

Pre-Launch Calibration Procedures for IR Sensors

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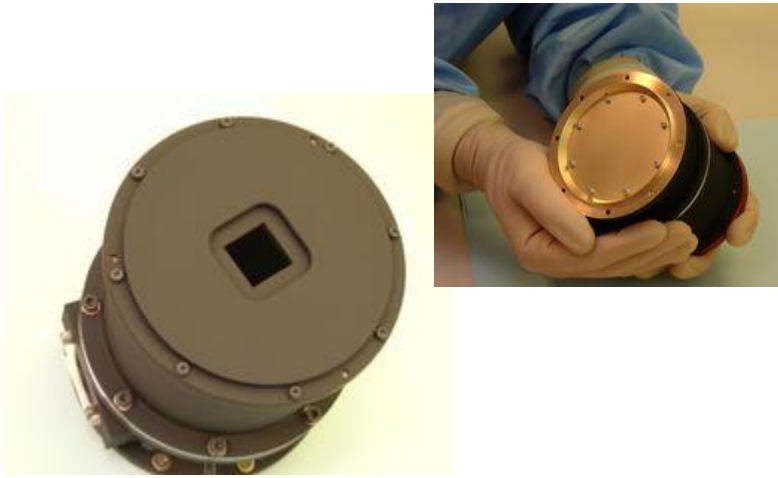
Space Science and Technology Department
Rutherford Appleton Laboratory

Overview

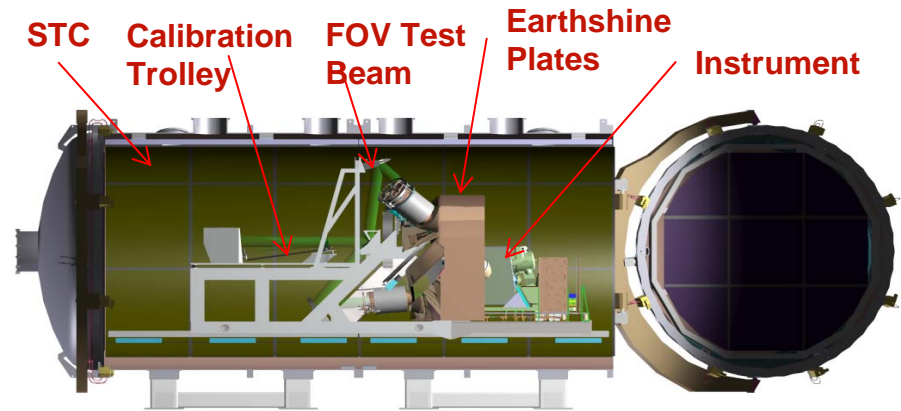
- Motivation
 - SLSTR on Sentinel-3
- Calibration Strategy
 - Radiometric Model
 - Required Measurements
- Pre-Launch Calibration Procedure
 - Calibration Sources
 - Test Configuration
 - Measurement Sequence
 - Data Processing
 - Data Review

Requirements for a Calibrated EO System

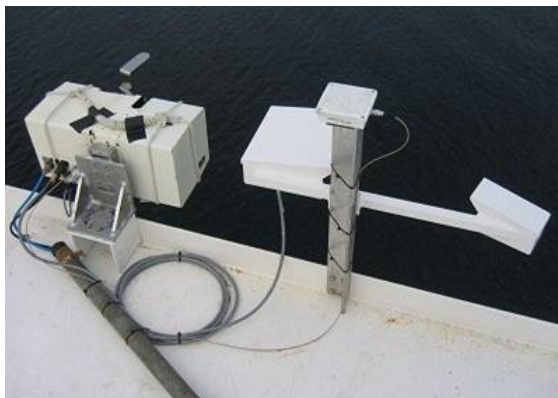
On-Board Calibration Sources



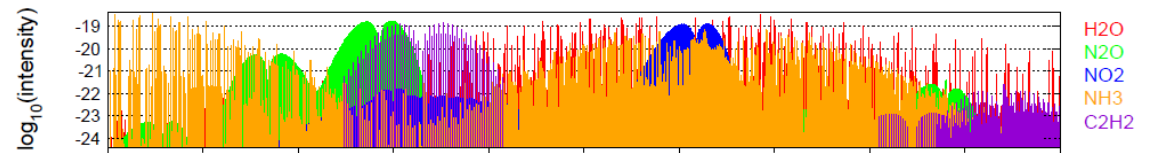
Pre-Launch Calibration



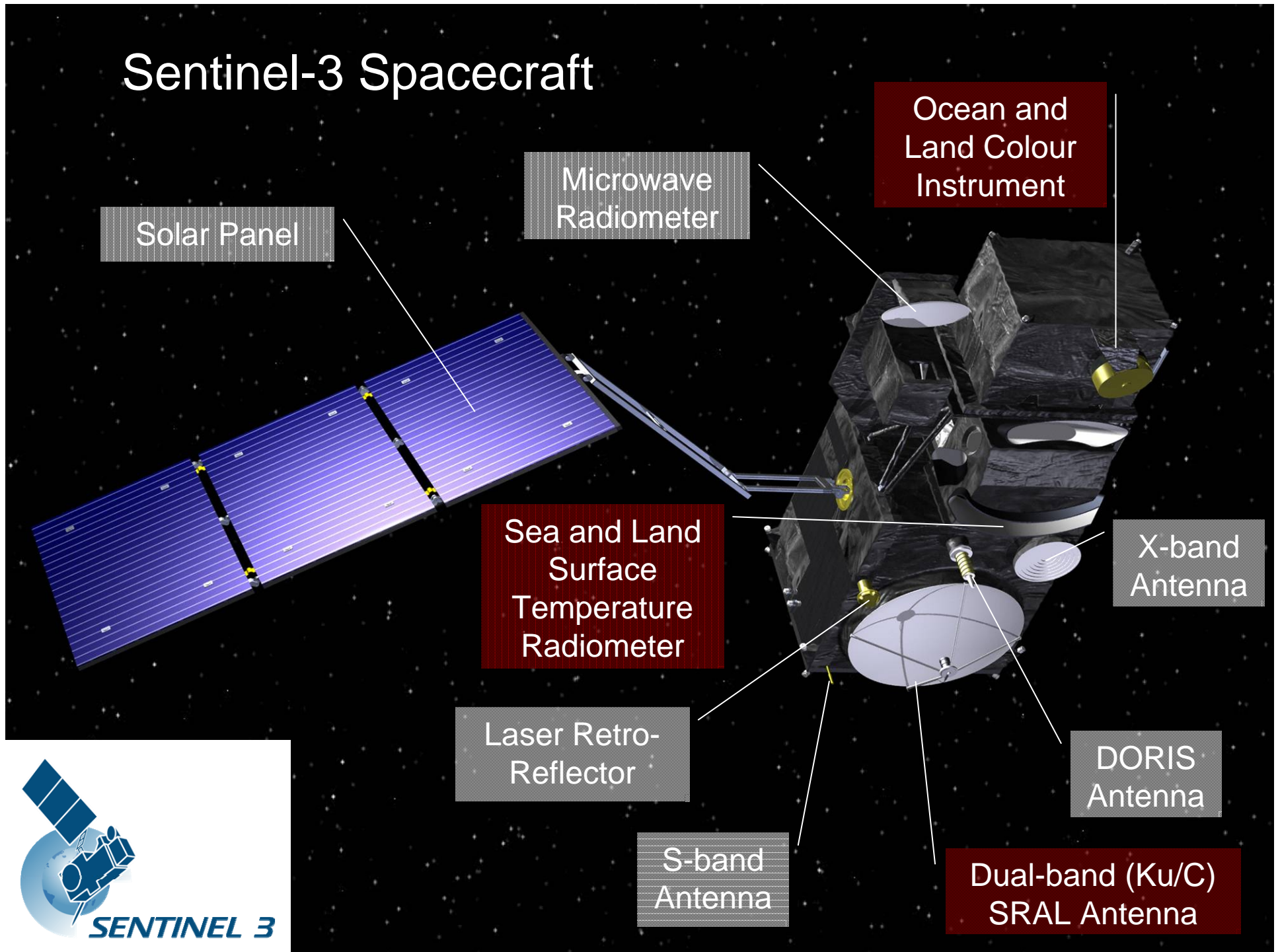
Sustained Post Launch Activities



Theoretical Modelling Radiative Transfer Code

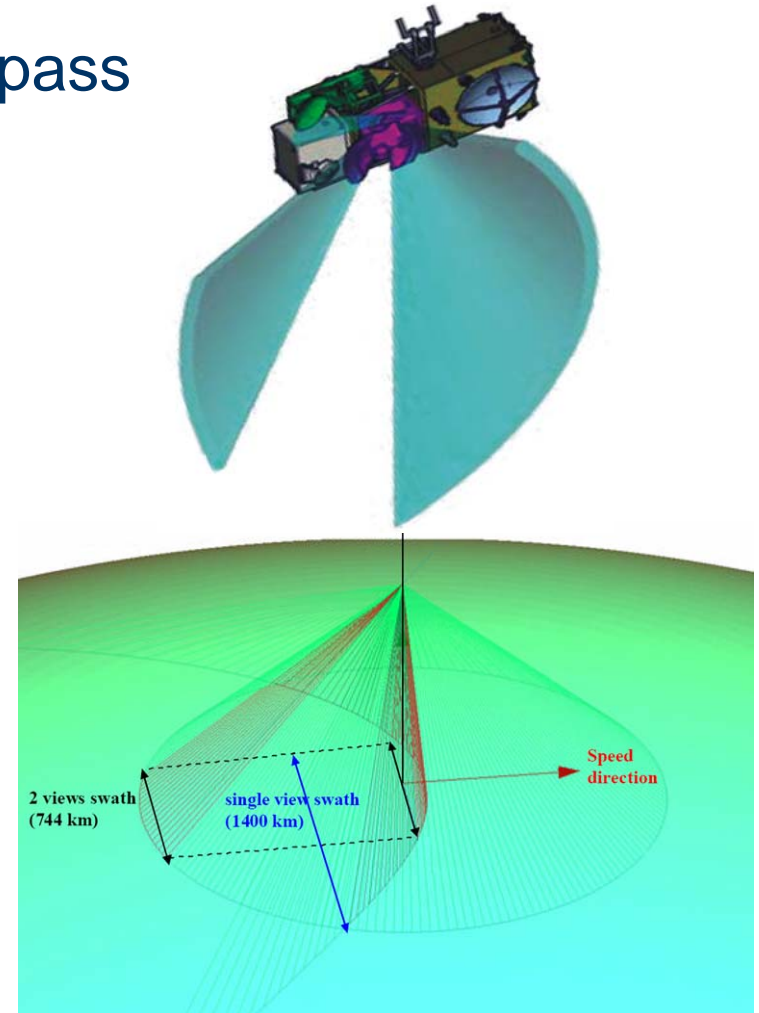


Sentinel-3 Spacecraft

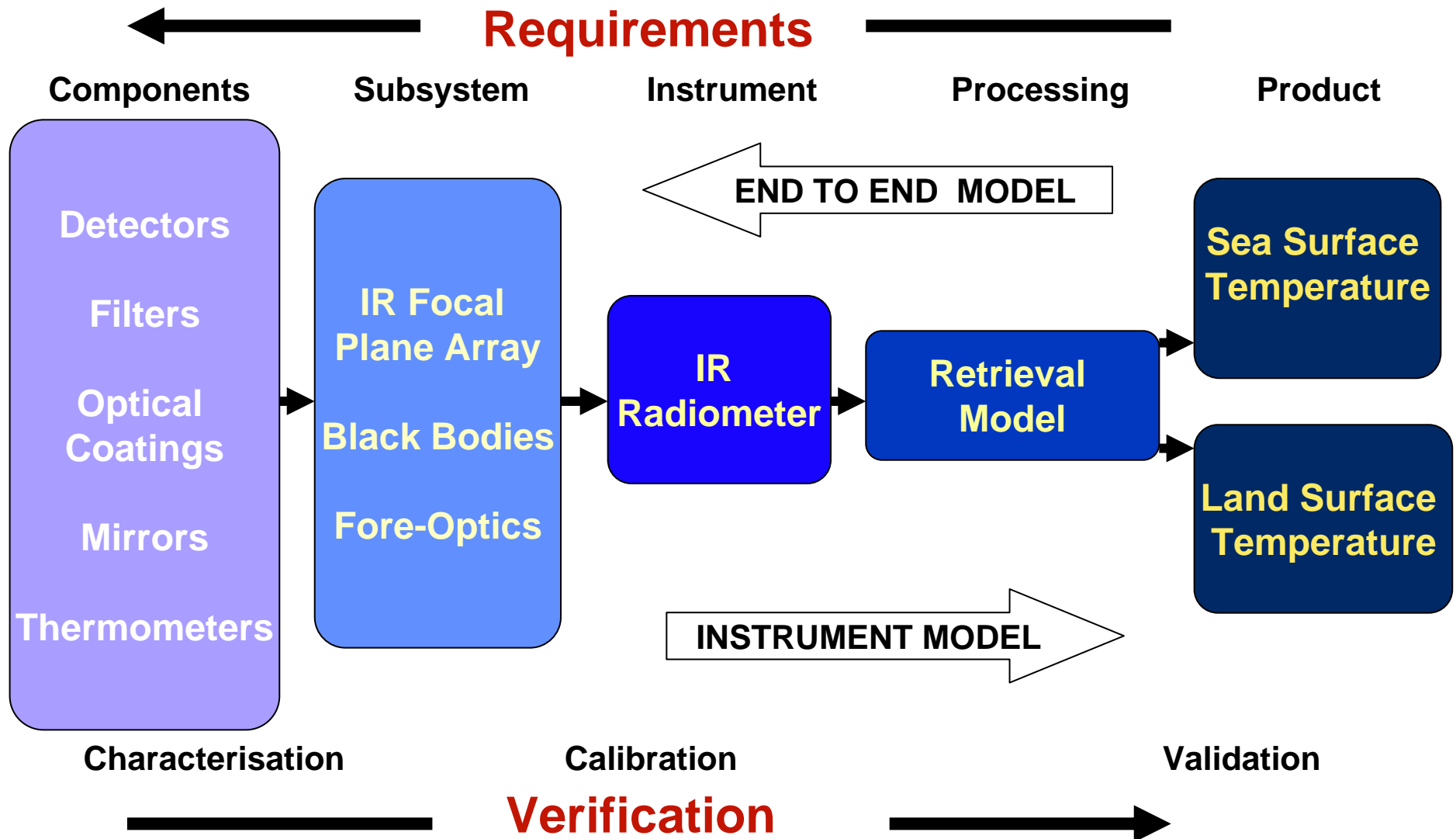


Summary of SLSTR Main Requirements

- Extended Swath for single and double pass
- Spatial Sampling Interval (at Nadir)
 - <1km for TIR channels
 - <500m for solar channels
- Spectral Bands
 - Infrared 1.378, 1.6, 2.25, 3.7, 10.8, 12 μ m
 - Visible 0.55, 0.66 and 0.85 μ m
- Absolute radiometric accuracy
 - 0.2K for IR channels
 - 2% BOL and 5% EOL

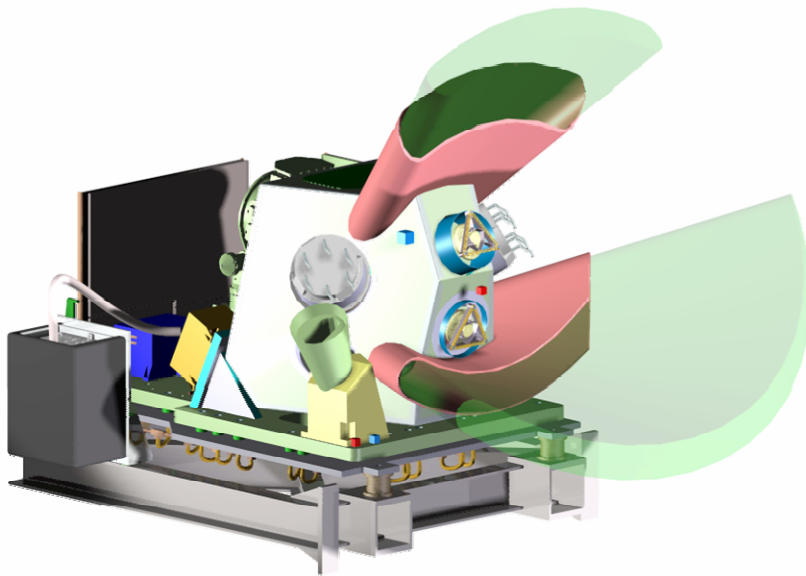


SLSTR Calibration Overview

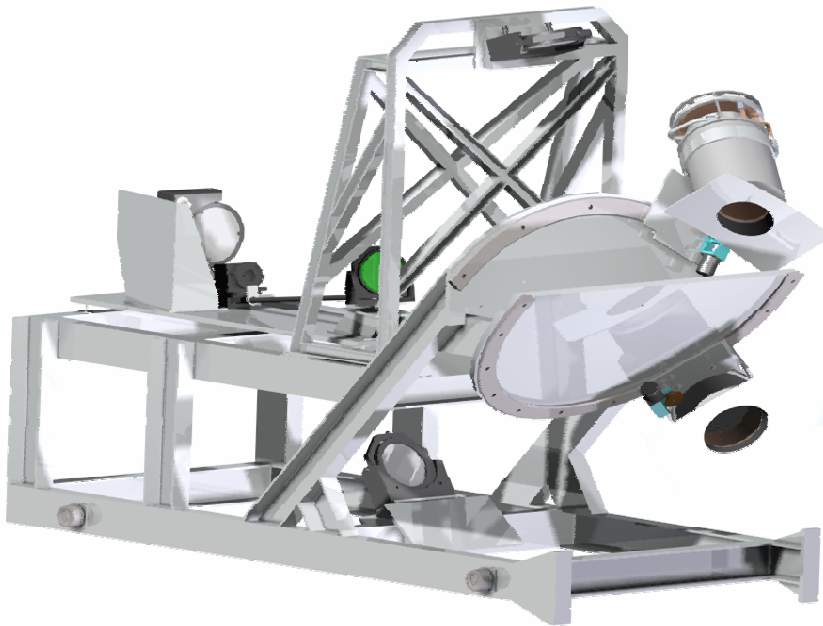


IR Radiometric Calibration – Subsystem Level

- Blackbody emissivity (ϵ_λ)
- Temperature Calibration
 - Blackbodies (T_{bb})
 - Instrument thermometers (T_{back})
- Spectral response
 - IR Focal Plane Array ($R_{\lambda,FPA}$)
 - Optics ($R_{\lambda,OME}$)
- Linearity of IR channels
- Detector noise performance
- Polarisation



IR Radiometric Calibration – Instrument Level



Radiometric calibration for a range of target temperature.

Calibrate around the full instrument field-of-view

Radiometric performance under different thermal conditions.

Radiometric calibration vs. detector temperature.

Calibration with the on-board black-bodies set at different power levels.

Calibration Blackbodies

Standards



ATSR



ATSR-2



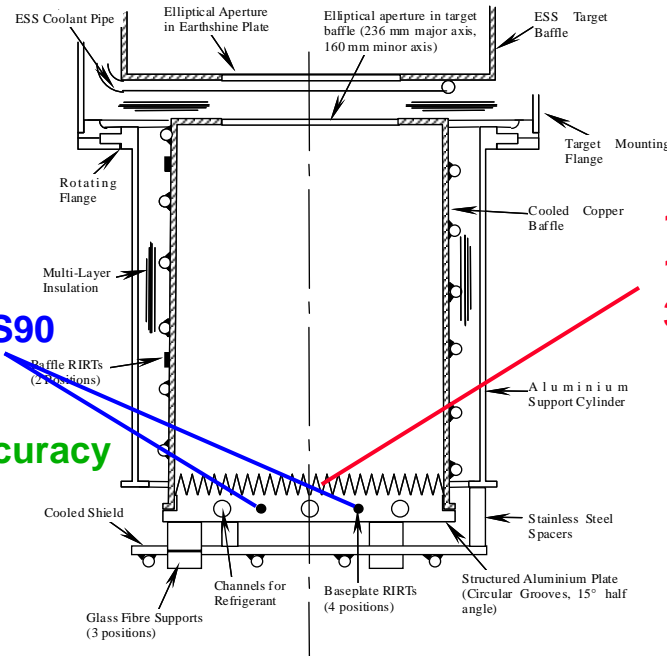
AATSR



GMES SLSTR?

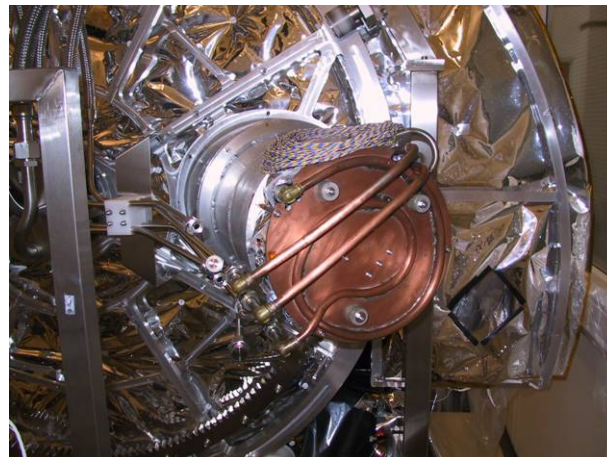
Emissivity
 $12\mu\text{m} = 0.99871$
 $11\mu\text{m} = 0.99870$
 $3.7\mu\text{m} = 0.99911$

Sources
 previously used
 for all ATSR
 instruments

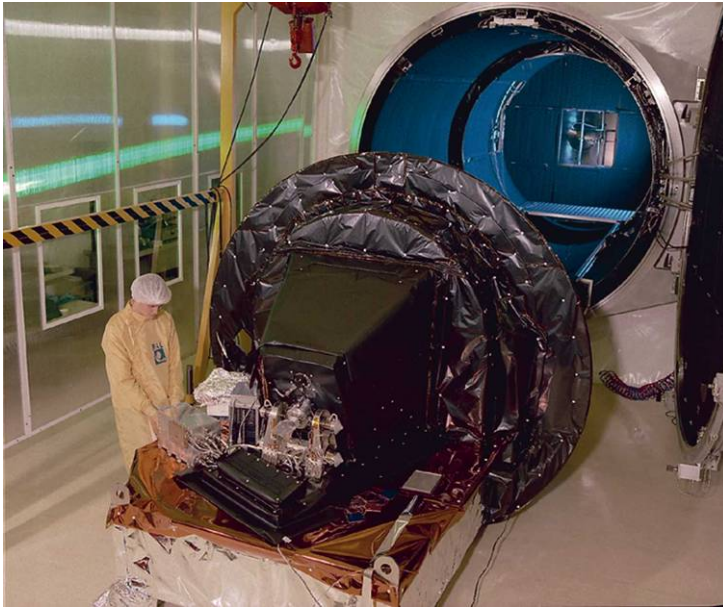


Precision RIRTs
 Calibrated to ITS90
 $< 0.01\text{K}$

Radiometric Accuracy
 $< 0.05\text{K}$

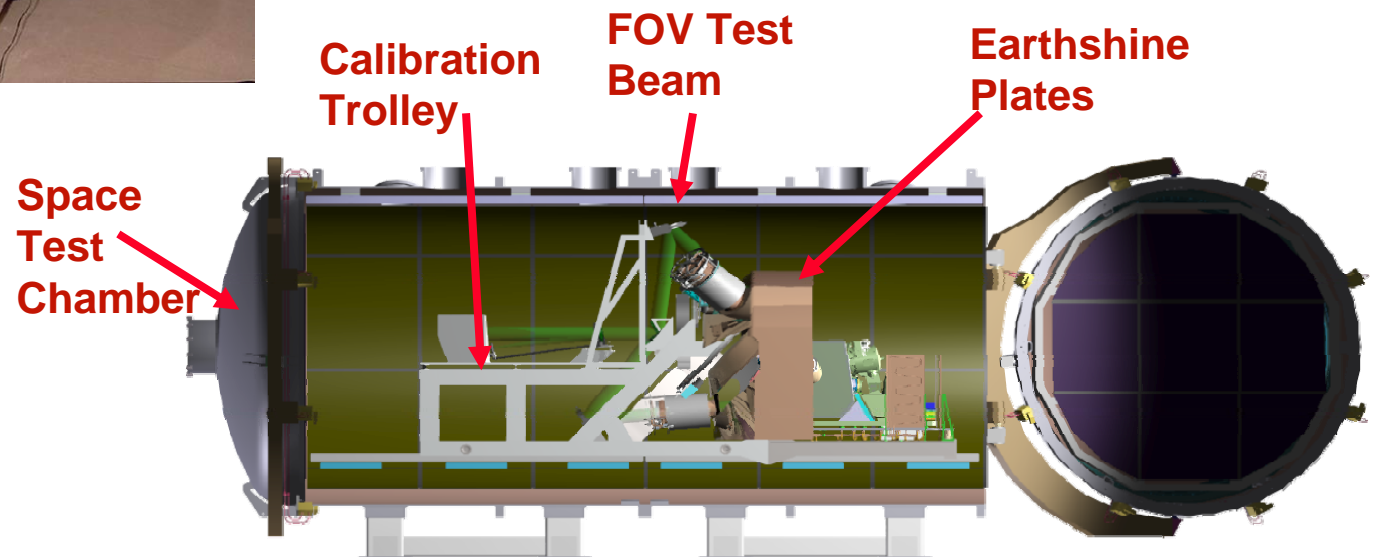


Calibration Test Configuration



Measurements must be performed under flight representative conditions.

- Thermal balance
- Steady State
- Instrument fully operational



IR Measurement Sequence

Passed all required environmental conditions



Set External Blackbody Temperatures



Allow blackbody temperatures to stabilise



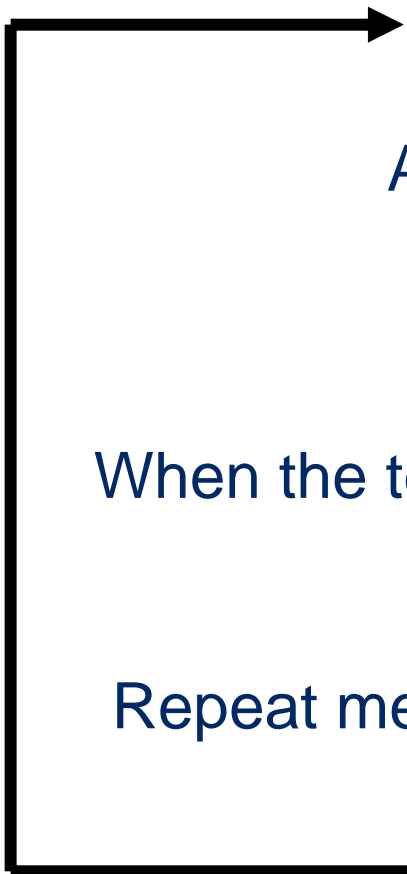
Move Blackbody to Required Position



When the temperature stability criteria have been met process data to confirm measurements are valid.



Repeat measurement for each Set Point Temperature and/or blackbody position



Data Analysis

Procedure for processing and quality checking the data.

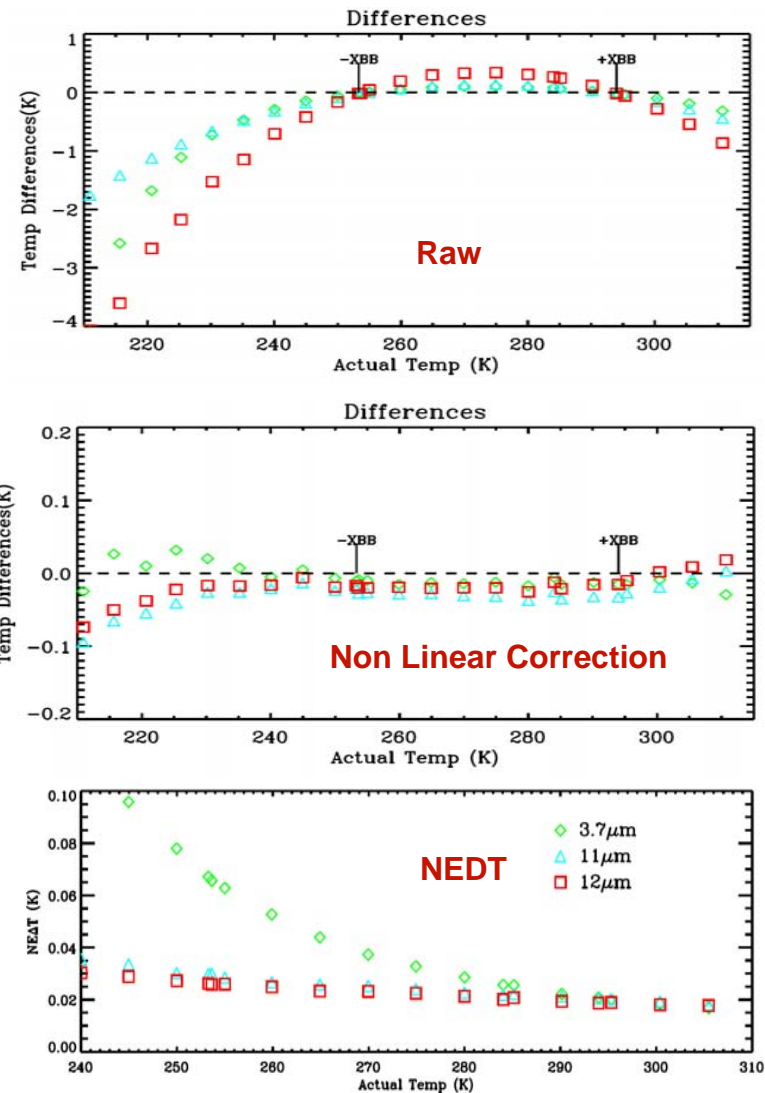
Source Packet Data Conditioning

- Time stamp
- Processed to engineering units
- Error check
- Instrument stability check

Data Analysis

- Apply flight calibration algorithms

SAVE Processed and RAW DATA!

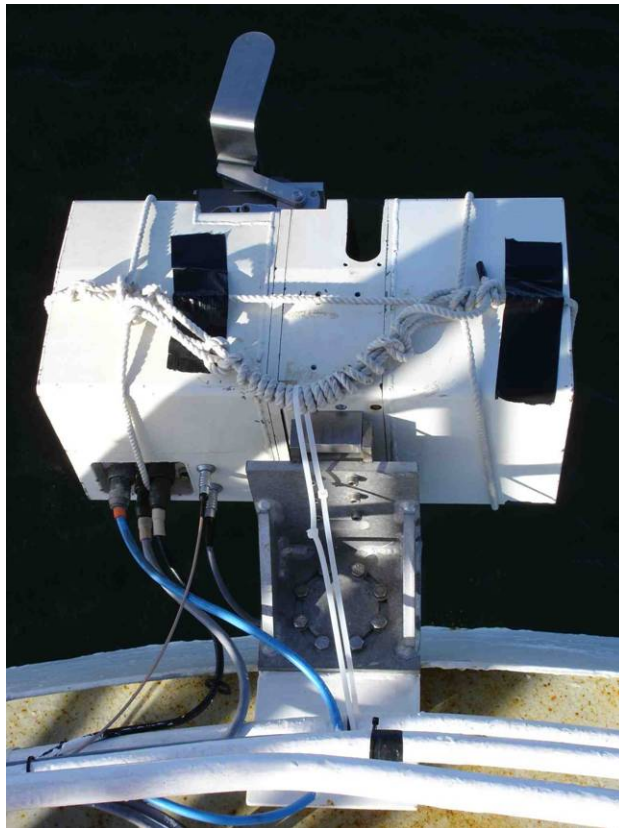


Conclusions

- Any EO instrument must be designed so that it can be calibrated
- The calibration strategy should be based on existing best practice procedures used for previous and/or similar instruments.
- An IR sensor calibration plan must be formulated well advanced of calibration campaign.
- IR calibration procedure is proposed as a recommended QA4EO best practice procedure

Sustained Post Launch Activities

The Scanning Infrared Sea-surface Temperature Radiometer (SISTeR)



- Chopped, self-calibrating filter radiometer.
- Internal hot and cold black body targets.
- Black body thermometer calibrations traceable to ITS-90
- Accuracy ~ 30mK.
- Noise (0.8s sample) ~ 30mK.
- GPS time stamps (and position)
- Fully programmable with measurement cycles ~ 1 minute.