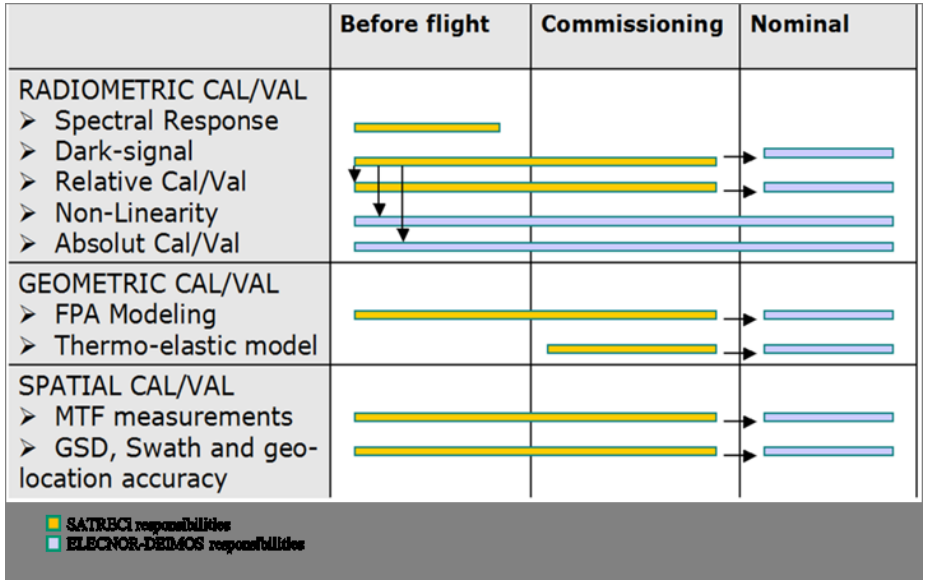
calval4EO
calibration & validation

- Cal/Val operations are the process of updating and validating on-ground configuration parameters to ensure the image data quality requirements

- Calibration Expert Team, which is responsible for the calibration and validation of the instrument products

- Calibration is based on characterization measurements performed on-ground before launch and in-flight

- **calval4EO** will be used during the commissioning and nominal operations



elecnor deimos

calval4EO provides the following services:

calval4EO
calibration & validation

- Systematic extraction of calibration data
- Production of calibration reports, with basic statistical figures and trends
- User interface to allow the operation to view, analyze and export the calibration reports (text and graphics)
- User interface to view and edit the calibration database, in a standard format (XML, NetCDF or similar) with a defined schema
- Toolboxes for updating of the calibration database from images in calibration sites
- Storage, under configuration control, of the calibration database and the calibration reports
- Dissemination of the calibration database and reports, via de Mission Archive and Catalogue.

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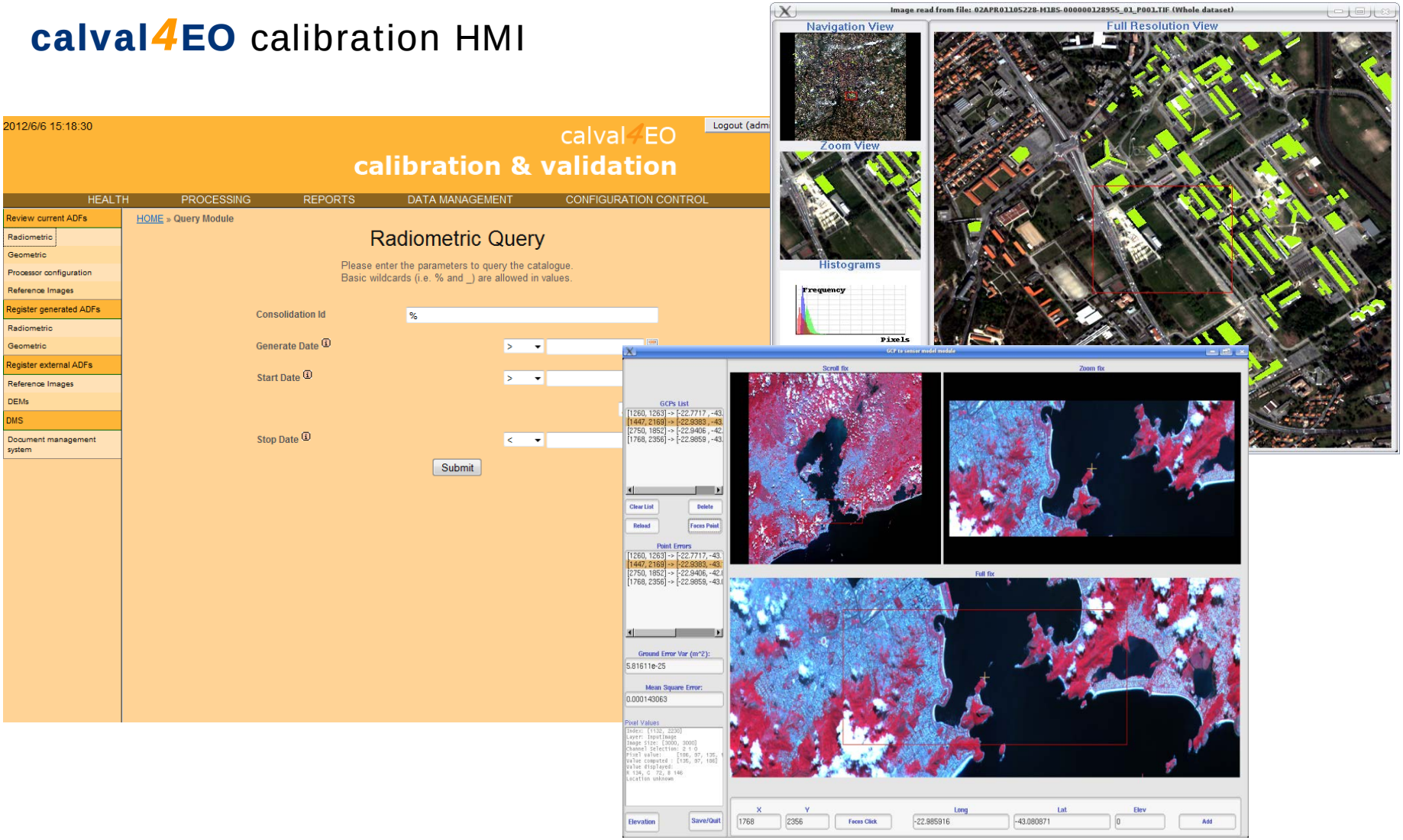
calval4EO calibration HMI



Thank you!

Any questions?

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