# The Design and Performance of the SCA Radar carried by the METOP Second Generation Satellites

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# METOP SECOND GENERATION

The space segment employs 2 types of satellite: SAT-A and SAT-B.

There are 3 satellites of each type; each with a lifetime of 7.5 years.
Adjacent satellites of the same type overlap by 6 months in orbit.

First SAT-A launch now scheduled for Middle of 2021.

First SAT-B launch now scheduled for End of 2022.

# THE METOP-SG SATELLITES: SATELLITE-A

SAT-A carries the following payload:

- METIMAGE (Visible & Infra-Red Imager)
- IASI-NG (Infra-Red Sounder)
- MWS (Cross-Track Scanning Microwave Sounder)
- SENTINEL-5 (Ozone and Atmospheric Chemistry Instrument)
- 3MI (Multi-polarisation, Multi-viewing angle, Multi-frequency Imager)
- RO (Radio Occultation Instrument)

# THE METOP-SG SATELLITES: SATELLITE-B

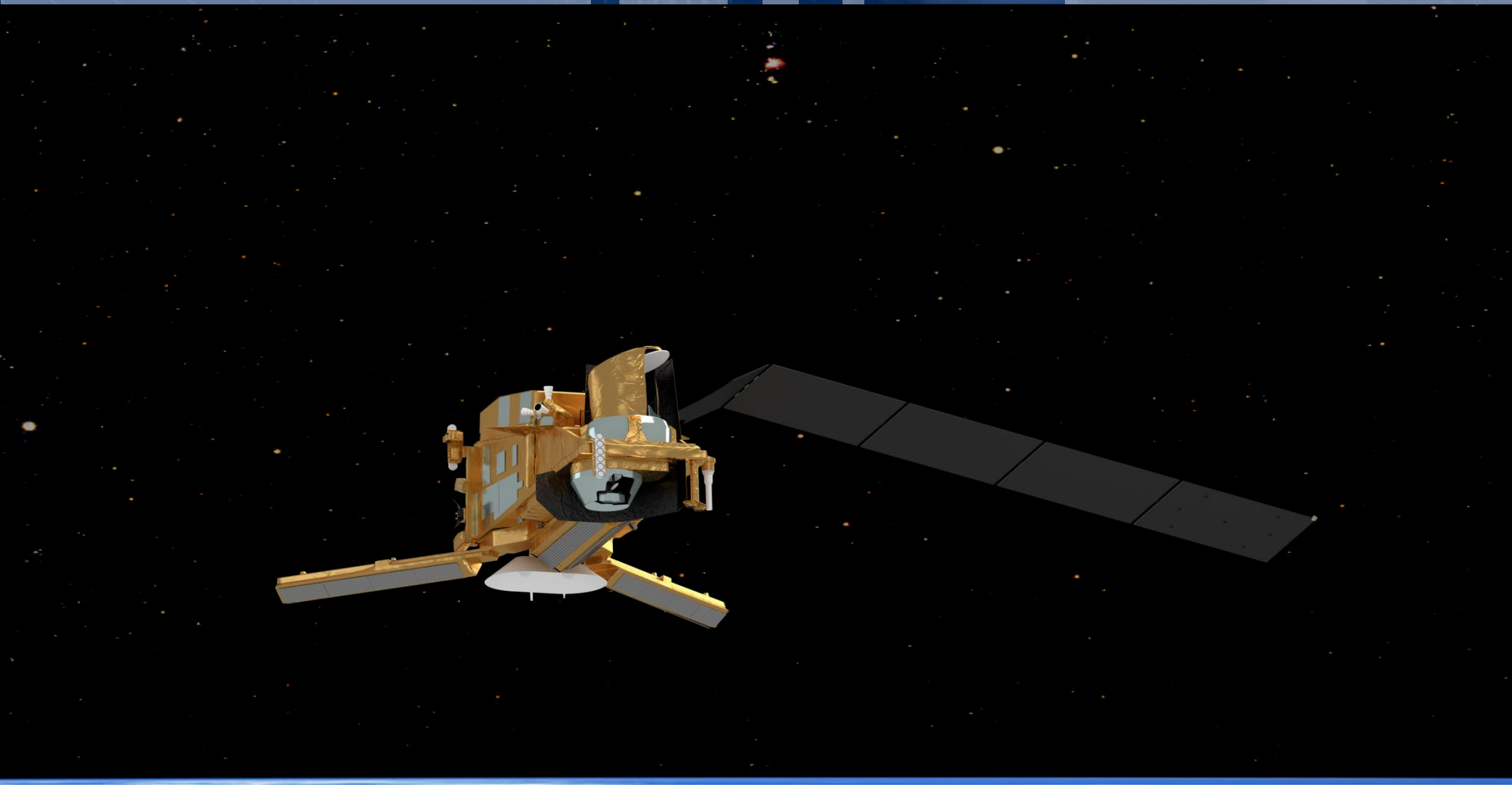
SAT-B carries the following payload:

- SCA (C-band Wind Scatterometer Radar)
- MWI (Conical Scanning Microwave Imager)
- ICI (Conical Scanning Ice Cloud Imager)
- RO (Radio Occultation Instrument)
- A-DCS (ARGOS Data Collection System)

Both satellites also carry:

- Navigation Receiver
- Attitude Control System employing Star Trackers

# METOP SECOND GENERATION: SATELLITE B



# SCA INSTRUMENT

Prime Contractor: AIRBUS-DS/FRIEDRICHSHAFEN

Development Funding: ESA & EUMETSAT

Spatial / Temporal Coverage

Orbits = Metop Orbit Type (Polar, Sun-Synchronous, Descending Node at 09:30 LST)

Ground Track Repeat Cycle = 29 day / 412 orbits. (Approximate 5 day sub-cycle.)

Two SCA Swathes, each of width = 660 km

SCA Radar Carrier Frequency

Frequency = 5.355 GHz

Bandwidth ~ 1 MHz

# SCA RADAR

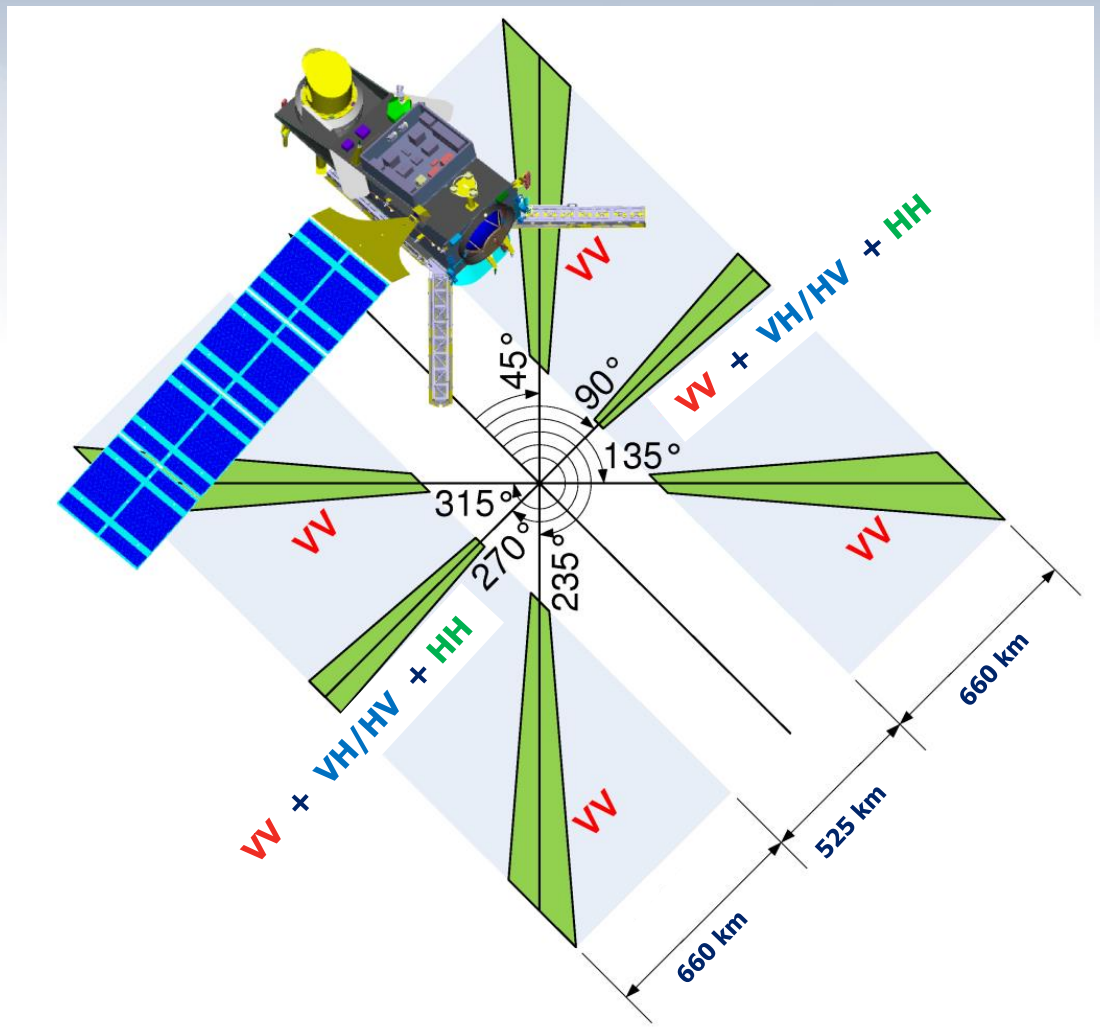
The SCA Radar is real aperture fan beam radar with six beams observing two swaths.

Three beams observe the right swath: 45° forward of broadside, broadside and 45° aft of broadside. Similarly for the left swath.

The fore and aft beams can measure VV for each radar shot.

The mid beams can measure VV, VH, HV or HH for each radar shot.

# SCA SWATH GEOMETRY





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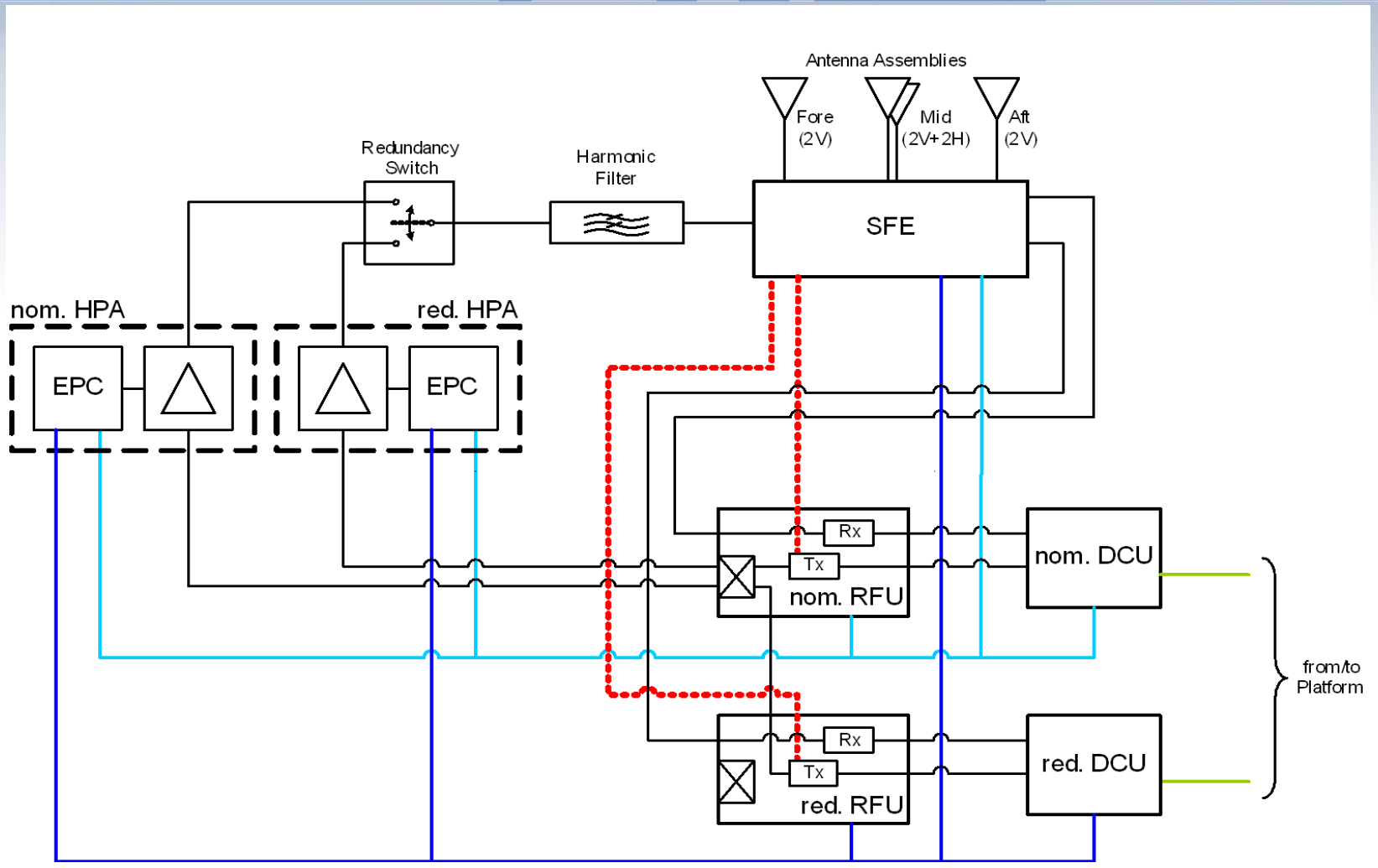
# SCA RADAR BLOCK DIAGRAM





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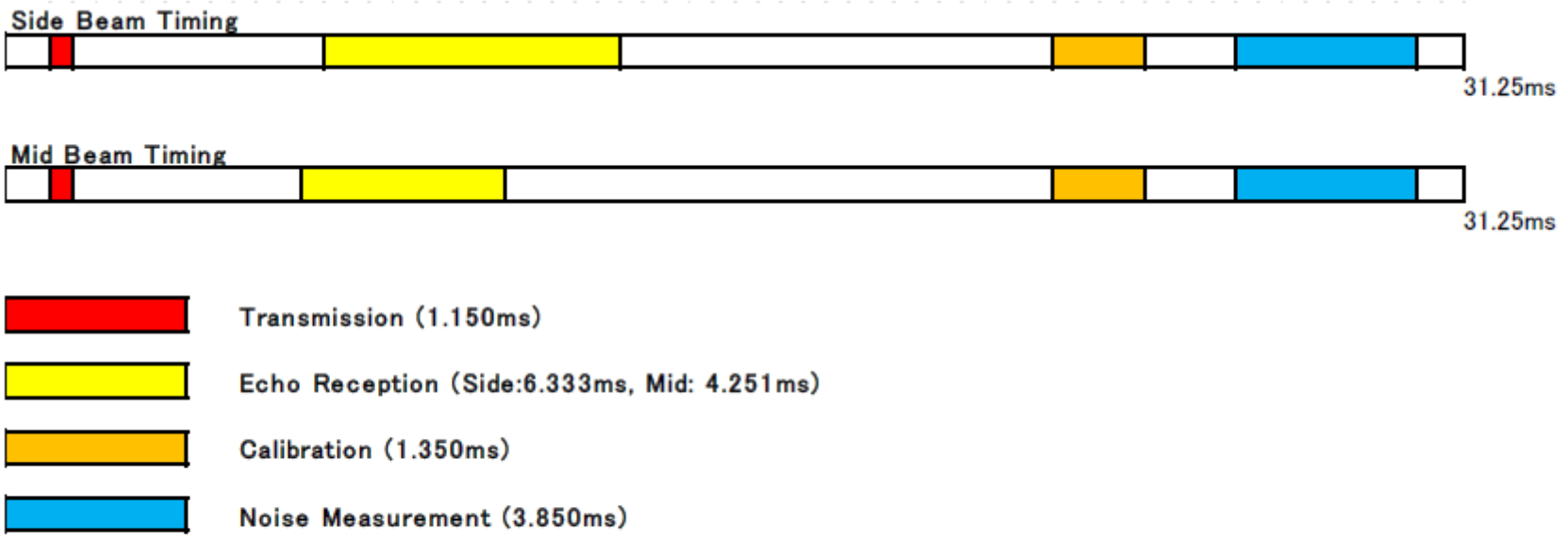
# SCA RADAR PRI TIMELINE

Each SCA Radar PRI contains windows for: TX, RX-Echo, RX-Int/Cal and RX-Noise.

SCA Calibration is performed with transponders. Transponder echoes are delayed such that reception occurs in the RX-Noise window of the PRI.

SCA Calibration does not disturb data collection; this is different from ASCAT.

# SCA RADAR TIMELINE DIAGRAM





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# SCA RADAR SHOT CYCLE: ORIGINALLY ENVISAGED

| OLD ORIGINAL | | |
|---|---|---|
| BEAM | TX | RX |
| Left Fore | V | V |
| Left Mid | V | V |
| Left Mid | V | H |
| Left Aft | V | V |
| Right Fore | V | V |
| Right Mid | V | V |
| Right Mid | V | H |
| Right Aft | V | V |

# SCA RADAR SHOT CYCLE: PRESENT BASELINE

| NOMINAL / BASELINE | | |
|---|---|---|
| BEAM | TX | RX |
| Left Fore | V | V |
| Left Mid | V | V |
| Left Mid | V | H |
| Left Aft | V | V |
| Right Fore | V | V |
| Right Mid | V | V |
| Right Mid | V | H |
| Right Aft | V | V |
| Left Fore | V | V |
| Left Mid | V | V |
| Left Mid | H | V |
| Left Aft | V | V |
| Right Fore | V | V |
| Right Mid | V | V |
| Right Mid | H | V |
| Right Aft | V | V |

**Kp(VV) = 3 % for all beams & Kp(VH/HV) = 3 % for mid beams**

# SCA RADAR SHOT CYCLE: POSSIBLE FUTURE CHOICE I

| ALTERNATIVE 4 | | |
|---|---|---|
| BEAM | TX | RX |
| Left Fore | V | V |
| Left Mid | V | V |
| Left Mid | V | H |
| Left Aft | V | V |
| Right Fore | V | V |
| Right Mid | V | V |
| Right Mid | V | H |
| Right Aft | V | V |
| Left Fore | V | V |
| Left Mid | V | V |
| Left Mid | H | H |
| Left Aft | V | V |
| Right Fore | V | V |
| Right Mid | V | V |
| Right Mid | H | H |
| Right Aft | V | V |
| Left Fore | V | V |
| Left Mid | V | V |
| Left Mid | H | V |
| Left Aft | V | V |
| Right Fore | V | V |
| Right Mid | V | V |
| Right Mid | H | V |
| Right Aft | V | V |
| Left Fore | V | V |
| Left Mid | V | V |
| Left Mid | H | H |
| Left Aft | V | V |
| Right Fore | V | V |
| Right Mid | V | V |
| Right Mid | H | H |
| Right Aft | V | V |

**Kp(VV) = 3 % for all beams & Kp(VH/HV) = 4.3 % for mid beams & Kp(HH) = 4.3 %**

# SCA RADAR SHOT CYCLE: POSSIBLE FUTURE CHOICE II

| ALTERNATIVE 3 | | |
|---|---|---|
| BEAM | TX | RX |
| Left Fore | V | V |
| Left Mid | V | V |
| Left Mid | V | H |
| Left Aft | V | V |
| Right Fore | V | V |
| Right Mid | V | V |
| Right Mid | V | H |
| Right Aft | V | V |
| Left Fore | V | V |
| Left Mid | V | V |
| Left Mid | H | V |
| Left Aft | V | V |
| Right Fore | V | V |
| Right Mid | V | V |
| Right Mid | H | V |
| Right Aft | V | V |
| Left Fore | V | V |
| Left Mid | V | V |
| Left Mid | H | H |
| Left Aft | V | V |
| Right Fore | V | V |
| Right Mid | V | V |
| Right Mid | H | H |
| Right Aft | V | V |

**Kp(VV) = 3 % for all beams & Kp(VH/HV) = 3.7 % for mid beams & Kp(HH) = 5.2 %**

# SCA PERFORMANCE

Radiometric Resolution

**VV Performance**

25 km x 25 km Horizontal Resolution Product (Nominal Product)

| | | |
|---|---|---|
| Kp (VV) at 4 m/s Cross-Wind | ≤ | 3 % for $i \leq 25°$ |
| | ≤ | ( 0.175 i - 1.375 ) % for $i > 25°$ |
| Kp (VV) at 25 m/s Up-Wind | ≤ | 3 % |

**VH Performance**

25 km x 25 km Horizontal Resolution Product

| | | |
|---|---|---|
| Kp (VH) at 20 m/s | ≤ | 4.5 % |

And Better Performance at Higher Wind Speeds.

# ASCAT & ERS AMI SCAT PERFORMANCE

Radiometric Resolution

**ASCAT VV Performance**

50 km x 50 km Horizontal Resolution Product (Nominal Product)

Kp (VV) ≤ 3 %

**ERS AMI SCAT VV Performance**

50 km x 50 km Horizontal Resolution Product

Kp (VV) ≤ 6 %

# SCA PRODUCTS

(1) 25 km x 25 km Horizontal Resolution Product. (Nominal Product)
Sigma Zero Quadruplets (Fore VV, Mid VV, Aft VV, Mid VH/HV, Mid HH)

(2) Full Horizontal Resolution Product at Radar Resolution.
Sigma Zero Quadruplet (Fore VV, Mid VV, Aft VV, Mid VH/HV, Mid HH)

(3) Noise Powers (Fore V, Mid V, Aft V, Mid H)

(4) Under Investigation for Feasibility: Mean Scattering Centre Radial Speed.

# SCA TRANSPONDER CALIBRATION

Continuous SCA Transponder Calibration without interruption to SCA Measurements.

Baseline Three New SCA Transponders at Existing Turkish Sites / 58-day sliding Calibration Window (TBC).

Calibration Quality will be similar to ASCAT.

SCA Radar Stability is expected to be better than ASCAT.

# POSSIBLE FUTURE DEVELOPMENTS

It is foreseen to investigate further if the SCA could have some potential for ocean current measurement. Preliminary analysis indicates this is unlikely.

The cross-polar backscattering from the ocean (VH, HV) is much lower than the co-polar backscattering from the ocean (VV, HH) even for high wind speeds. This causes to cross-polar measurements to be heavily contaminated due to Faraday rotation. It is presently thought that the cross-polar measurements over ocean may only be useful when the satellite is in eclipse (i.e. at night). This matter is under investigation including possible corrections employing external non-SCA data.