WaPA – Final Review

Airbus DS WP2400 overview

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Wavemill Primary Scientific Products – Ranges of Instrument and Satellite Performance

As part of WP2000: Validity of Wavemill Scientific Products…

WP2400 Airbus DS tasks

- Review Preliminary Wavemill MRD in context of key requirements / parameters pertinent to Wavemill instrument
- and mission, to establish areas that may be performance drivers
- Support the definition of the Wavemill mission and instrument performance requirements
- Contribute to recommendations for expected product performance

WP2400 Airbus DS outputs

D2.5 Wavemill Instrument Requirements Document, embodied in:

1. **WVM-TN-ASU-SY-0001: Wavemill Instrument Requirement Consolidation**
   - Review of consolidated instrument requirements (OSCM MATER / MRD) in respect of to what extent these are drivers on either the mission, system or instrument
3. **WVM-TN-ASU-SY-0002: WaPA Instrument Parameter Dependence**
   - Relationship between imaging / image quality parameters and instrument physical / operating parameters
   - Inter-relationships and dependencies outlined qualitatively along with Wavemill-specific quantitative examples
5. Supplemented by updates to Wavemill Instrument performance estimates following further Instrument definition and analysis work in OSCM Study – captured in Final Review presentation

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Ranges of Instrument and Satellite Performance

WaPA Instrument Parameter Dependence (1)

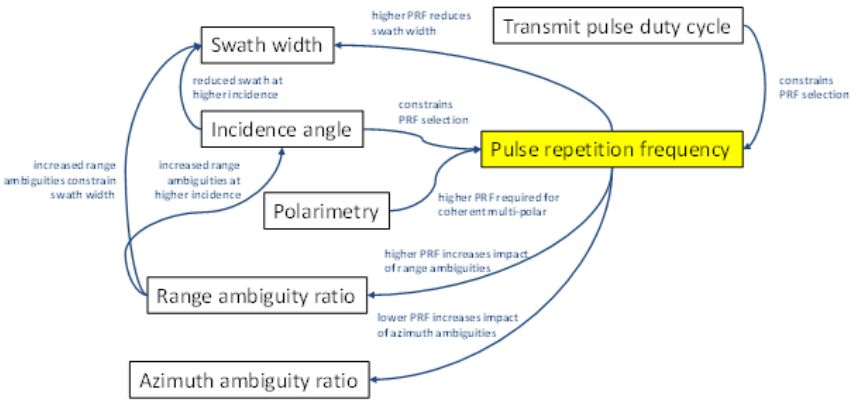
Qualitative relationship between Wavemill instrument parameters outlined in WVM-TN-ASU-SY-0002:

- to explain instrument performance / implementation trade-offs
- to ensure all design inter-dependencies are identified
- for the benefit of the WaPA science team and mission team

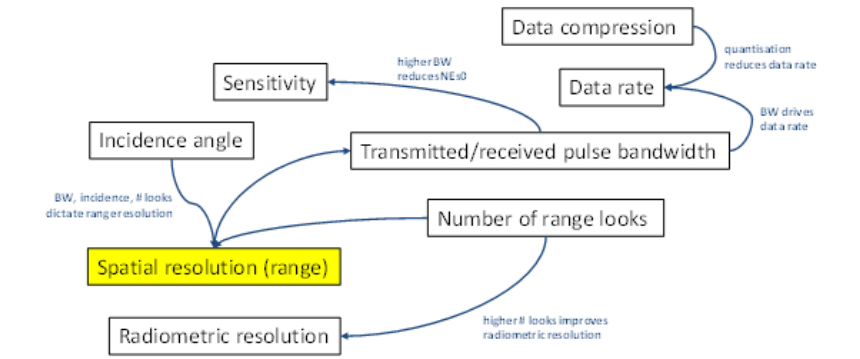
Key Instrument parameters –

Imaging / image quality parameters	Instrument physical / operating parameters
Swath width	Transmit frequency
Incidence angle (coverage, access)	Transmitted/received pulse bandwidth
Range ambiguity ratio	Transmit pulse duty cycle
Azimuth ambiguity ratio	Pulse repetition frequency
Sensitivity	Antenna length and height
Radiometric resolution	Elevation and azimuth beam pattern
Polarimetry	Transmitted / received polarisation
Revisit	Power (mean, peak)
Around-orbit operating duty cycle	Number of independent looks (range, azimuth)
Spatial resolution (range)	Data rate
Spatial resolution (azimuth)	Data compression (quantisation)
	Orbit
	Instrument/spacecraft thermal control
	Antenna configuration (mass, complexity)

Instrument PRF dependencies



Range resolution dependencies



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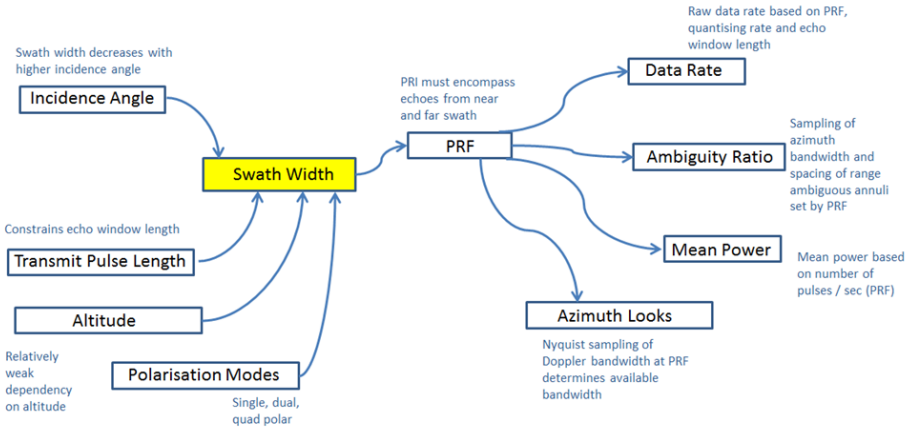
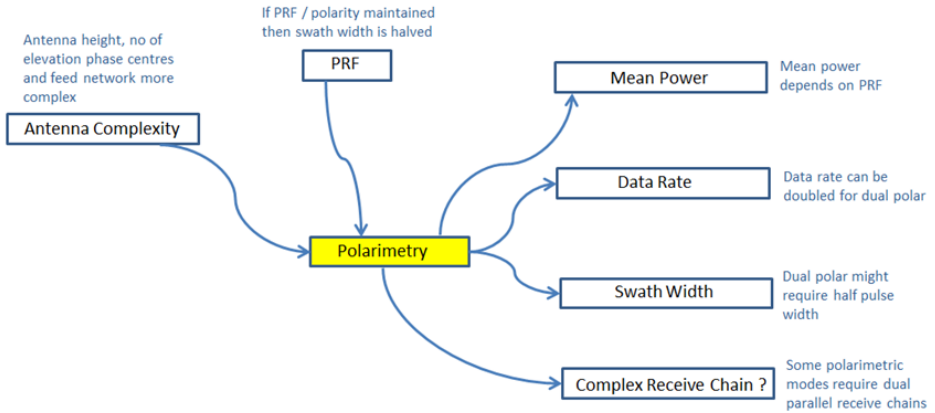
Ranges of Instrument and Satellite Performance

WaPA Instrument Parameter Dependence (2)

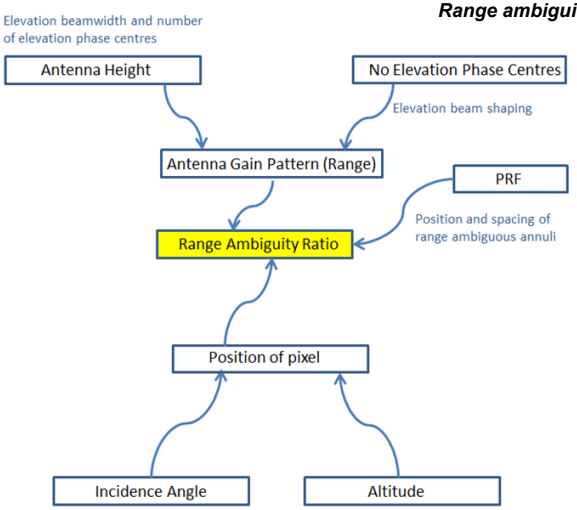
Swath width dependencies



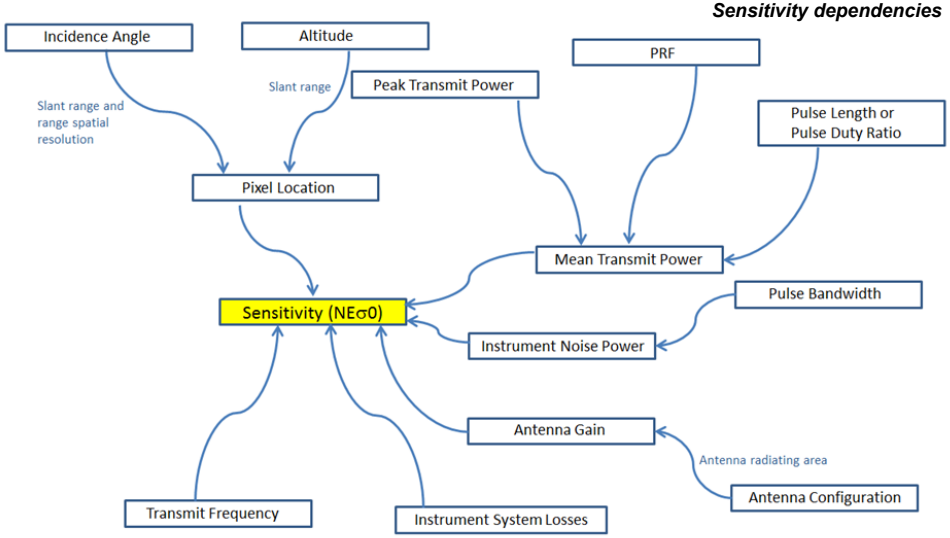
Polarimetry dependencies



Range ambiguity ratio dependencies

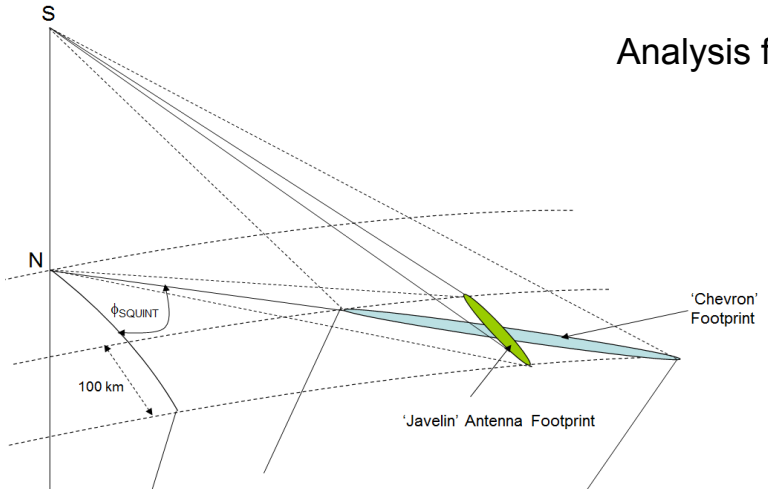


Sensitivity dependencies

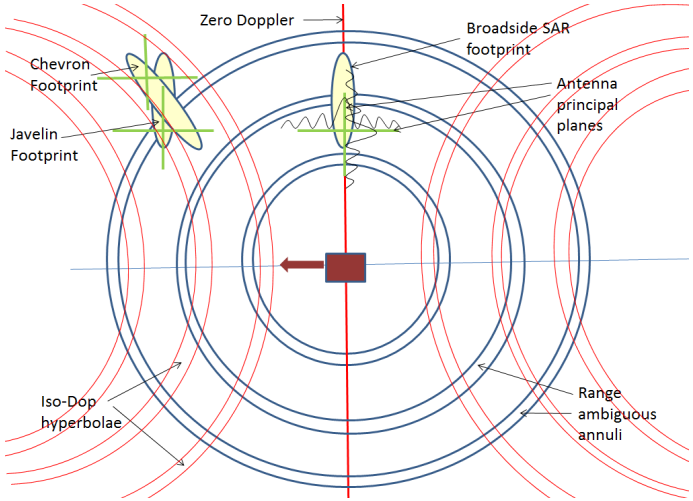


Ranges of Instrument and Satellite Performance

WaPA Instrument Parameter Dependence (3)

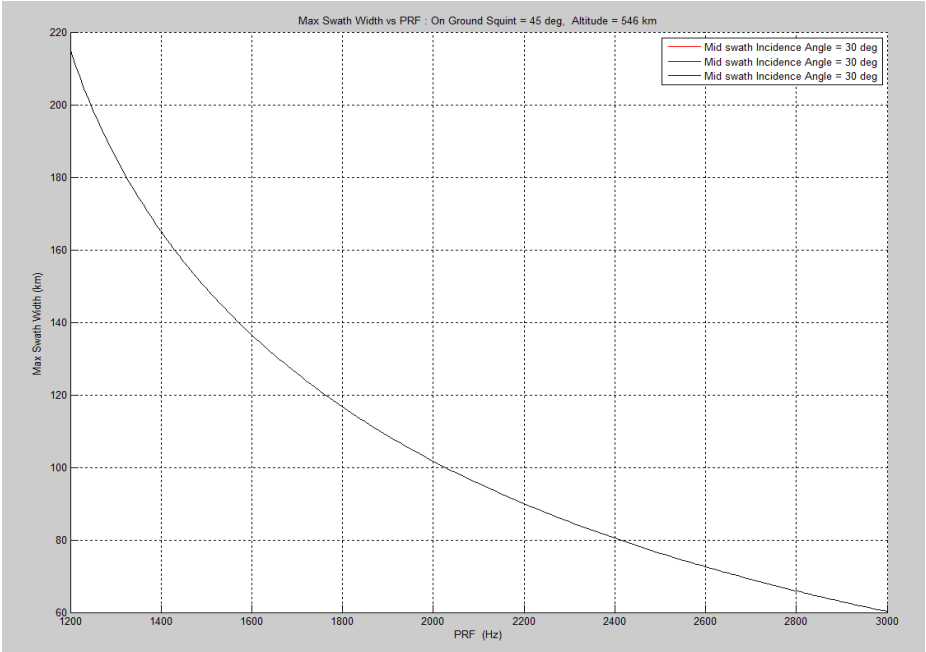


Contrast between 'Javelin' and 'Chevron' beam positions



Positions of the ambiguous zones

Analysis from WVM-TN-ASU-SY-0002, prior to OSCM MTR



Permissible swath lengths as a function of PRF for Javelin (assuming suppressing of nadir return)

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Ranges of Instrument and Satellite Performance

Wavemill Instrument Requirements (1)

The areas of the MATER document that have a direct and critical effect on the OSCM design moving forward, have been deemed to be in the following areas:

a) **Instrument configuration**, specifically:
- The split between XTI and ATI and their relative contributions
- The inclusion of dual-polarisations and its knock-on affect on power, data and complexity
- The requirement on current retrieval performance in low wind conditions (>2m/s) which provides a poor SNR and drives a more stringent control of the ambiguity performance than might be expected
- The need to have a (likely not-yet-developed) metrology system to measure antenna geometry

b) **Instrument data processing and downlink** , specifically:
- The very large data throughput of the instrument (~2Gbits per antenna) in combination with the need to have raw SLC data downlinked to the ground without pre-processing
- The probable under-capacity of traditional X-band downlink rates, and the dependence of the mission on advanced very high-rate communications

c) **Instrument compatibility with the Launcher**:
- The requirement to be compatible with the VEGA class launcher, in combination with other requirements, puts extreme demands on the power, radiator area, and instrument/platform configurations possible

d) **Coverage**, specifically:
- The need to have full global ocean coverage, which in turn puts large demands on the power requirement for such an interferometric SAR instrument, as well as the downlink strategy

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Ranges of Instrument and Satellite Performance

Wavemill Instrument Requirements (2)

- The instrument design has moved to an **ATI only** solution
  - this is because of the inability to separate across and along track components of the data, with one acting as an effective error on the other
- In order to adequately deal with ambiguities, either the use of **longer antenna lengths** than the original 4m will be required, or the **use of DPCA**
- The use of a single polar instrument has given way to a likely **dual-polar implementation** in order to achieve the required wind/current discrimination
- Some form of **data compression** is likely to be required to cope with the large quantities of raw instrument data,
  - however raw data will be provided up to the maximum allowable data bandwidth
- Both **single and dual sided operation** is now being considered and has been shown to be viable w.r.t. performance

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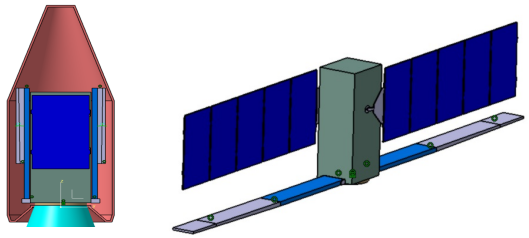
Ranges of Instrument and Satellite Performance

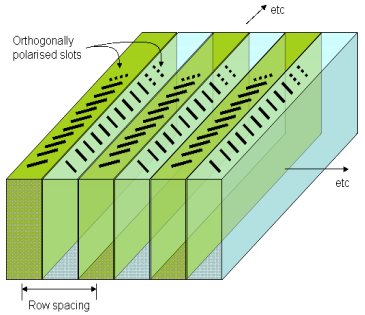
WaPA Instrument Performance (1)

Dual polarisation, squinted ATI instrument in an in-line ‘Javelin’ configuration

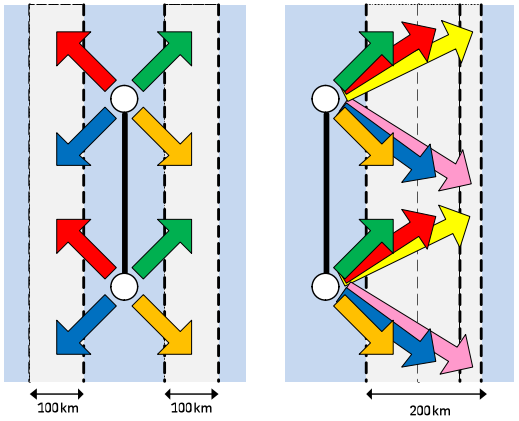
Folding antenna to generate required antenna length and additional booms to generate required baseline

- Waveguide antenna for lightness and simplicity with passive beams





Parameter	Value
Polarisation	VV and HH
Mid swath incidence angle	30°
Near swath incidence angle	>25°
Swath width	100km (dual sided) or 200km (single sided)
Centre Frequency	13.5GHz (Ku-band)
Transmit bandwidth	25MHz
Intermediate product size	~14m



Operation

- At MTR DPCA operation was considered, however it is not required as long as antenna length is sufficient to control ambiguities
- Operation in a burst interleaved mode (akin to scansar), with bursts for each beam
- Single vs dual sided operation trade-off remains open

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Ranges of Instrument and Satellite Performance

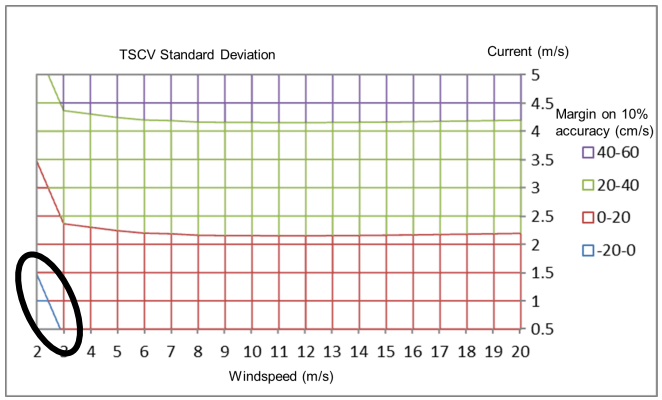
WaPA Instrument Performance (2)

Key performance requirements:

Parameter	Required Performance
Product size	1km to 4km
TSCV accuracy	5cm/s over 3m/s to 20m/s wind speeds
Minimum surface wind	2m/s
Wave spectral information	Significant wave height, dominant swell wavelength

Achieved performance:

- Performance expected at 4x4km product size apart from very low wind conditions (very poor SNR)
  - finer product resolution available at higher wind speeds/higher currents
- Work on-going to refine performance



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