CENTRE NATIONAL D'ÉTUDES SPATIALES

KaRIn/SWOT Performance analysis tool

Application to near nadir swath extension

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Foreword

- **NASA and CNES** have recently agreed on the sharing of responsibilities for the SWOT mission.

- Closer technical discussions between JPL and CNES will take place in the framework of a joint team.

- The following study is based on a set of KaRIn input parameters that are likely to evolve in the next future

Outline

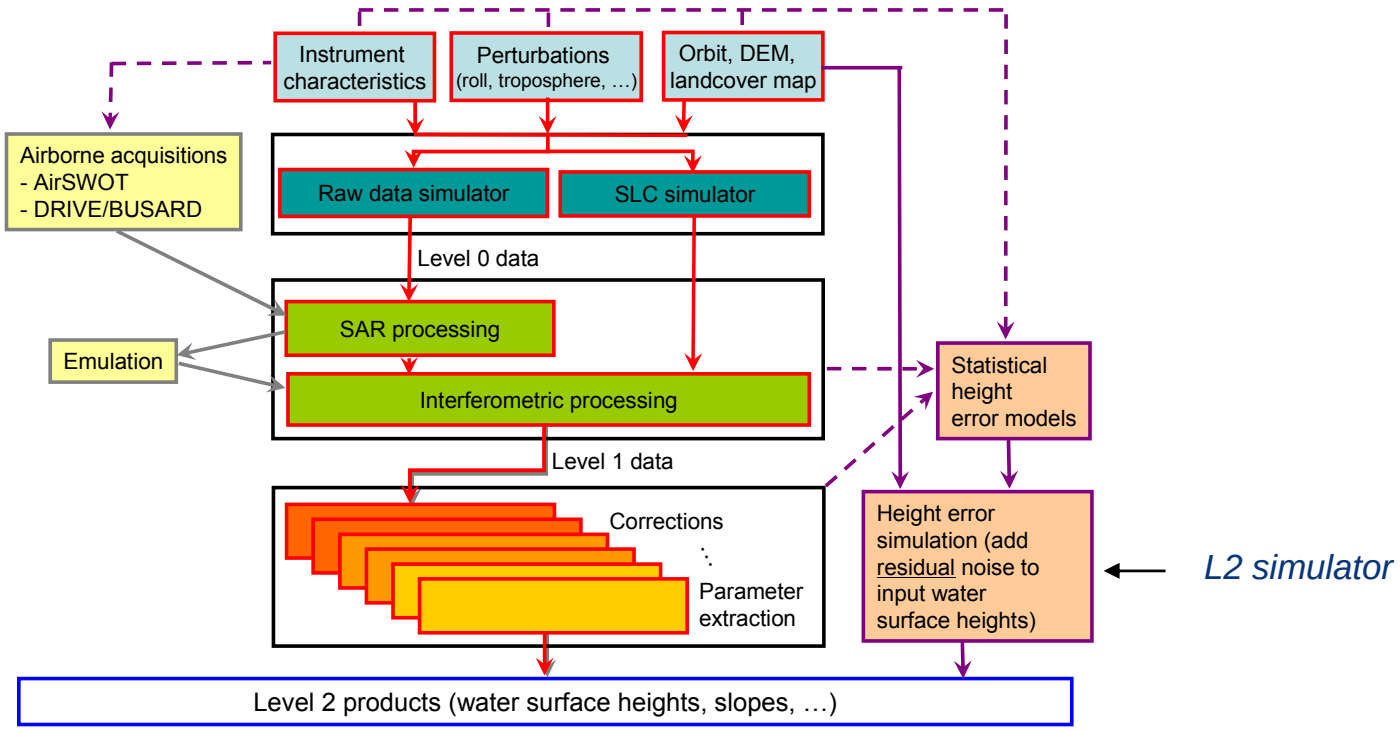
- KaRIn/SWOT Performance analysis tool
  - Introduction
  - Presentation

- Application to near nadir swath extension
  - Introduction
  - Chronogram
  - Geometry
  - Signal to Noise Ratio
  - Interferometric / Height Sensitivity

KaRIn/SWOT Performance analysis tool

Introduction

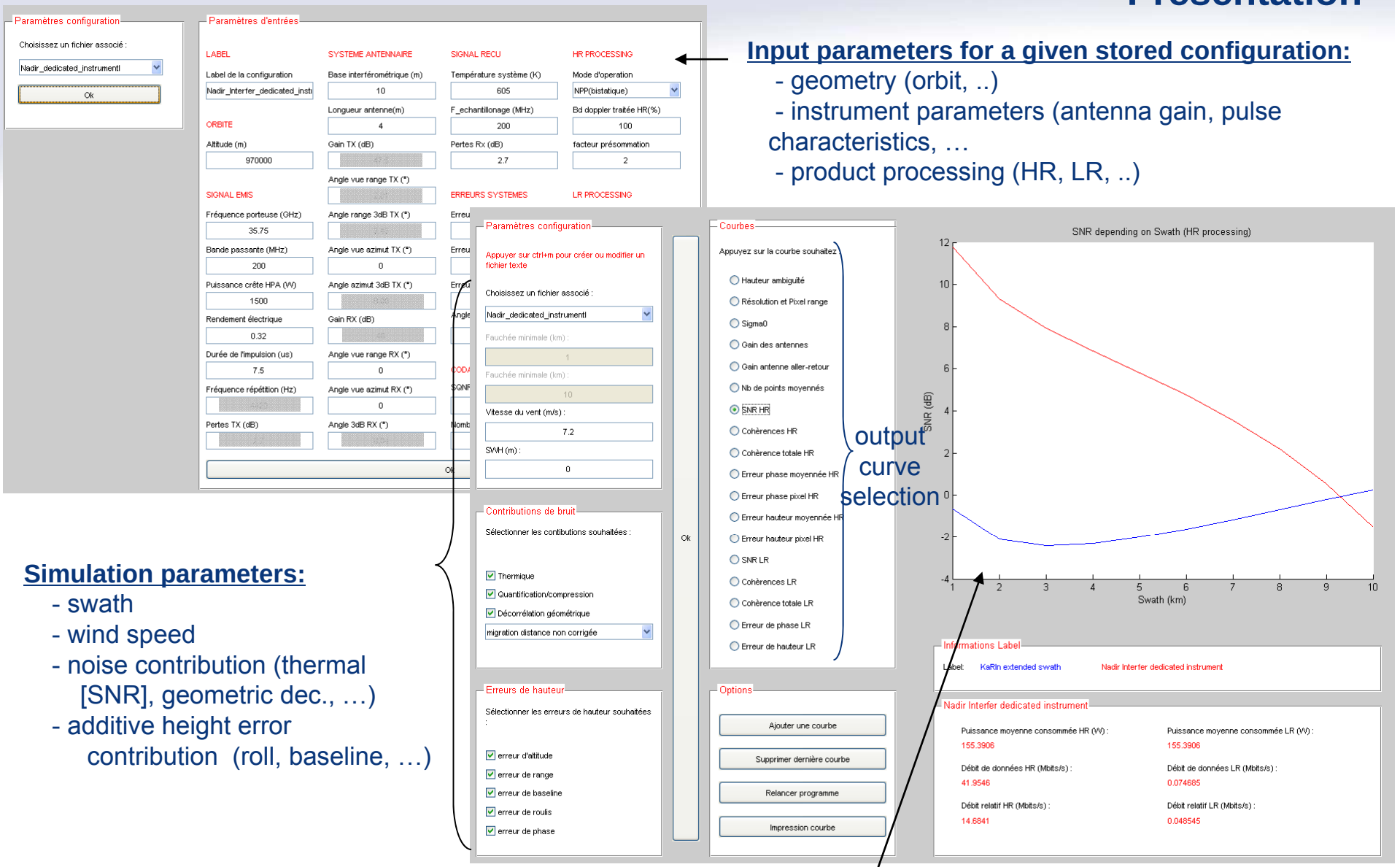
- **Goals :**
  - Evaluate height error performances at instrument level in order to consolidate the operating point, to evaluate the sensitivity of different parameters, …
  - To couple this statistical height error model with a L2 simulator *[PhD thesis of S. Biancamaria]*



- **Developed** by B. Mametsa at CNES from a tool delivered by Thales Alenia Space *[in the continuity of PhD thesis of V. Enjolras]*

KaRIn/SWOT Performances analysis tool

Presentation



Input parameters for a given stored configuration:

- geometry (orbit, ..)
- instrument parameters (antenna gain, pulse characteristics, …
- product processing (HR, LR, ..)

Simulation parameters:

- swath
- wind speed
- noise contribution (thermal [SNR], geometric dec., …)
- additive height error contribution (roll, baseline, …)

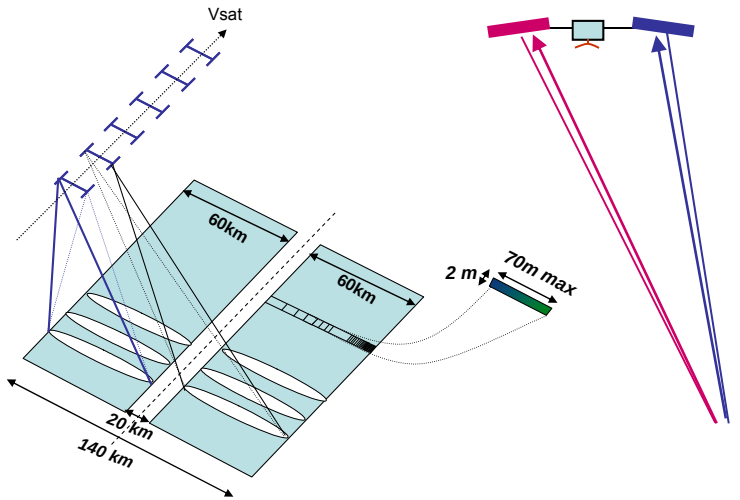
output curve selection

easy comparison of several configurations

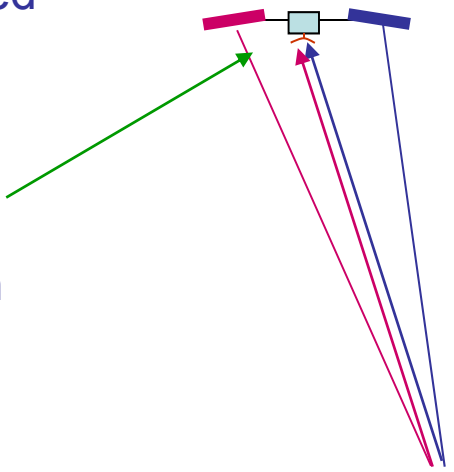
Application to near nadir swath extension

Introduction

- KaRIn is basically a **side looking radar** that is by nature incompatible with nadir observation. Thus, the nominal KaRIn swath is **10km to 60km** from nadir, leading to a **20km** nadir gap.

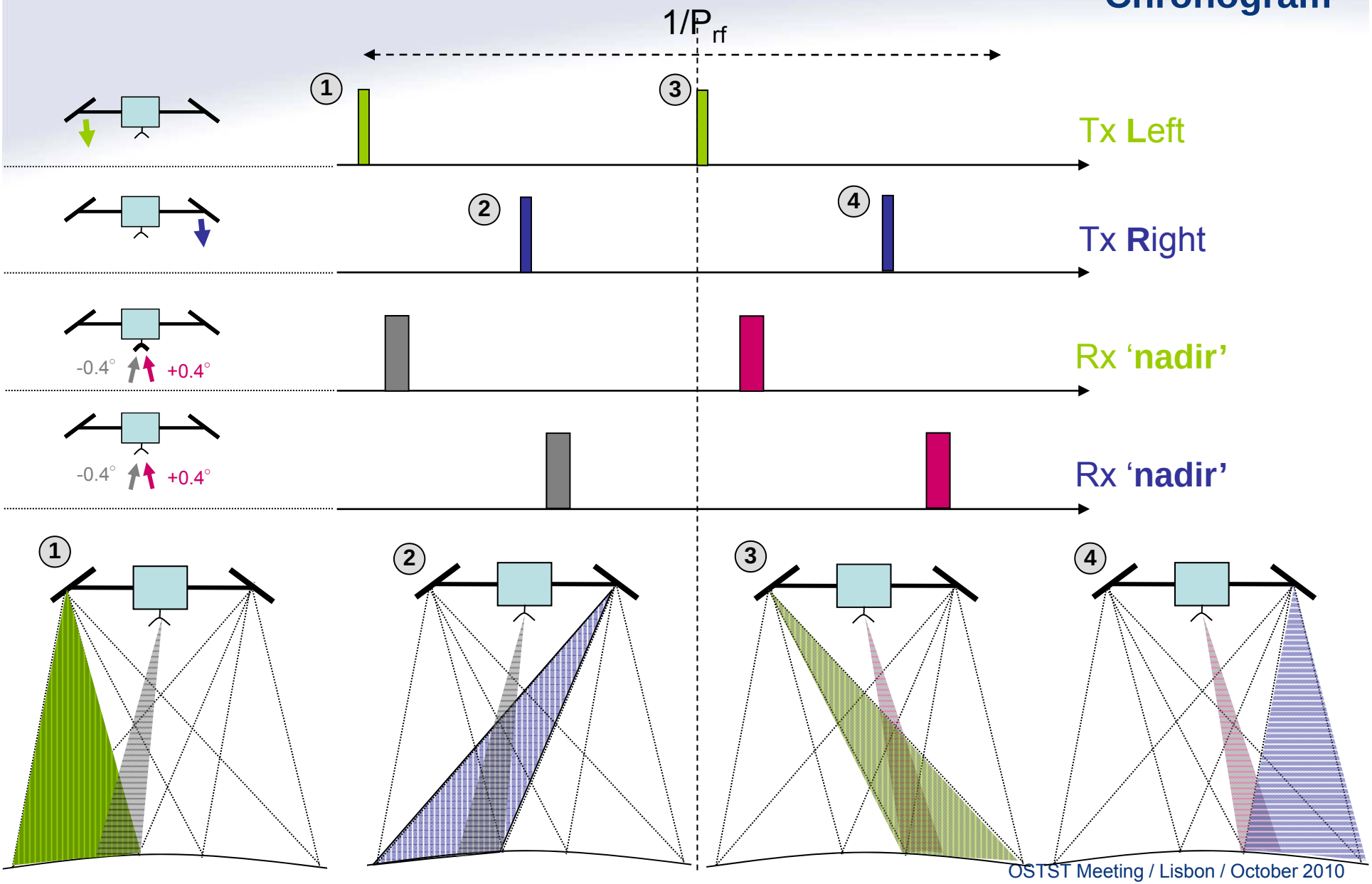


- In that context, E. Rodriguez has proposed a partially dedicated instrument, the "**Nadir interferometer option**", to extend the observation closer to nadir
  - Two additional feeds looking at ~ +/- 0.4° accommodated on the AMR antenna (switched into a single receive channel)
  - The near nadir interferometry is based on the signals received on the near nadir feeds from the KaRIn nominal transmission
  - The equivalent baseline is halved



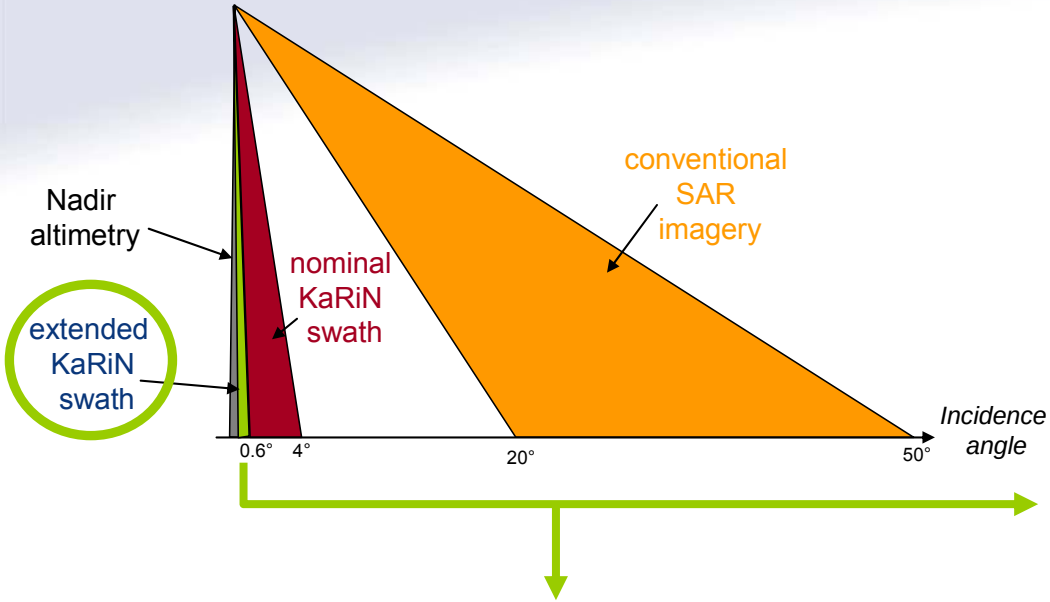
Application to near nadir swath extension

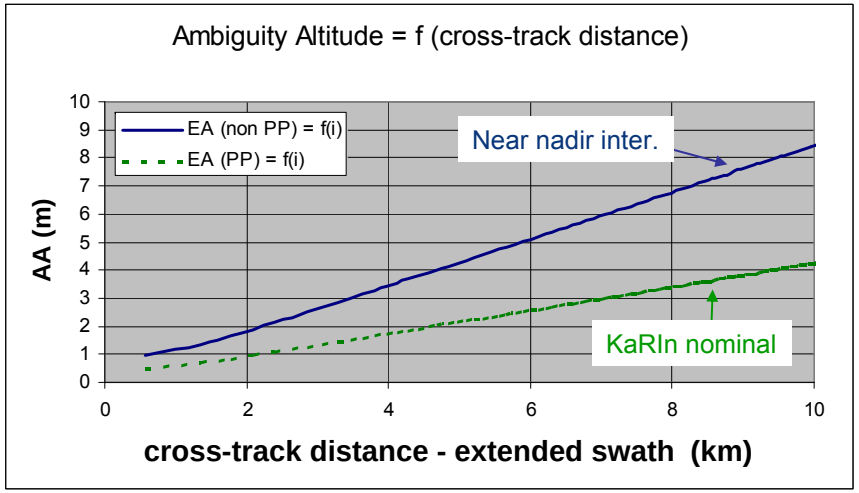
Chronogram

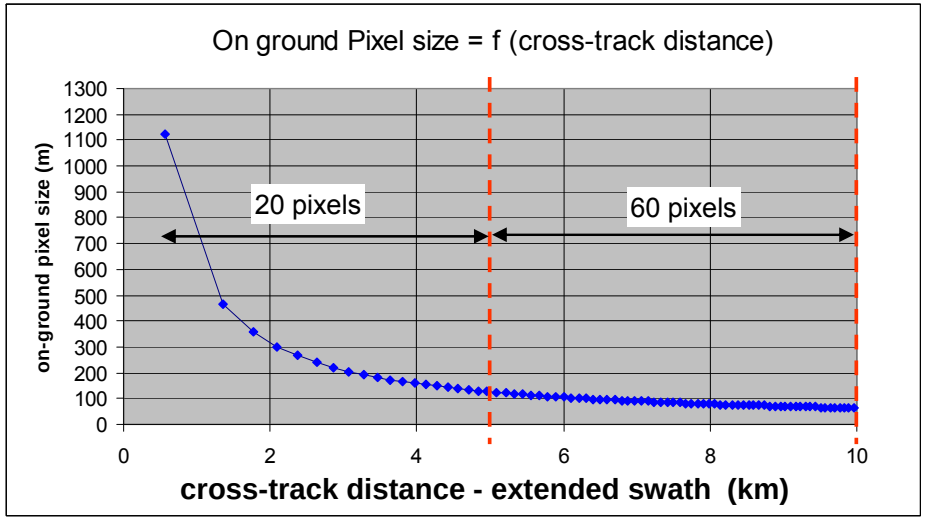


Application to near nadir swath extension

Geometry (1/2)





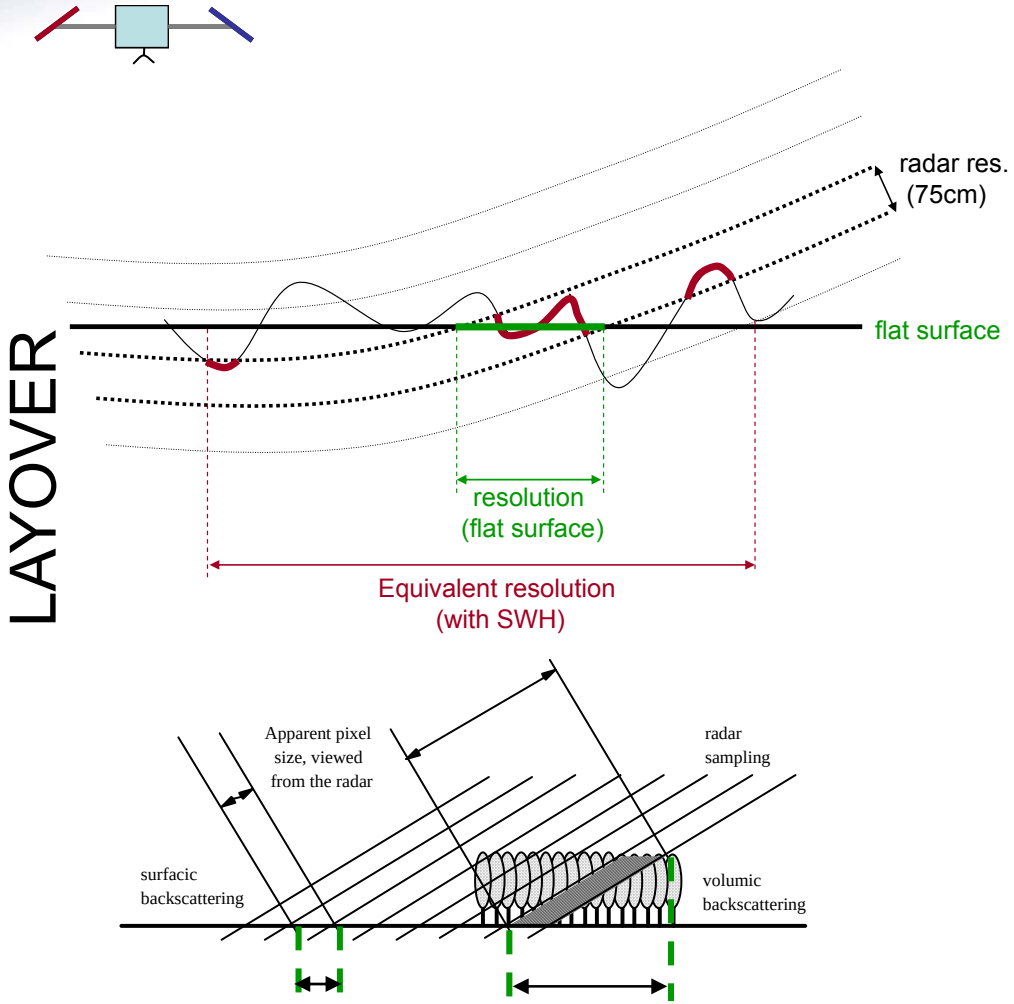


- Swath extension
  - Negligible impact on TM data rate
  - Only considered for **oceanography** due to large range pixel size *(compared to 10m-70m for the nominal swath)*
  - More limited range multilooking (1 km²)
- Near nadir interferometer vs. nominal KaRIn
  - Altitude of ambiguity doubled

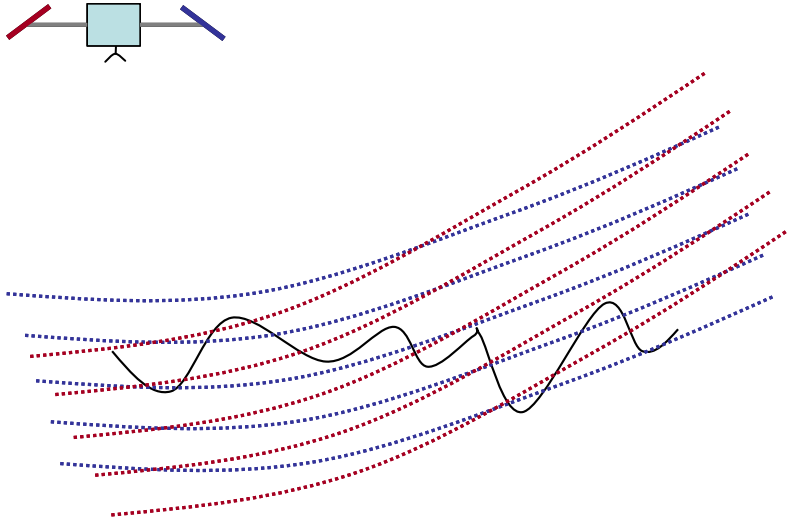
Application to near nadir swath extension

Geometry (2/2) – Impact of waves (SWH)

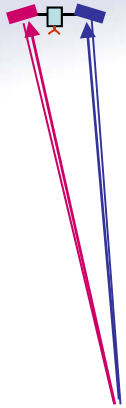
➢ **Degradation of projected resolution**



➢ **Geometric decorrelation**



❑ KaRIn nominal mode / extended swath



$$\gamma_{SNR} = \frac{1}{1+\frac{1}{SNR}} \qquad \gamma_{BAQ} = \frac{1}{1+\frac{1}{SQNR}}$$

$$\gamma_{GEOM} = 1 - \frac{\Delta_f}{B_f} \qquad \Delta_f \approx \frac{f_o.B}{2.r.\tan(\theta)}$$

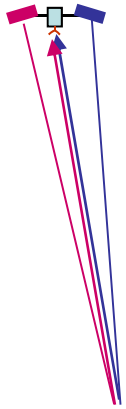
Total coherence

$$\gamma = \gamma_{SNR} \cdot \gamma_{BAQ} \cdot \gamma_{GEOM}$$

$$\tau_\Phi = \frac{1}{\sqrt{2.N_{look}}} \cdot \frac{\sqrt{1-\gamma^2}}{\gamma} \Rightarrow \tau_Z \approx \frac{\lambda.R.\tan(\theta)}{2.\pi.(2.B)}.\tau_\Phi$$

Random phase error ⇨ *Random height error*

❑ Near nadir interferometry option



Higher gain near nadir (AMR nadir pointing)

$$\gamma_{SNR} = \frac{1}{1+\frac{1}{SNR}} \qquad \gamma_{BAQ} = \frac{1}{1+\frac{1}{SQNR}}$$

$$\gamma_{GEOM} = 1 - \frac{\Delta_f}{B_f} \qquad \Delta_f \approx \frac{f_o.B/2}{2.r.\tan(\theta)}$$

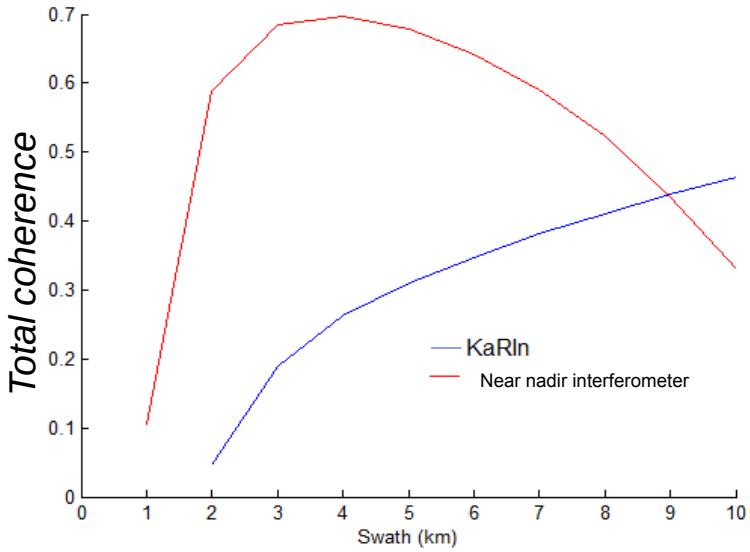
$$\gamma = \gamma_{SNR} \cdot \gamma_{BAQ} \cdot \gamma_{GEOM}$$

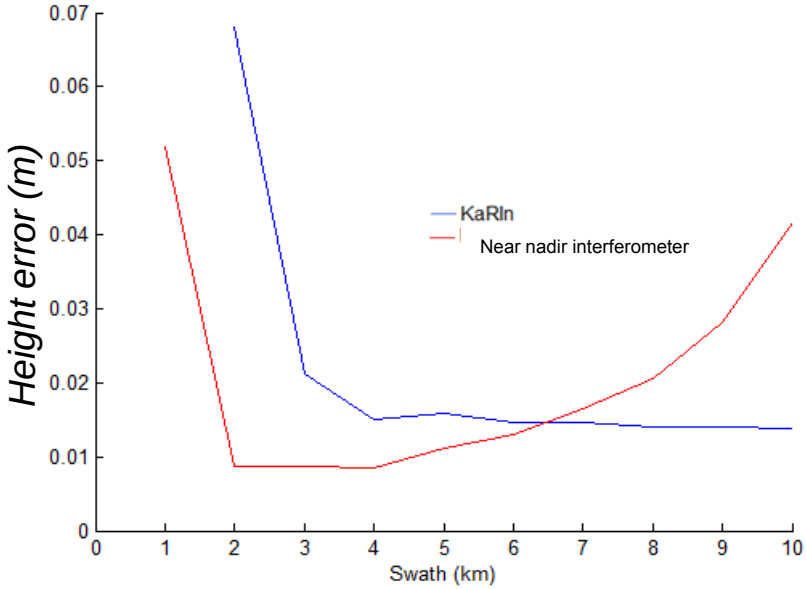
$$\tau_\Phi = \frac{1}{\sqrt{2.N_{look}}} \cdot \frac{\sqrt{1-\gamma^2}}{\gamma} \Rightarrow \tau_Z \approx \frac{\lambda.R.\tan(\theta)}{2.\pi.(2.B)}.\tau_\Phi$$

Equivalent baseline (B/2)

Interferometric / Height Sensitivity

- Comparison of Near nadir interferometer and nominal KaRIn with extended swath





Limitations (phenomena not yet taken into account):

- Impact of azimuth ambiguities
- **Geometric decorrelation** must be carefully studied, mainly at very low look angles on ocean (with waves)
- Ground projected resolution also affected by SWH

Outlook

- *Update results after JPL/CNES technical discussion*
- *Continue the analysis of the geometric decorrelation (near nadir) with a precise sea high resolution model [PhD thesis of P. Dubois]*
- *Couple the KaRIn/SWOT performance analysis tool with level 2 thematic simulator (PhD thesis of C. Lion in the continuity of PhD thesis of S. Biancamaria)*
- *Apply this methodology to evaluate the performances of airborne validation campaigns (DRIVE on BUSARD on French side soon [2010-2011])*