

Introduction of two design issues



1. MWR Configuration Option
2. Altimeter Mode of Operation

- **Jason-CS shall be an Operational Mission.**
- **Jason-CS products shall be of sufficient quality for scientific research.**

(No degradation in comparison to J1,J2,J3)

Services (continuity)



Altimetry Primary Mission:

1. **ALT-NTC: Non Time Critical (GDR)**
2. **ALT-STC: Short Time Critical (IGDR)**
3. **ALT-NRT: Near Real Time (OGDR)**

Radio Occultation Secondary Mission (optional):

4. **RO-NTC : Climate**
5. **RO-NRT : Meteorology**

MWR: 2 or 3 frequencies?



		Doc. No.: JC-TN-ESA-MW-0034 Issue: Issue 1.0 Date: 10 Sept 2012 Page: 1
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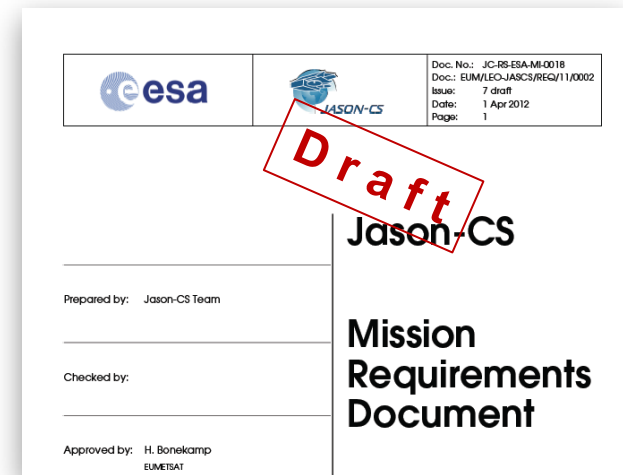
<hr/> <hr/> <p>Prepared by: Jason-CS Team</p> <hr/> <hr/> <p>Checked by: Robert Cullen Jason-CS Payload Manager</p> <hr/> <hr/> <p>Approved by: Richard Francis Jason-CS Project Manager</p> <hr/> <hr/> <p>ESTEC Netherlands 10 Sept 2012</p> <hr/>	<h2>Jason-CS</h2> <h3>Microwave Radiometer Design Configuration Options</h3>
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Expression of Requirements

Wet Troposphere Correction:

The radiometer will provide information that in part allows for the accurate estimation of the radar altimeter pulse and backscatter echo delay due to the water vapour content.

Expressions of User and Mission Requirement



R-S-6.1.0-50:

Jason-CS shall embark a microwave radiometer to measure the brightness temperature of the upwelling microwave radiation at three frequencies.

Two Studies



- **EU-MWR : (EU) Industry design study.**
 - Heritage from ERS-1/2, EnviSat and Sentinel-3.
 - Two frequencies as baseline.
 - Three being investigated under a feasibility study.

- **AMR-C : (US,NASA) Industry design study**
 - Development with heritage from the Jason-2/3.
 - Three frequencies as baseline.

1. Embark EU-MWR only

- We have to include a third frequency or ...
- Accept 2-frequency solution and adjust the requirement

2. Embark AMR-C only

- Would implement the baseline
- Programmatically not possible

3. Embark both EU-MWR and AMR-C ! (baseline)

- Individual antennae or...
- Joint antenna

- Are the scientific benefits of a 3-frequency radiometer over a 2-frequency system clear enough?
 - **Inputs needed for cost/benefit analyses**
 - **Prelaunch theoretical analyses by e.g. Ruf et al. 1996**
- Is there any science benefit to having two radiometers on-board?
 - **Different centre frequencies for the two radiometers (34GHz and 37 GHz)**
 - **Estimation and effective minimisation of radiometer drift**

MRD Draft

R-S-6.5.1-10

“Jason-CS shall measure globally averaged sea level, relative to levels established during the calibration and validation phase, with zero bias ± 1 mm (standard error) averaged over any one year period.”

? Clarification and breakdown of this requirement in order that the agencies can supply the related system requirement(s) .

Altimeter Operations Issue



“ESA Altimeter note”

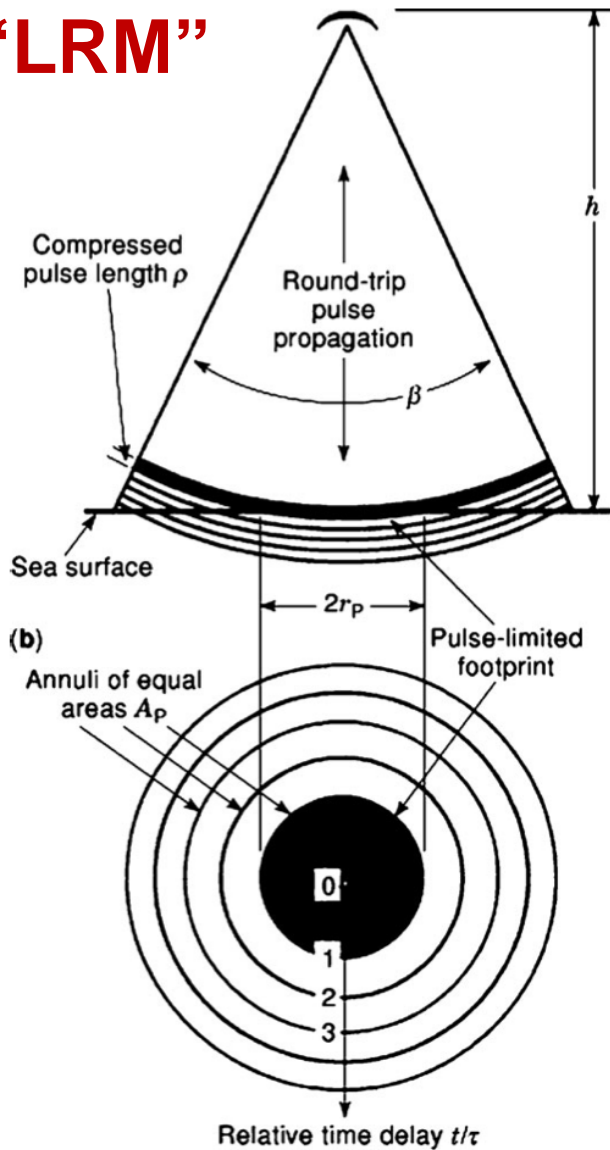
		Doc. No.: JC-TN-ESA-MI-0036 Issue: 3.0 Date: 10 Sept 2012 Page: 1
Prepared by: Jason-CS Project Checked by: Robert Cullen Jason-CS Payload Manager Approved by: Richard Francis Project Manager * ESTEC Noordwijk The Netherlands * 10 Sept 2012 *		<h3>Jason-CS</h3> <h4>Poseidon-4 Modes of Operation</h4>

“TAS Altimeter Note”

		INTERNAL THALES ALENIA SPACE REFERENCE: JC-TN-TAF-P4-00075 DATE: 11/06/12 ISSUE: 01 Page: 1/35																		
<div style="border: 1px solid black; padding: 10px;"> <p>JASON CS – POSEIDON 4</p> <p>Summary of interleaved mode requirements and preliminary results (CN interleaved ref. JC-CN-TAF-P4-00070)</p> </div>																				
<table border="1"> <thead> <tr> <th>Written by</th> <th>Responsibility + handwritten signature if no electronic workflow tool</th> </tr> </thead> <tbody> <tr> <td>E. CAUBET</td> <td>Radar engineer</td> </tr> <tr> <td colspan="2">Verified by</td> </tr> <tr> <td>L. PHALIPPOU</td> <td>Radar altimeter expert</td> </tr> <tr> <td>J. RICHARD</td> <td>Head of Radar Engineering Department</td> </tr> <tr> <td>L. RYS</td> <td>Jason CS – Poseidon 4 Technical Responsible</td> </tr> <tr> <td>S. BEDIU</td> <td>Jason-CS/Poseidon4 PA Manager</td> </tr> <tr> <td colspan="2">Approved by</td> </tr> <tr> <td>M. DESCHAUX-BEAUME</td> <td>Jason CS – Poseidon 4 Project Manager</td> </tr> </tbody> </table>	Written by	Responsibility + handwritten signature if no electronic workflow tool	E. CAUBET	Radar engineer	Verified by		L. PHALIPPOU	Radar altimeter expert	J. RICHARD	Head of Radar Engineering Department	L. RYS	Jason CS – Poseidon 4 Technical Responsible	S. BEDIU	Jason-CS/Poseidon4 PA Manager	Approved by		M. DESCHAUX-BEAUME	Jason CS – Poseidon 4 Project Manager		
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Approval evidence is kept within the documentation management system.																				
THALES INTERNAL THALES ALENIA SPACE – COMMERCIAL IN CONFIDENCE																				

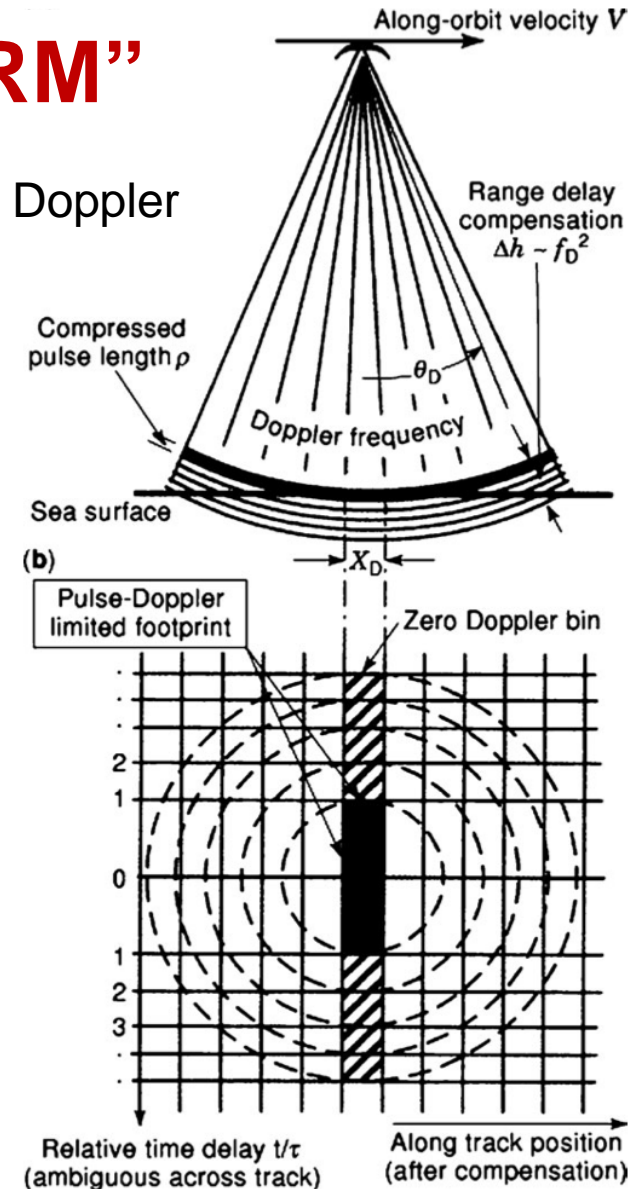
Modes Of Operations

“LRM”



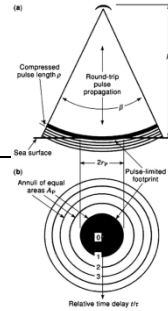
“SARM”

Delayed Doppler



Modes Of Operations

“LRM”



Low (~2 kHz) Pulse

Repetition Frequency (**PRF**).

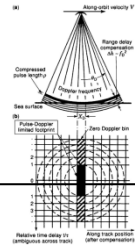
- Statistical independence in each pulse echo.

Simple (“incoherent”) **processing** of individual echoes.

- Measurement area (“footprint”) is *circularly symmetric*.
- Measurement is *insensitive to wind or wave direction*.
- Pulses may be processed individually and sequentially.

On-board averaging can reduce data rate (~20 kb/s).

“SARM”



High (~9–18 kHz) Pulse

Repetition Frequency (**PRF**).

- Successive echoes are correlated.

Echoes are processed in groups of N ($N=64$ or 32 , typically).

- Doppler beam sharpening narrows footprint along-track.
- Footprint is quasi-rectangular. Along-track dimension (~300 m) is fixed by N , PRF , orbit height.
- Possible sensitivity to wind or wave direction TBD.

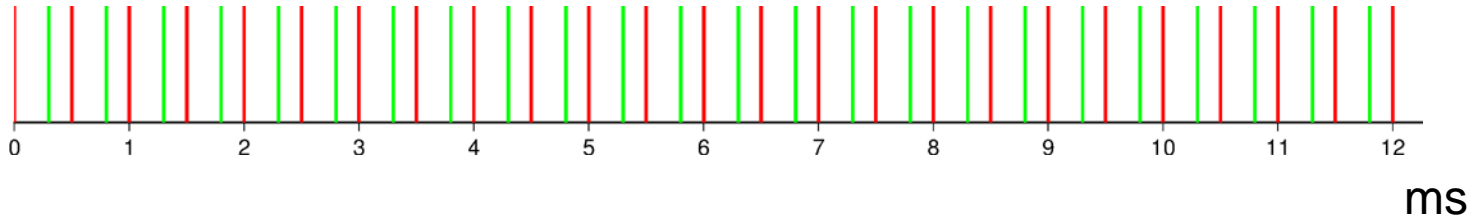
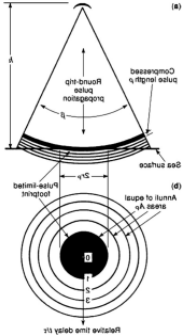
High data rates (6–20 Mb/s) if not processed on-board.

Courtesy:W. Smith (NOAA)

Pulses

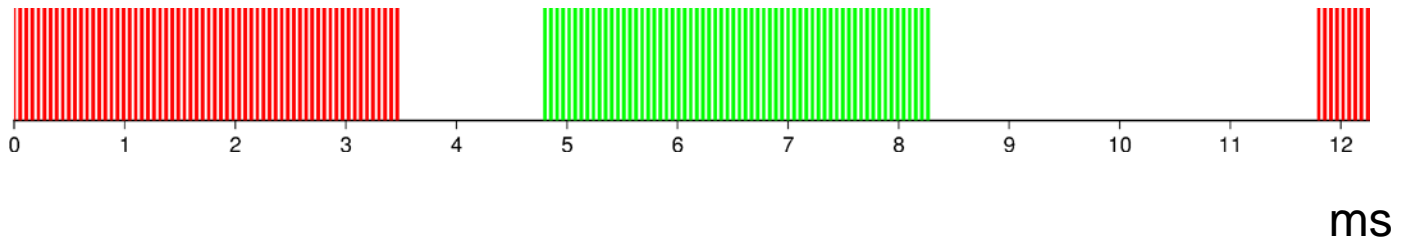
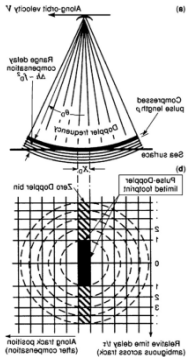
LRM

— Transmit
— Receive



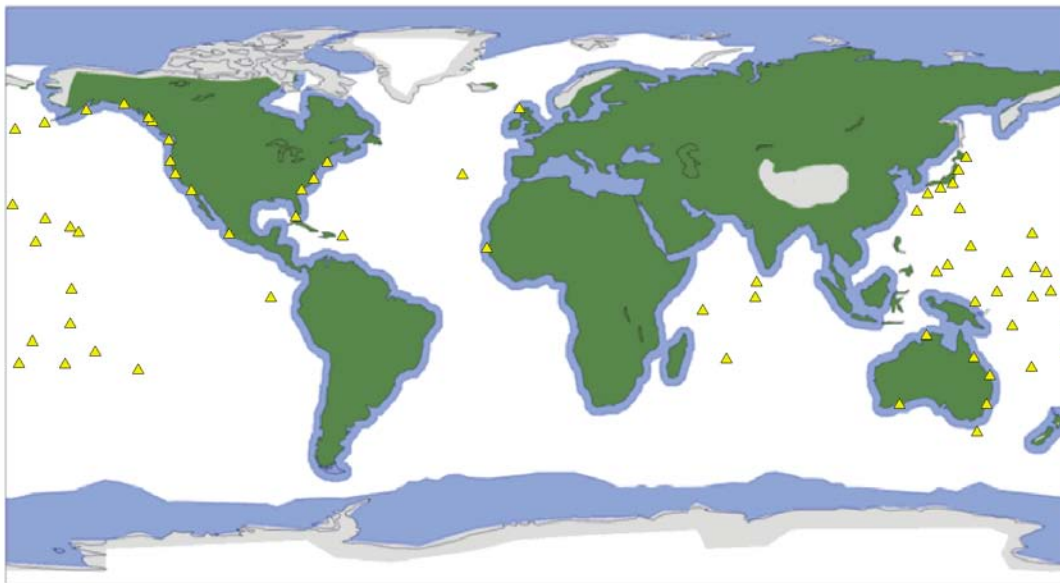
SARM





“Closed Burst” (Sentinel-3, Cryosat-2, **Jason-CS baseline**)



Courtesy:W. Smith (NOAA)

S3 Topography mission Mode mask



	SAR Open/Closed Loop:	Land, Inland Waters
	SAR Open Loop:	Ice Sheet Margins
	SAR Closed Loop:	Sea Ice, Coastal Regions
	LRM Mode:	Open Ocean, Ice Sheet Interiors

Rationale :
Need for higher Resolution
especially for the coastal
Applications.

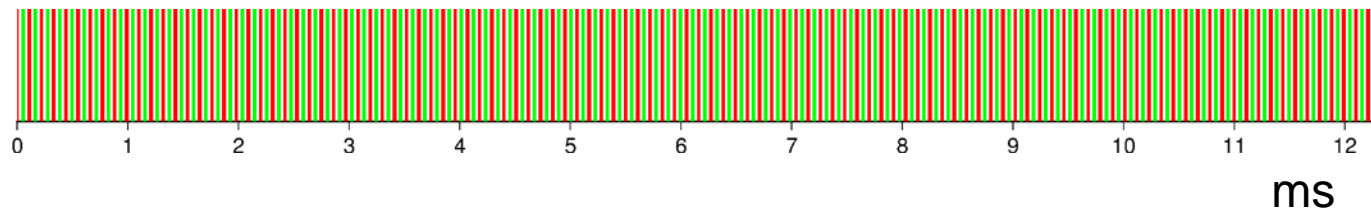
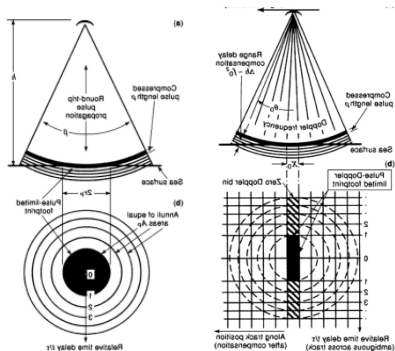
Under Discussion!

Pulsing: a novel way

“Interleaved Mode”

— Transmit
— Receive

LRM+SARM continuously



No Operations Mode Mask needed

Courtesy:W. Smith (NOAA)

“Interleaved Mode”

PRF $\sim 9 \text{ kHz}^1$ and continuously interleaved transmit/receive throughout the ocean.

All possible statistically independent measurements are made.

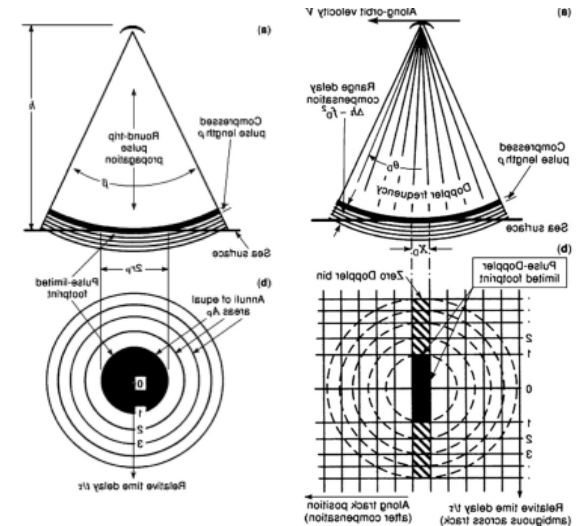
SAR and LRM can both be made from the same echoes, under the same conditions.

LRM from simple sequential averaging of all echoes yields optimal LRM everywhere, both coastal and open ocean.

Where individual echoes can be downlinked, SAR products also can be made.

¹The Doppler beam sharpening / footprint narrowing is better (for a nadir ocean instrument) at 9 kHz than at 18 kHz, if $N = 64$ in each scenario.

LRM+SARM



BUT :
There are considerable development costs!

Courtesy:W. Smith (NOAA)

Questions



LRM xor SAR:

- **Where does one operate SARM and LRM as a function of geophysical location? ("Mode Mask")**
- **Is there a consistent understanding of the uncertainties between LRM and SARM?**
- **If one generates Brown echoes from the SARM data stream then how do errors compare with those from the LRM data?**
- **Platform pointing: SAR retrievals have been shown to be sensitive to pointing, SWH, directional waves.**

LRM and SAR interleaved:

- **Can SAR mode bursts be processed in a pulse-width limited manner to generate Brown model echoes effectively?**

END