



***CRISTAL mission***

# Interferometric Radar altimeter for Ice & Snow (IRIS)

**Atelier Altimétrie et Glaciologie**

**25 juin 2019**



# IRIS INSTRUMENT IN CRISTAL MISSION

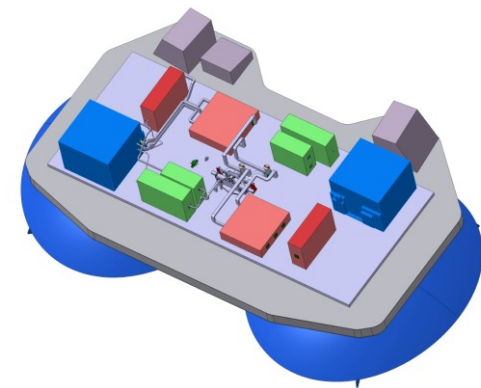
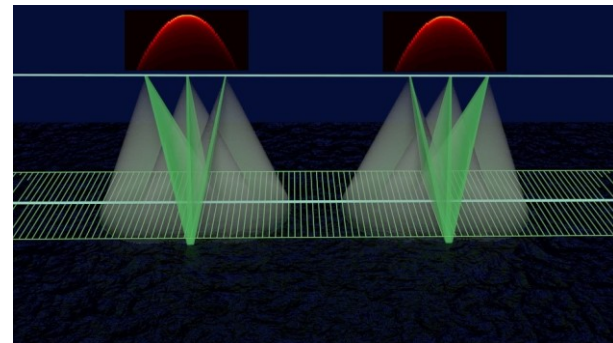
## 1. Enhanced ice topography measurements

- SNOW DEPTH RETRIEVAL ON SEA ICE
- ENHANCED AZIMUTH RESOLUTION (FULLY-FOCUSED MODE) ON SEA ICE
- IMPROVED RETRIEVAL ACCURACY OVER SEA & LAND ICE
- IMPROVED ECHO ACQUISITION OVER ICEBERGS, GLACIERS AND ICE MARGINS

## 2. Continuity of sea topography measurements

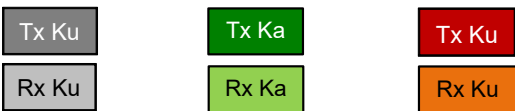
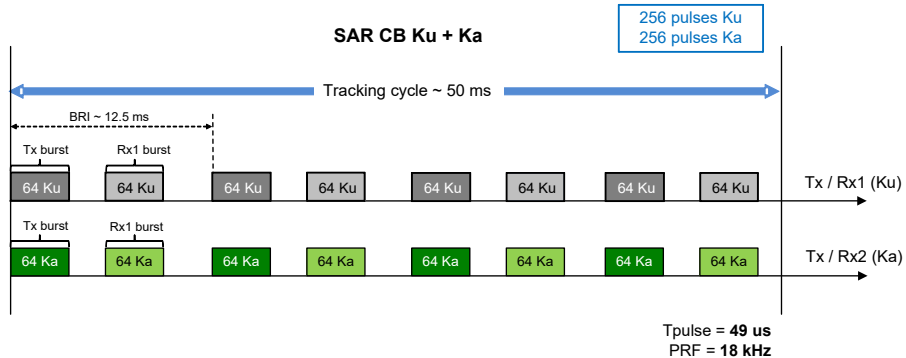
➔ Thanks to a radar altimeter featuring:

- DUAL KU/KA BAND
- 500-MHZ CHIRP BANDWIDTH
- HIGH RESOLUTION MODES (SAR CLOSED/OPEN BURST)
- INTERFEROMETRIC CAPABILITY IN KU-BAND
- ENHANCED TRACKING (CLOSED+OPEN LOOP) CAPABILITY



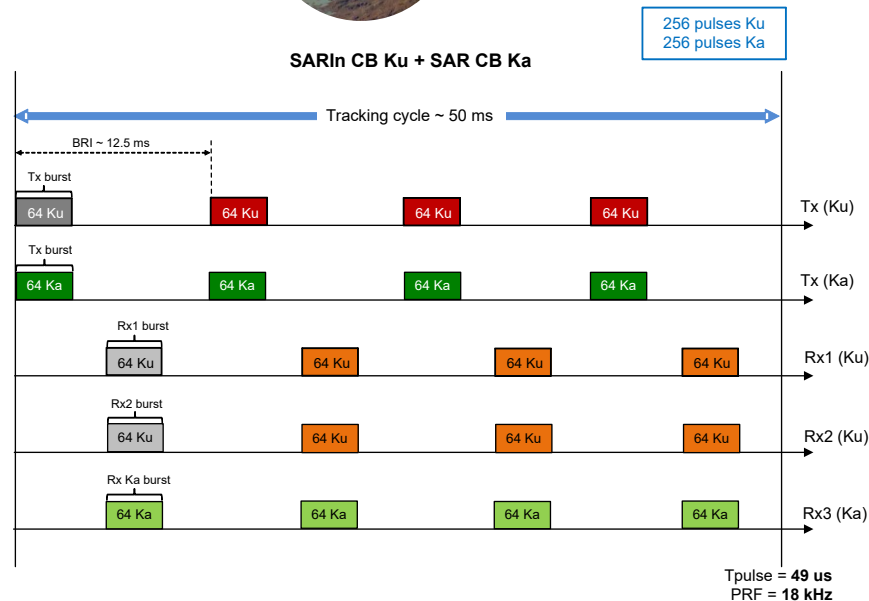
# ENHANCED MODES FROM CRYOSAT-2

## SAR Closed-Burst → Open/Coastal Ocean



**CS-2  
chronogram**

## SARIn Closed-Burst → Land Ice

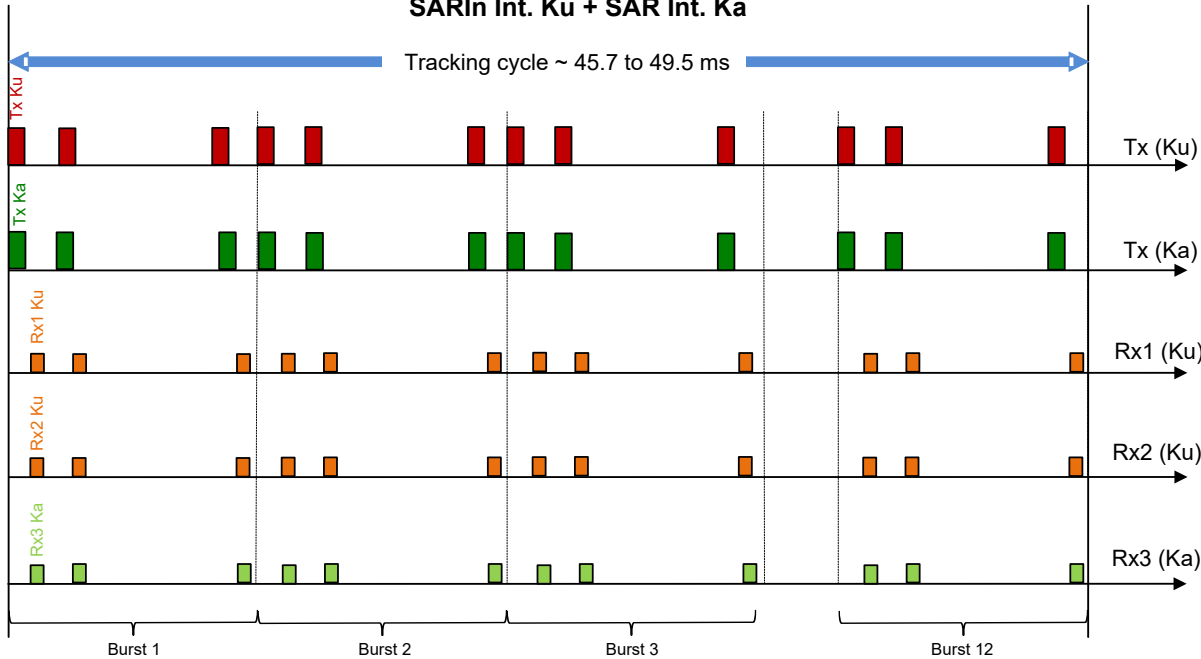


# MEASUREMENT MODE DEDICATED TO SEA ICE

Ku : 12 bursts x 64 pulses = 768 pulses  
 Ka : 12 bursts x 64 pulses = 768 pulses

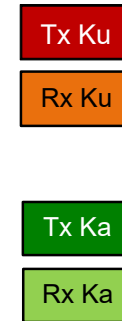
## SARIn Int. Ku + SAR Int. Ka

Tracking cycle ~ 45.7 to 49.5 ms

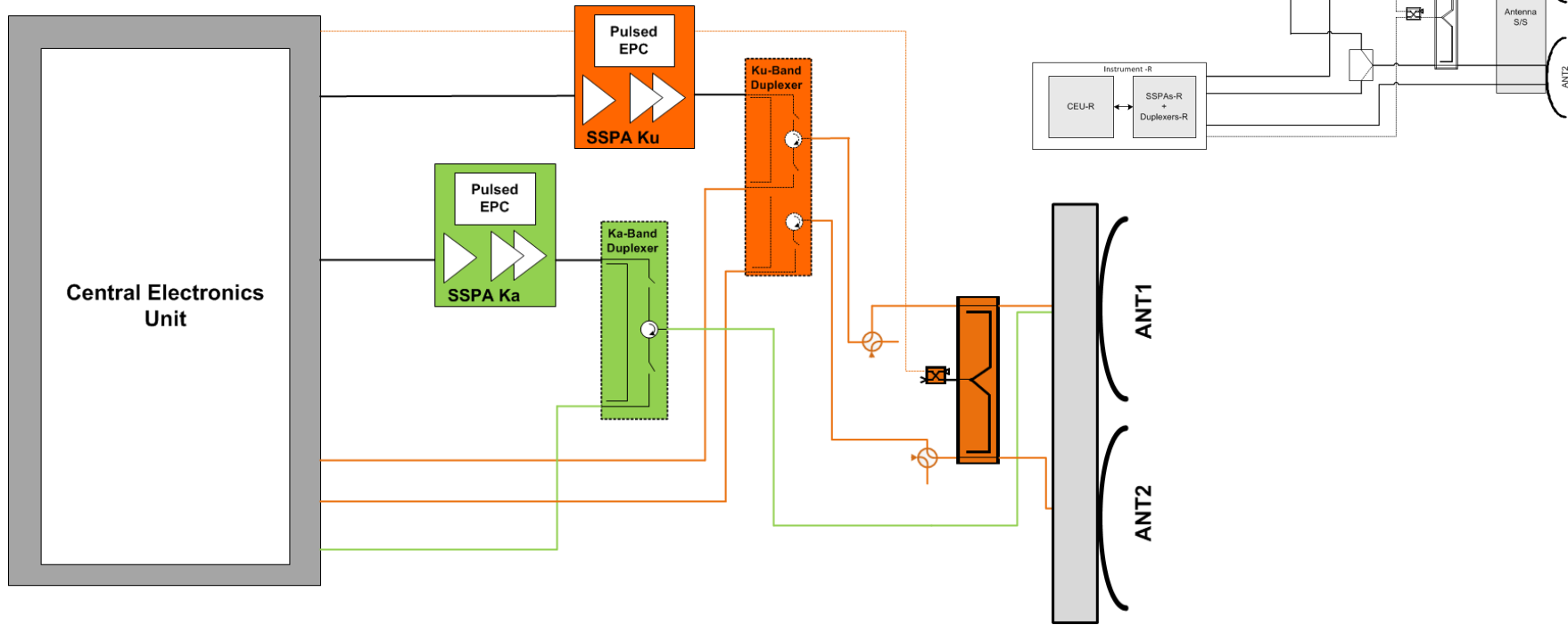


$T_{pulse} = 18 \mu s$   
 $PRF = [15.5, 16.8 \text{ kHz}]$

## SARIn Open-Burst → Sea Ice & Icebergs



# IRIS BLOCK DIAGRAM



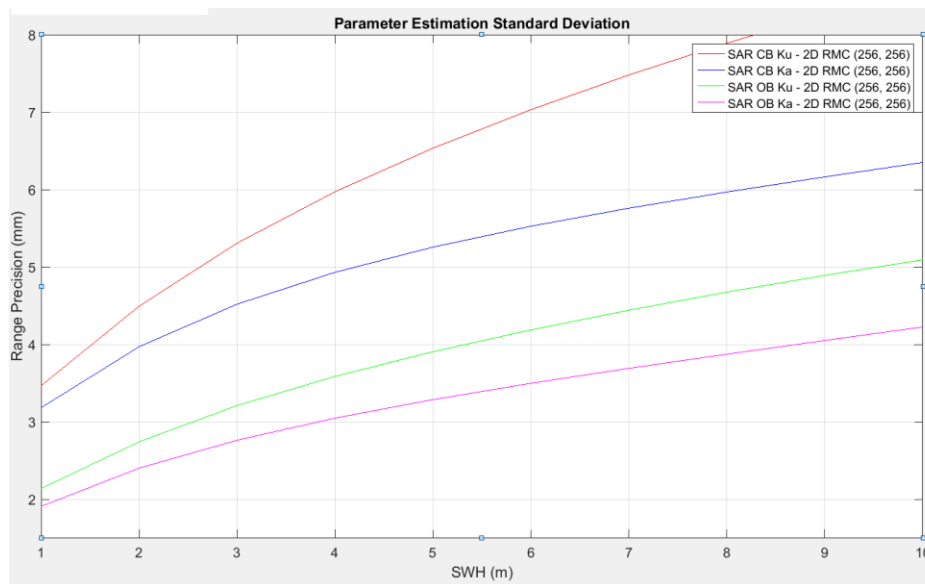
# IRIS MAIN PERFORMANCES (1)

## Signal to Noise Ratio

	Open and Coastal Ocean (OCO)	Sea Ice & Icebergs (SII)	Land Ice & Glaciers (LIG)	
			Ice sheet interiors (Ice sheet / Ice cap)	Ice margins & glaciers
$\sigma_0$ range in Ku	6dB to +25dB	0dB to +55dB	0dB to +40dB	-10dB to +40dB
$\sigma_0$ range in Ka	+8dB to +27dB	+2dB to +57dB	2dB to +42dB	-8dB to +42dB
Measurement mode in Ku	SAR-CB	SARIn Open Burst	SARIn-CB	
Measurement mode in Ka	SAR-CB	SAR Open-Burst	SAR-CB	
Tracking mode	Closed-Loop (Ku)	Closed-Loop (Ku)	Closed-Loop (Ku)	Open-Loop
Min SNR in Ku before SAR processing	19,3 dB	9,5 dB	13,3 dB	3,3 dB
Min SNR in Ka before SAR processing	12,7 dB	2,9 dB	6,7 dB	-3,3 dB
Min SNR in Ku after SAR processing	32,4 dB	22,1 dB	26,4 dB	16,4 dB
Min SNR in Ka after SAR processing	21,5 dB	11,7 dB	15,5 dB	5,5 dB

## Range Accuracy

- 1-S RANGE NOISE
- CRAMER-RAO BOUNDS
- MLE-3 ALGORITHM
- ECHO MODEL: 2D RMC



# IRIS MAIN PERFORMANCES (2)

## Across-Track Angular error

### /// Main contributors

■ **IN-ORBIT BASELINE CHARACTERISATION ACCURACY (EXT. CALIBRATION) ~ 5 ARCSEC**

- External calibration performed over the sea (idem CS-2)

■ **DRIFT ERROR BETWEEN TWO EXTERNAL CALIBRATIONS ~ 22 ARCSEC**

■ **INTERNAL CALIBRATION ERROR AT MEASUREMENT DATE ~5 ARCSEC**

➔ **Global across-track angular error ~23 arcsec (CS-2: 28 arcsec)**

### /// Main ways of improvement

■ **IN-FLIGHT RETRIEVAL OF BASEPLATE SYMMETRICAL BENDING**

■ **IN-FLIGHT MODELING OF WAVEGUIDE DIFFERENTIAL LENGTH**

■ **MORE FREQUENT EXTERNAL CALIBRATION (TYPICALLY EVERY MONTH)**