The SCA Instrument Onboard MetOp Second Generation

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Agenda

1. SCA Measurement Principle and Ocean Backscatter
   (slides 3-4)
2. Instrument Requirements, Design, Calibration and Performance
   (slides 5-11)
3. Industrial Setup and Progress
   (slide 12)

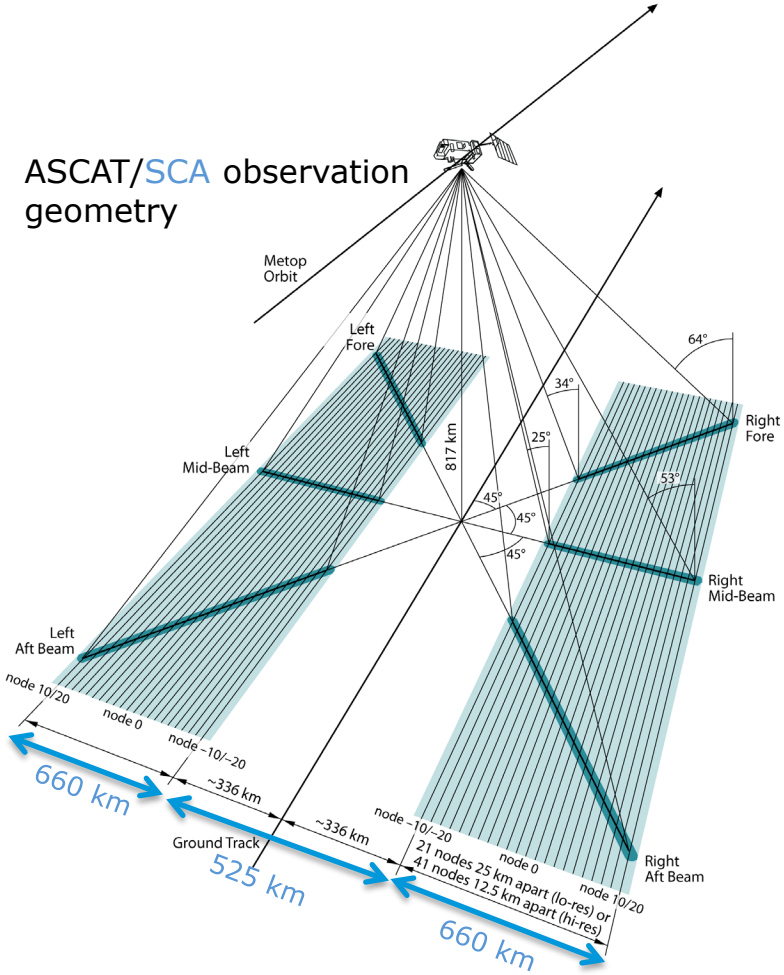
SCA at a glance

SCA is a real aperture radar measuring the sea/land backscatter (NRCS) along two parallel sub-satellite swaths. In each swath the backscatter is measured at three separate azimuth look angles using separate fan-beam antennas illuminating and receiving from across the swath.

- Key figures (including margins)
  - Mass PEB: 138kg < 150kg
  - Mass NDR: 612kg < 620kg
  - Power: 458W < 500W
  - Data rate: 11.7Mbps < 12.0 Mbps

- Antenna lengths/width (limits)
  - Side: 3.100 m / 0.315 m.
  - Mid: 2.760 m / 0.315 m

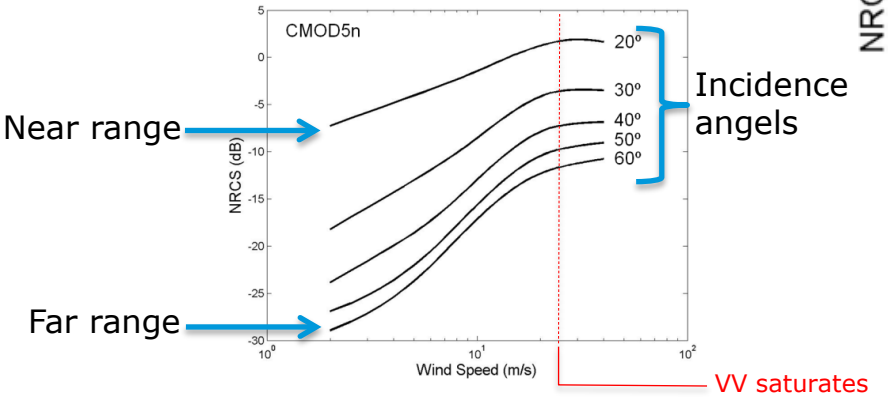
ASCAT/SCA observation geometry

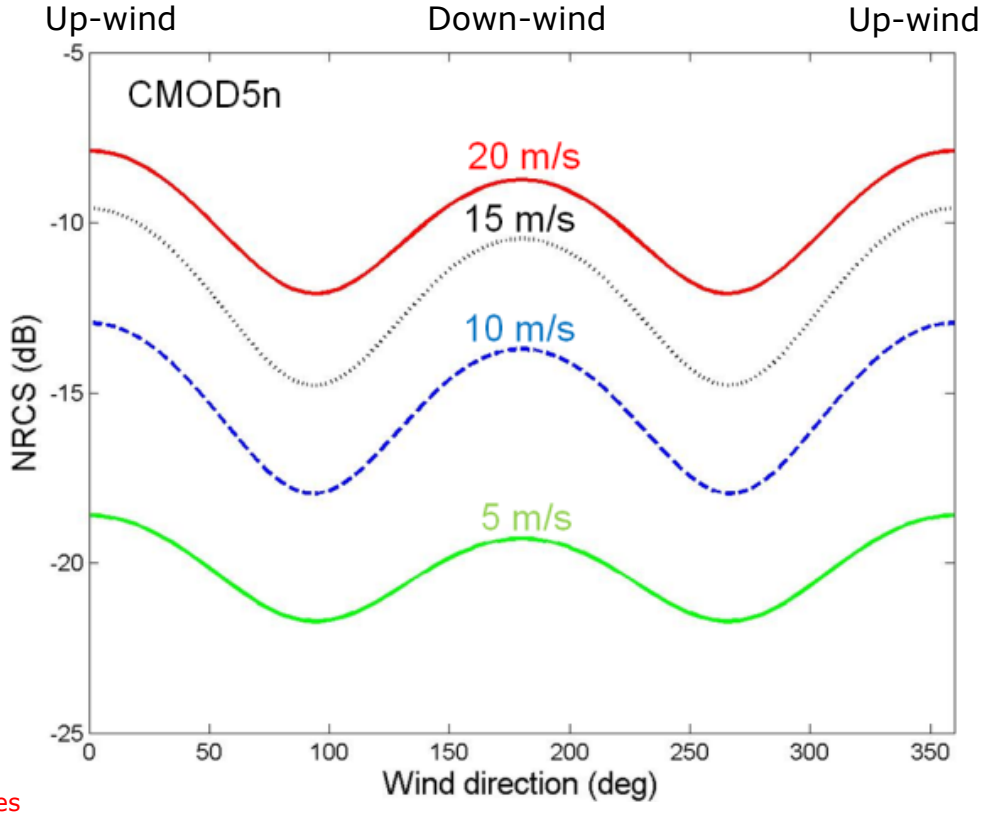


Ocean backscatter dependencies

NRCS or σ^0 [dBm^2/m^2]:

- Wind speed at 10m ASL (U10)
- Wind direction
- Incidence angle, measured from local surface normal vector
- Polarisation (VV, HH and VH/HV)
- Carrier frequency or wavelength



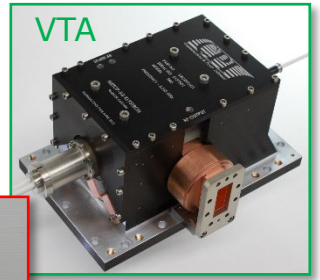


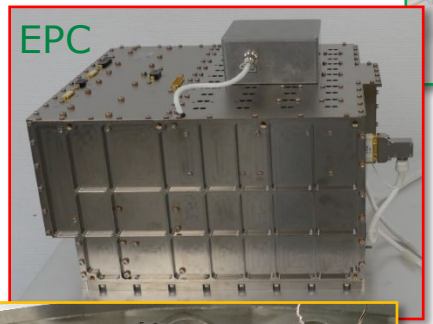
SCA main requirements

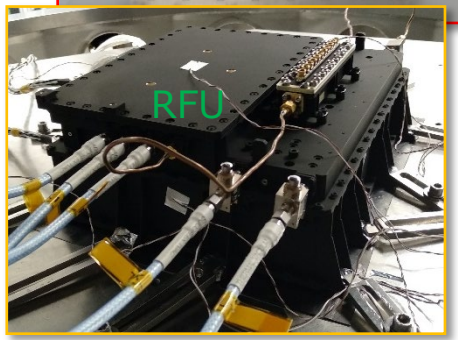
Polarisation	VV, HH and HV/VH
Swath width (full performance)	2 * 645 km
Radiometric resolution (Kp) A 24 shots cycle is applied serving all polarization combinations (VV, HH and HV/VH)	 <3% (VV) <4.25% (HH and HV/VH)
Radiometric stability Over orbit and lifetime	0.1 dB (1σ)
Radiometric bias	0.35 dBpp
Nominal spatial resolution	25 km
Geo-location of Level 1B product	< 1 km

SES

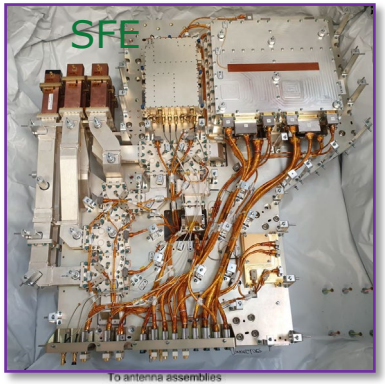
- High power amplification



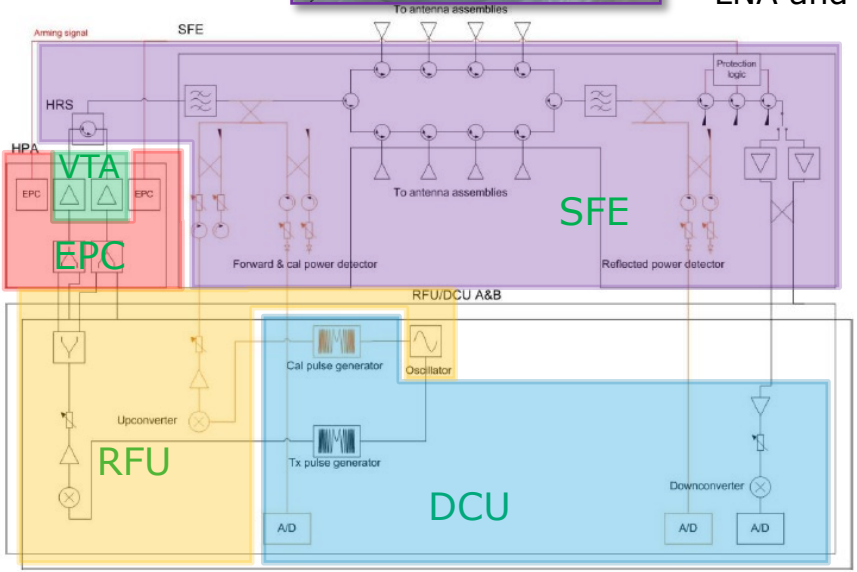




- Stable oscillator
- Up-conversion and amplification



- High Power Redundancy Switch
- Harmonic filter
- Invar calibration coupler
- Ferrite Switch Matrix
- Temperature controlled ferrite magnetisation
- Rx band pass filtering
- LNA protection
- LNA and down conversion



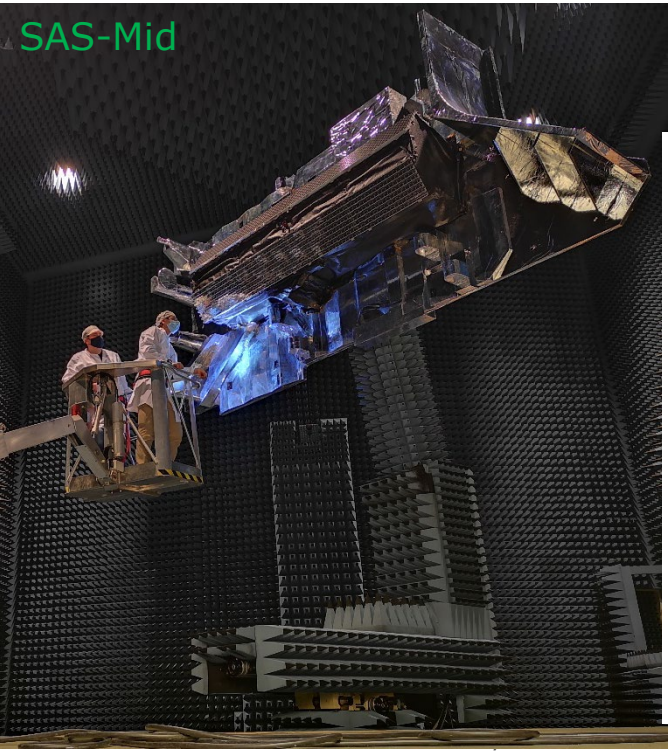
- Digital IQ Chirp generation
- SCA PRI control
- Control of internal calibration loop
- Digital IQ de-modulation

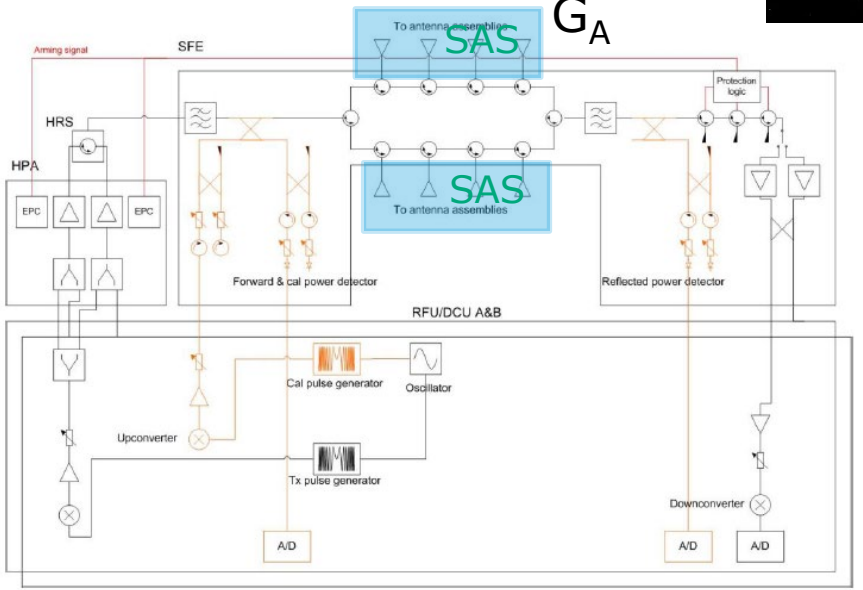
SAS

- All aluminium radiating panels and support structure
- True time delay (bar-line and radiating WGs)

SAS-HDRM SAS-DLM

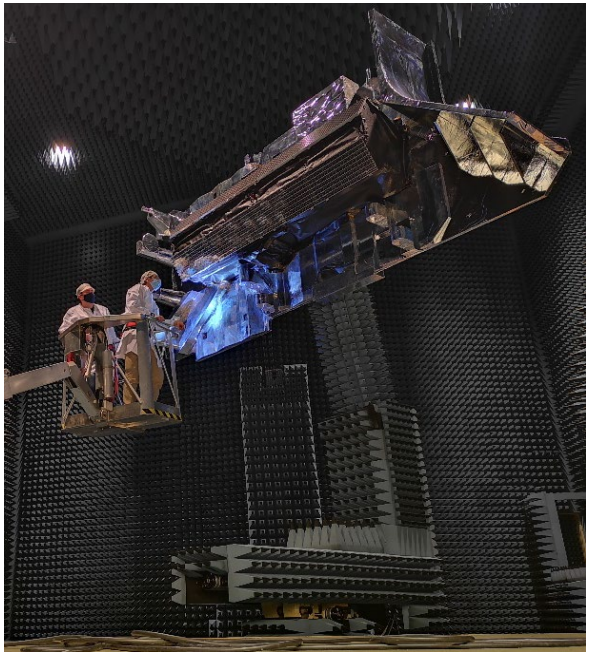
SAS-Mid



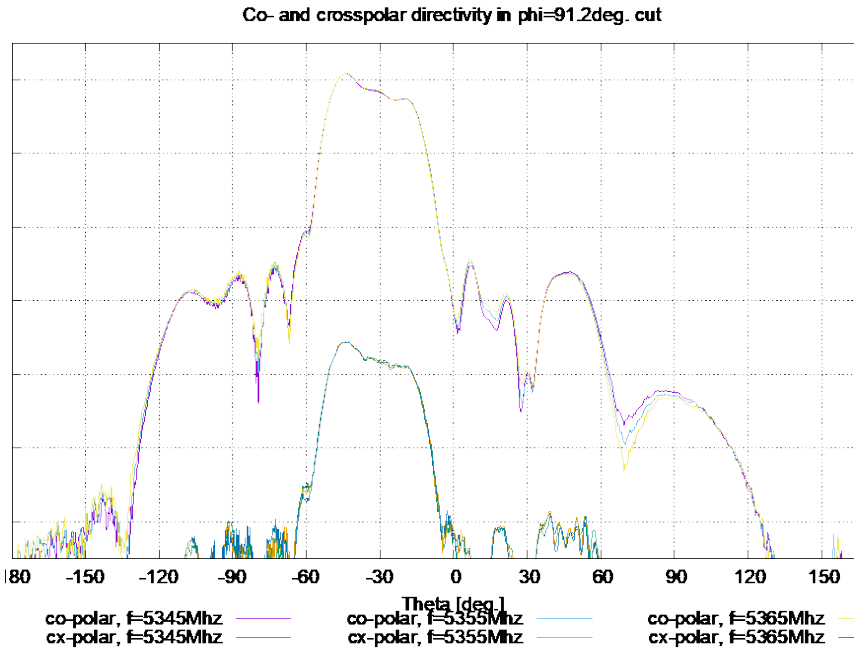


SAS-Side

SAS MID Antenna PFM RF Test: Directivity



TUD Anechoic Chamber



SCA Tx/Rx Phases

Transmit (Tx) Phase:

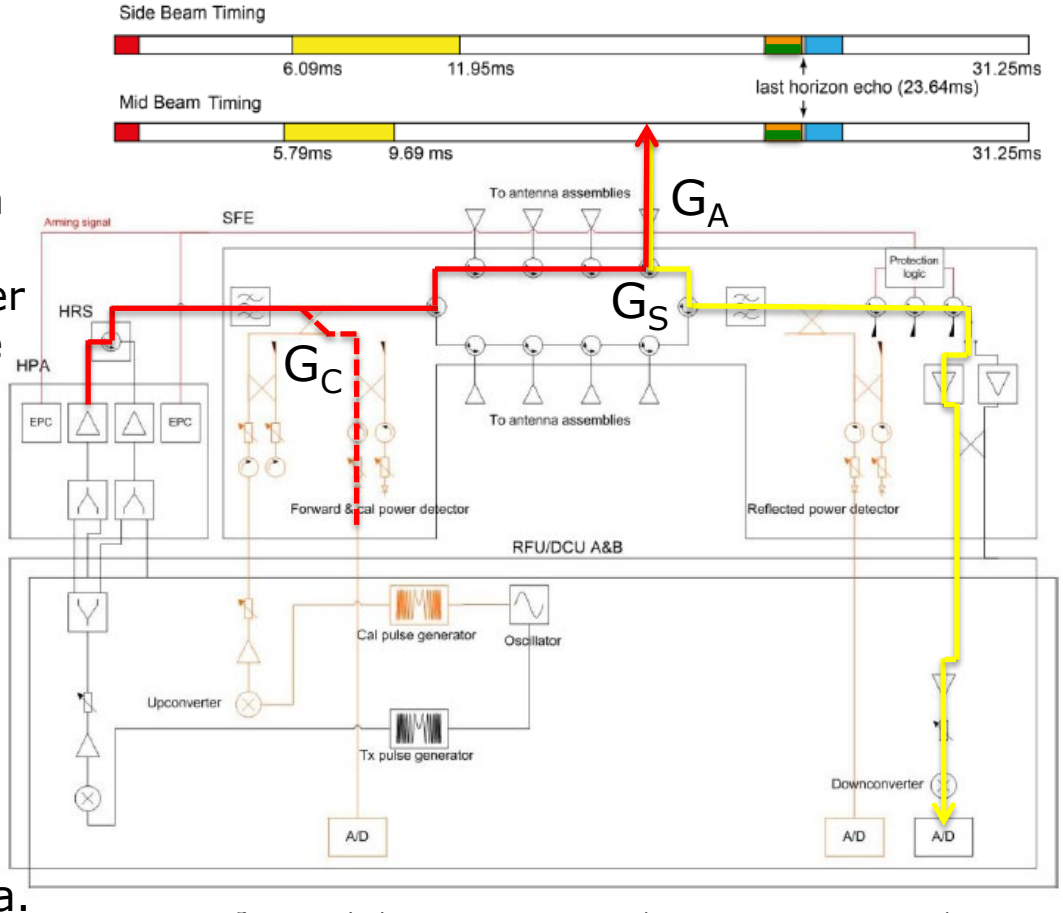
- The power generated in the VTA is guided via the HRS, HFIL and ferrite switch matrix to the selected antenna (and polarization).
- Simultaneously, the calibration coupler guides a small fraction (-72dB) to the forward power detector.

Receive (Rx) Phase:

- The echo power received by the selected antenna (and polarization) is guided via the ferrite switch matrix to the receiver.

Tx and Rx Phases:

- Note the chirp is guided twice through the switch in closest proximity with the selected antenna.



SCA Calibration

Covered by Internal Calibration:

- Transmitter power (E_F)
- Internal Cal path losses (E_C)
- Receiver gain (E_R)

$$P_{R,cal} = P_R \frac{E_T E_C}{E_R E_F}$$

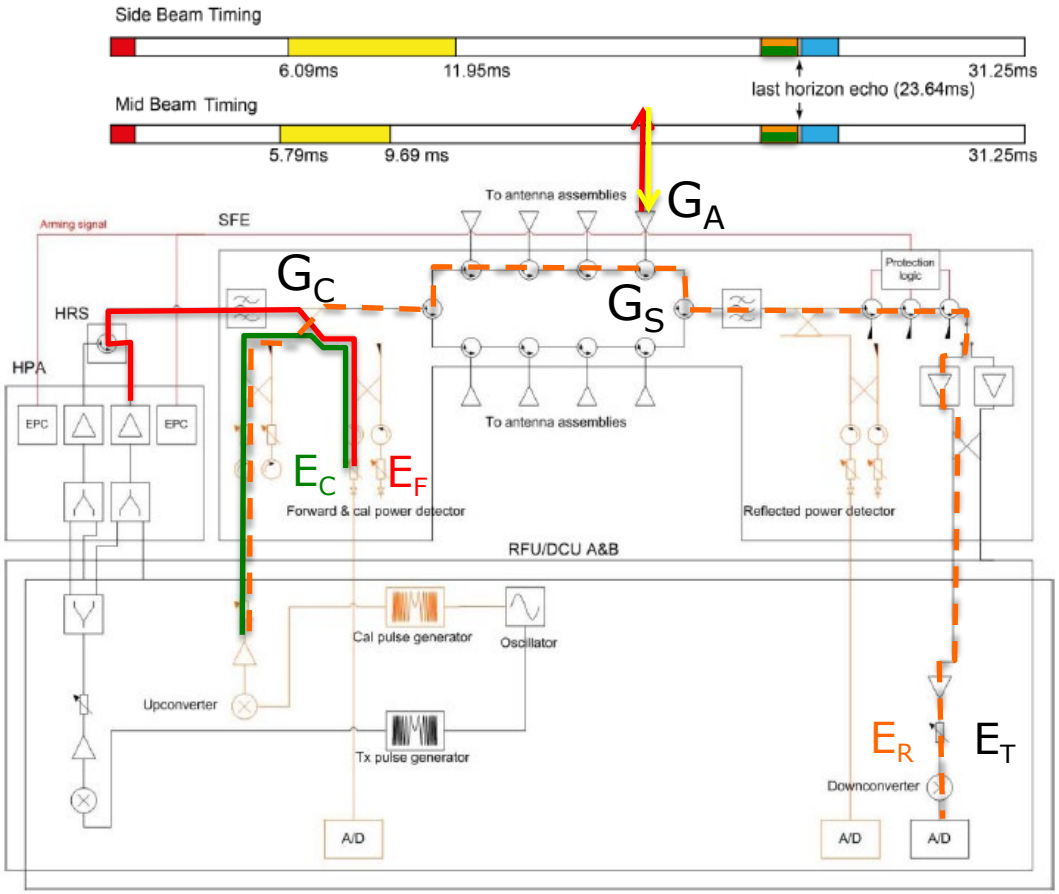
Units outside calibration:

- The antenna – twice (G_A^2)
- Cal Coupler (G_C^2 via E_R and E_F)
- One ferrite switch (G_S)

Absolute Calibration (E_T):

- External Transponders

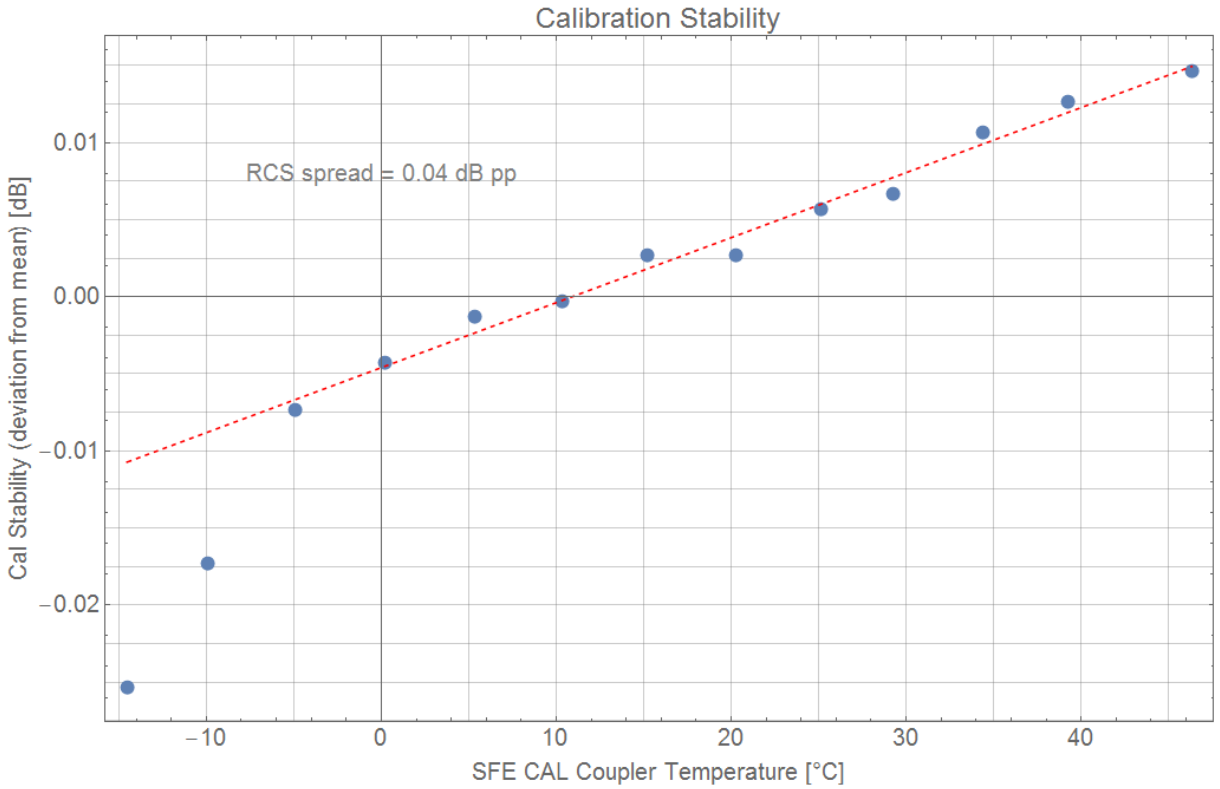
Corrected for Antenna Mismatch



SES EM Thermal RF Test: SCA Stability

Requirement SES-2604:
0.1dB pp

The SCA calibration stability is already compliant and is expected to further improve for the SES PFM due to improved control of the ferrite switch magnetisation currents at cold temperatures.

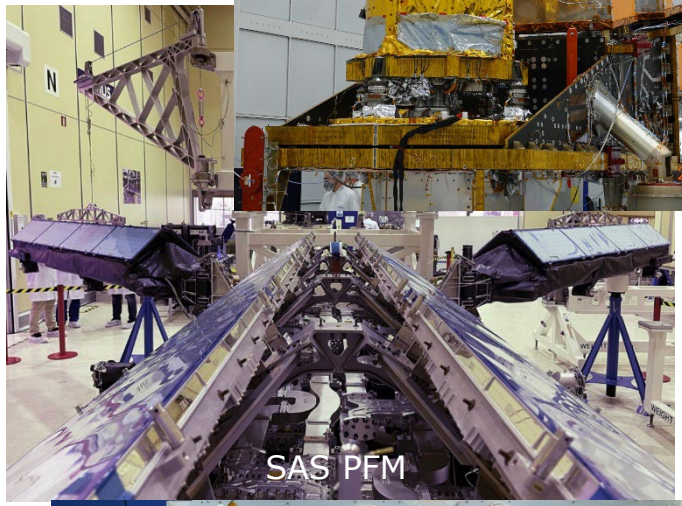


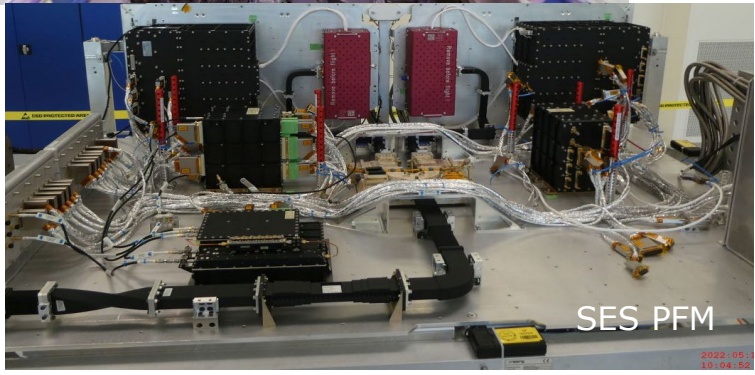
Industrial Progress

SCA PDR (Board Meeting 23.11.2015)
SCA CDR (Board Meeting 18.03.2020)
SCA QR (Board Meeting 30.06.2021)
SES EM Testing (Completed 10.08.2021)
- Functional Test (FT)
- RF Performance (RF) Test
- RF Performance vs. Temperature (RFT) Test
- EMC Test
- SFE ESD Test

SES PFM Integration and Testing
- HW-integration and hybrid testing on-going

SAS STM Testing (Completed 30.07.2020)
SAS PFM Testing (Completed, DRB 06.04.2022)
- MID and SIDE antennas RF Test (RL and patterns)
- TVAC
- Acoustic/Vibration Test
- Deployment Test





Thank you

SCA products

- L0 product consists of complex raw data and noise measurements
- L1a product consists of multi-look detected, calibrated, geo-coded and time-stamped σ_0-values in relevant polarisation combinations VV, HH, VH/HV and noise samples
- The L1b product consists of multi-looked, noise-subtracted, calibrated, geocoded and time-stamped σ_0-values in relevant polarisations
- Both L1a and L1b products include the relevant geometrical parameters, such as local incidence and azimuth view angles and quality flags
- L2 gives directly the wind speed (±1.2 m/s) and direction over the ocean and is key to NWP as it governs the dynamics between the oceans and atmosphere.
- HH improves estimation of soil moisture, snow water equivalent and sea-ice extent and type. VH/HV for U10 > 24m/s.