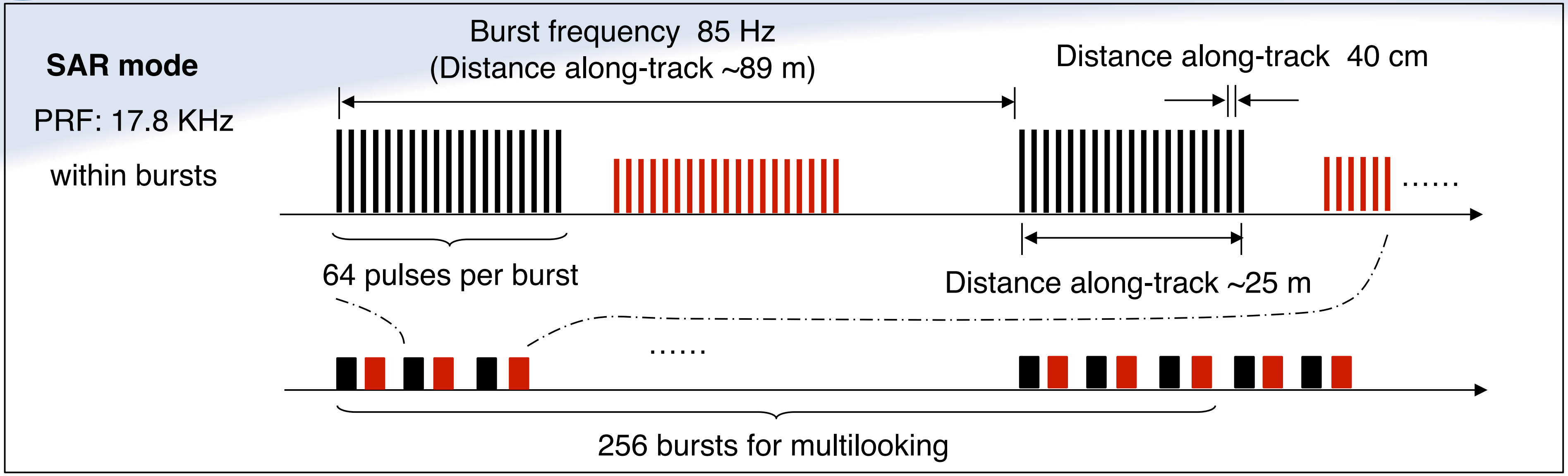
CENTRE NATIONAL D'ÉTUDES SPATIALES

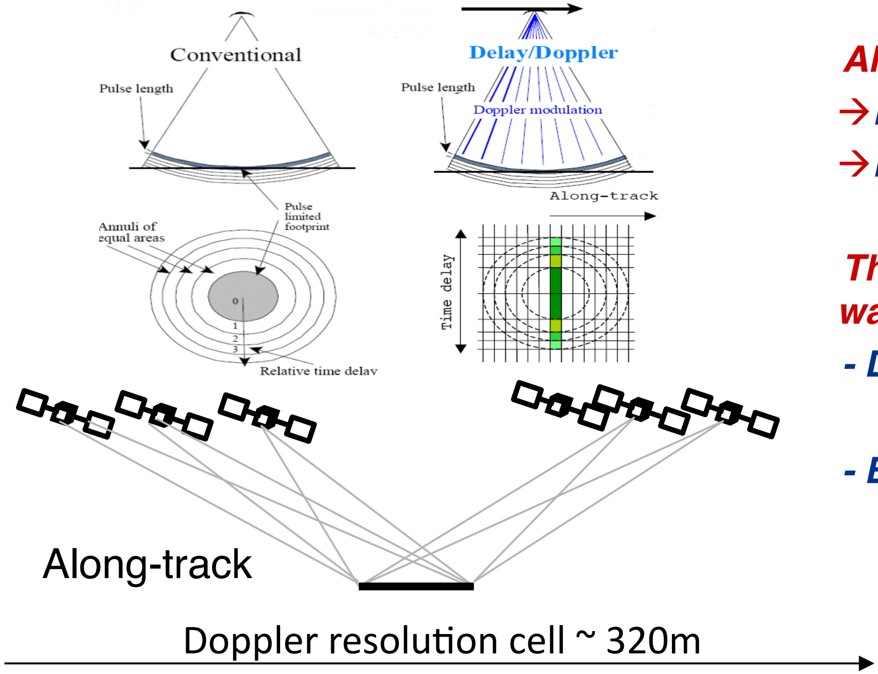
Cryosat-2 Processing Prototype (CPP)

SAR and RDSAR Processing

François Boy
Jean-Damien Desjonquères
Nicolas Picot

CRYOSAT-2 SAR Mode





All complex (I,Q) waveforms are downlinked in the telemetry.

→ ***High wealth of information***

→ ***Many ways to process the data***

The Doppler echo is built on-ground from the complex waveforms:

- Doppler synthesis processing on each BURST (« single look »)

→ **Beam sharpening (300m along track resolution)**

- Beams stacking: multilook processing

→ **Speckle noise reduction**

Lessons learned

- The Doppler model must translate accurately the Doppler echo generation process

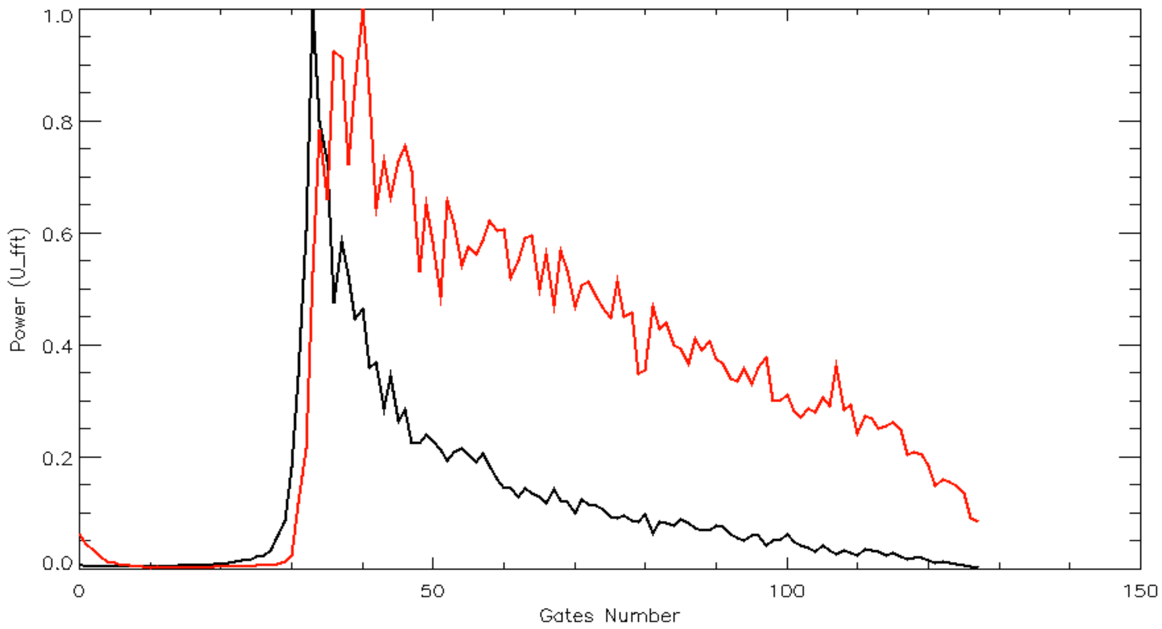
- If the Doppler echo generation process evolves, the Doppler model must be adapted adequately

- The whole performances of SAR mode are both linked to the Doppler model accuracy (L2 processing) and to the Doppler echo generation process (L1B processing).

SAR and RDSAR measurements

From SAR BURST pulses

SAR and RDSAR measurements



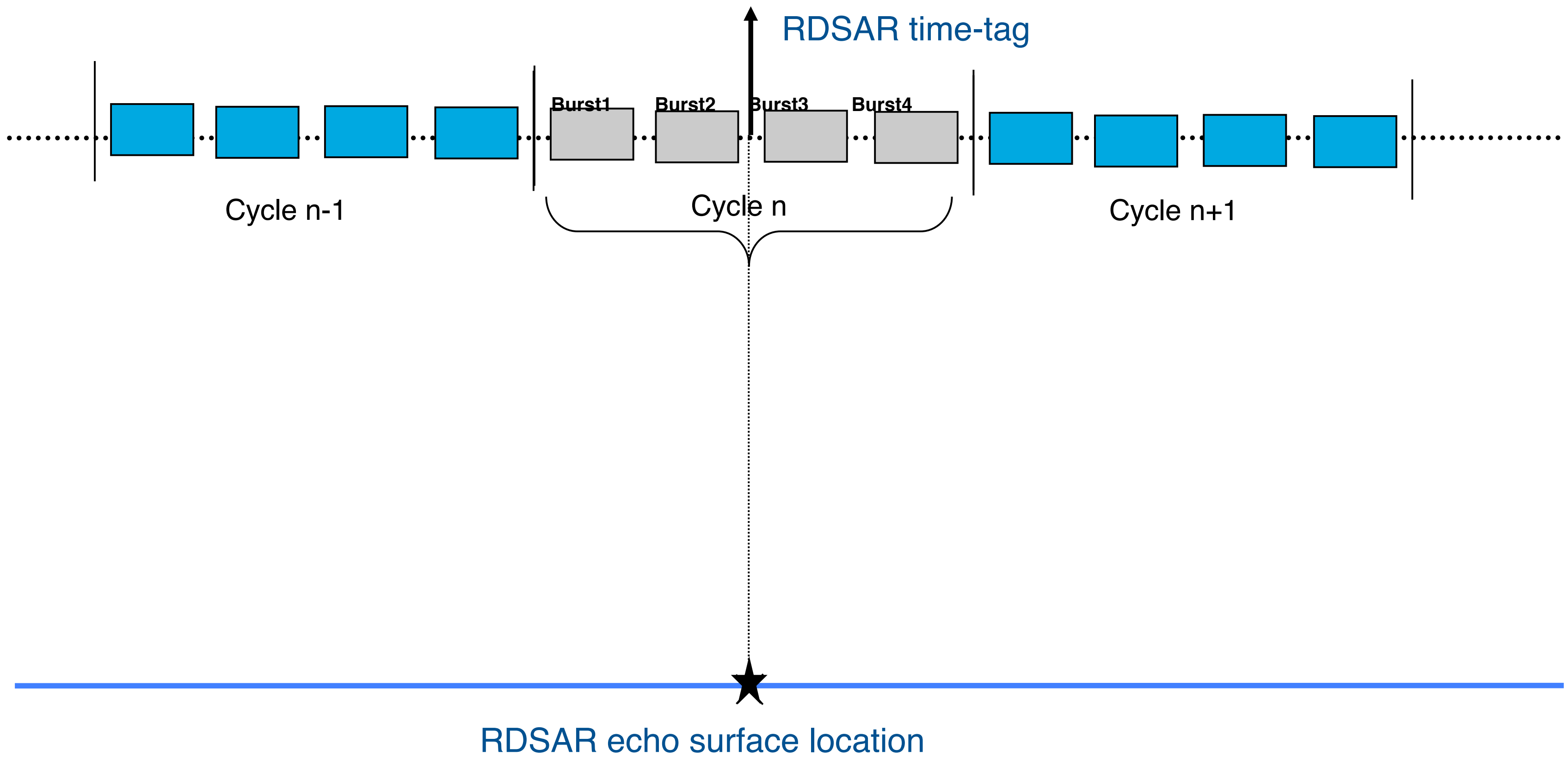
P-LRM (or RDSAR) is a LRM reference to validate/calibrate the SAR results.

But, given that only 32 echoes are accumulated, this reference is more noisy than real LRM (sqrt(3) higher than real LRM).

CPP RDSAR Algorithms

RDSAR measurement is computed for each cycle, referenced at the center of the cycle (time-tag, location, tracker range …).

The RDSAR echo is generated by accumulating all the pulses of the cycle.



CPP RDSAR Algorithms: Echo generation

1. **To assemble 4 x 64 pulses**

Meas. is first time-tagged and located at the center of the cycle and the translated to the overflown surface.

2. **To correct the AGC**

Waveforms are corrected for the AGC and for the variation of the gain inside the BURST (CAL1)

3. **To align the 4x64 pulses**

- Undone the on-board alignment performed by the altimeter
- Apply an accurate alignment of the pulses using the precise radial velocity provided by the orbit ephemeris

4. **To generate RDSAR echoes**

For each of the 4*64 pulses (I and Q), I2+Q2 spectrum is derived. The 20 Hz RDSAR 128-points waveform is then computed by summing the 4*64 I2+Q2 waveforms.

CPP RDSAR Algorithms: Echo retracking

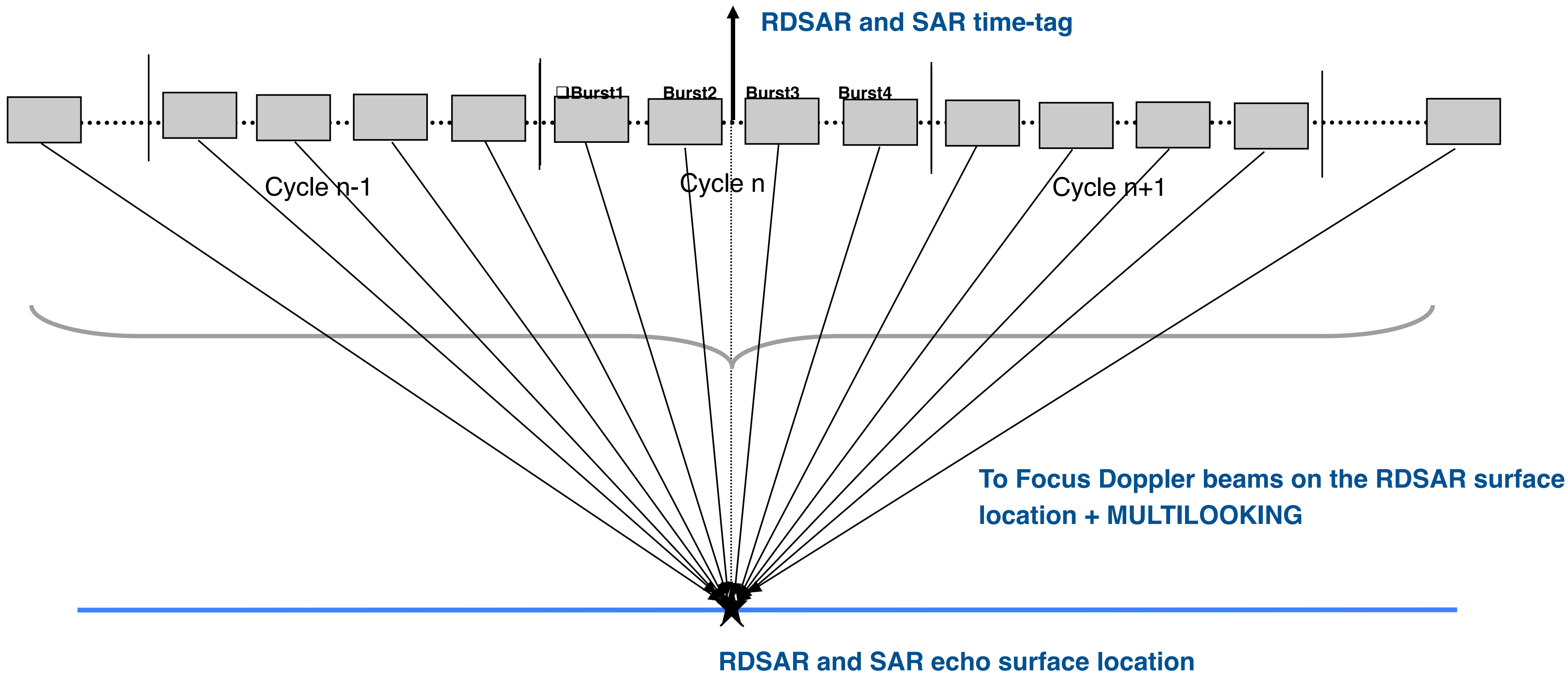
To retrack 20-Hz RDSAR waveform: Use of a Jason-2 like retracking:

-To retrieve range, SWH, σ0 and mispointing angle, a 4-parameter conventional Brown ocean retracker (MLE4) is used.

-LUT corrections, specially computed for Cryosat-2 RDSAR, are applied to retrievals to account for notably the Gaussian approximation of the PTR in the Brown model.

CPP SAR Algorithms

The RDSAR measurements are used as a reference to generate the SAR echoes → SAR and RDSAR echoes share the same time-tag and location.



CPP SAR Algorithms

- **Based on a full numerical Doppler model:** Numerical computation of the radar echo:

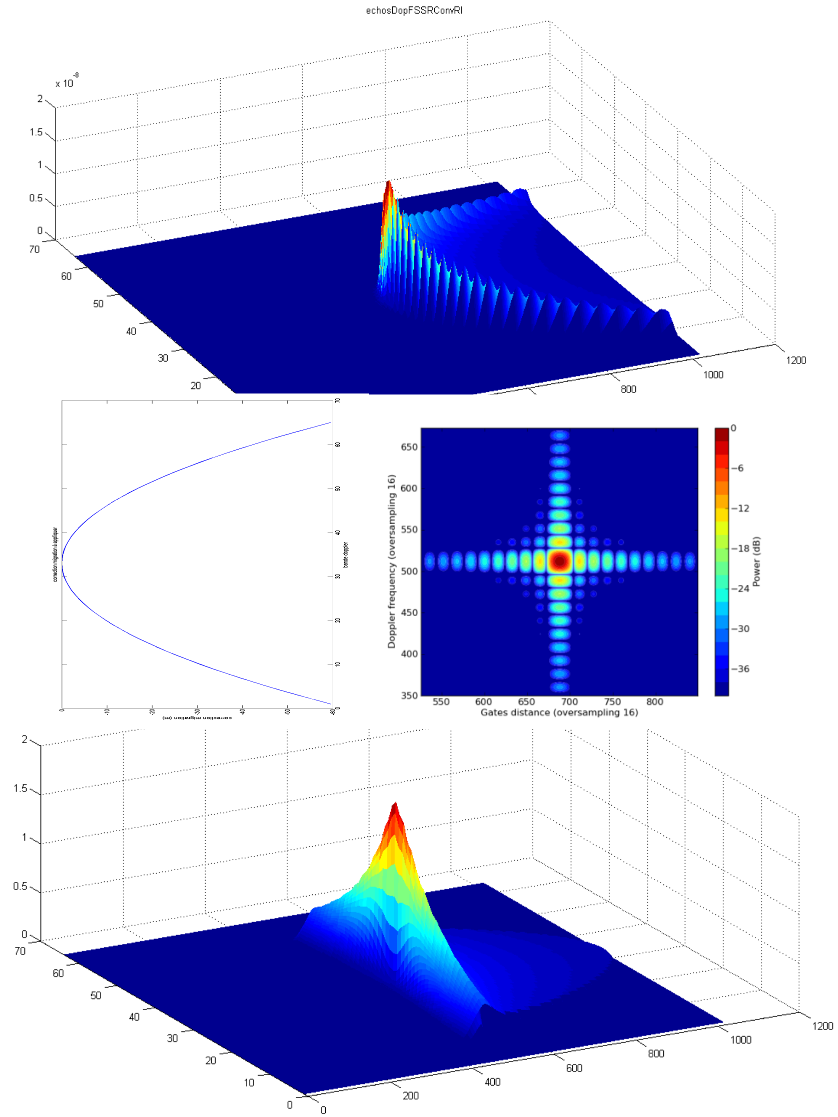
$$\text{Echo} = \text{FSSR} \otimes \text{IRs} \otimes \text{PDF}$$

Single Looks
- Computation of the FSSR for each doppler band (64). A constant mispointing configuration can be taken into account.
- Convolution with Instrument and Azimuth Impulse Response
- Convolution with the PDF of SWH

Multi Look
- Then, range migration is performed to align each single looks
- Sum of each Singlelook migrated: multilook Doppler echo

- Retracking: **inheritage from Jason-2 MLE3 Derivatives are numerically computed**.

- Mispointing information taken from StarTrackers (inputs of the retracking)



CPP SAR Algorithms

❑ Numerical approach?

Advantages:

-this approach allows to take into account any instrument characteristics (sinc PTR, antenna ellipticity, POS4 doppler ambiguities…)

-This approach allows to take into account any L1b specificities

Drawback:

requires CPU time but this can be managed using pre-computed database and/or parallel processing.