

Preliminary results from the
independent SAOCOM
commissioning phase



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Outline

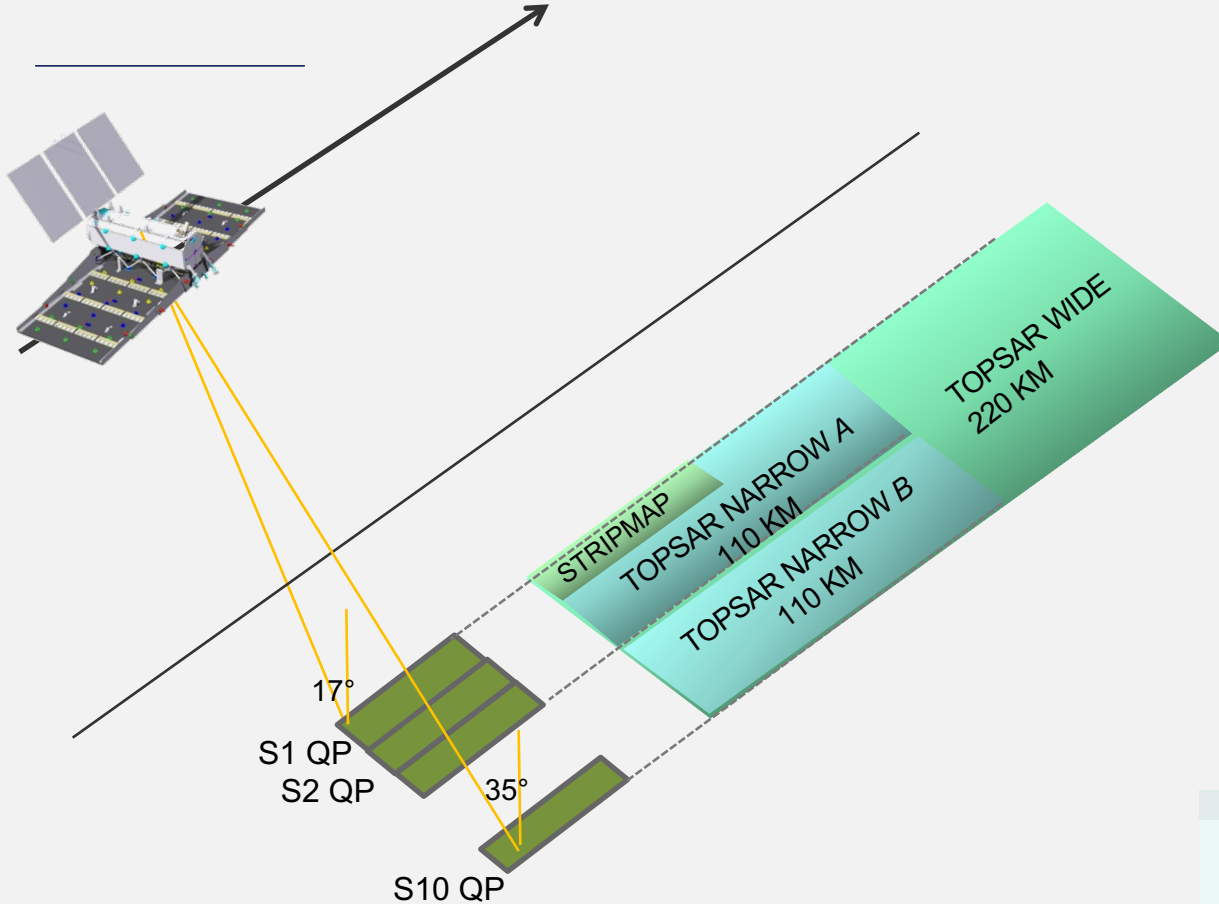
- SAOCOM introduction
- ARESYS' involvement in SAOCOM
- Commissioning Phase activities plan
- Status of the processor
- Outlook

SAOCOM mission overview

- *Satellites*: Constellation of 2 twin satellites
- *Orbit*: sun-synchronous, 625 – 650 Km altitude
- *Payload*: L-band SAR instrument, 50 MHz band
- *Antenna*: full-pol, active array antenna (7 x 20 phase centers)

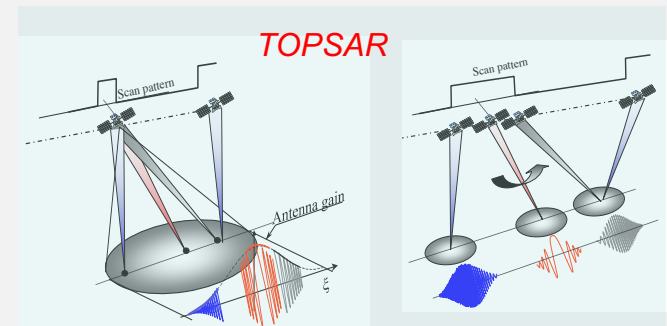


SAOCOM Quad POL swaths: overview

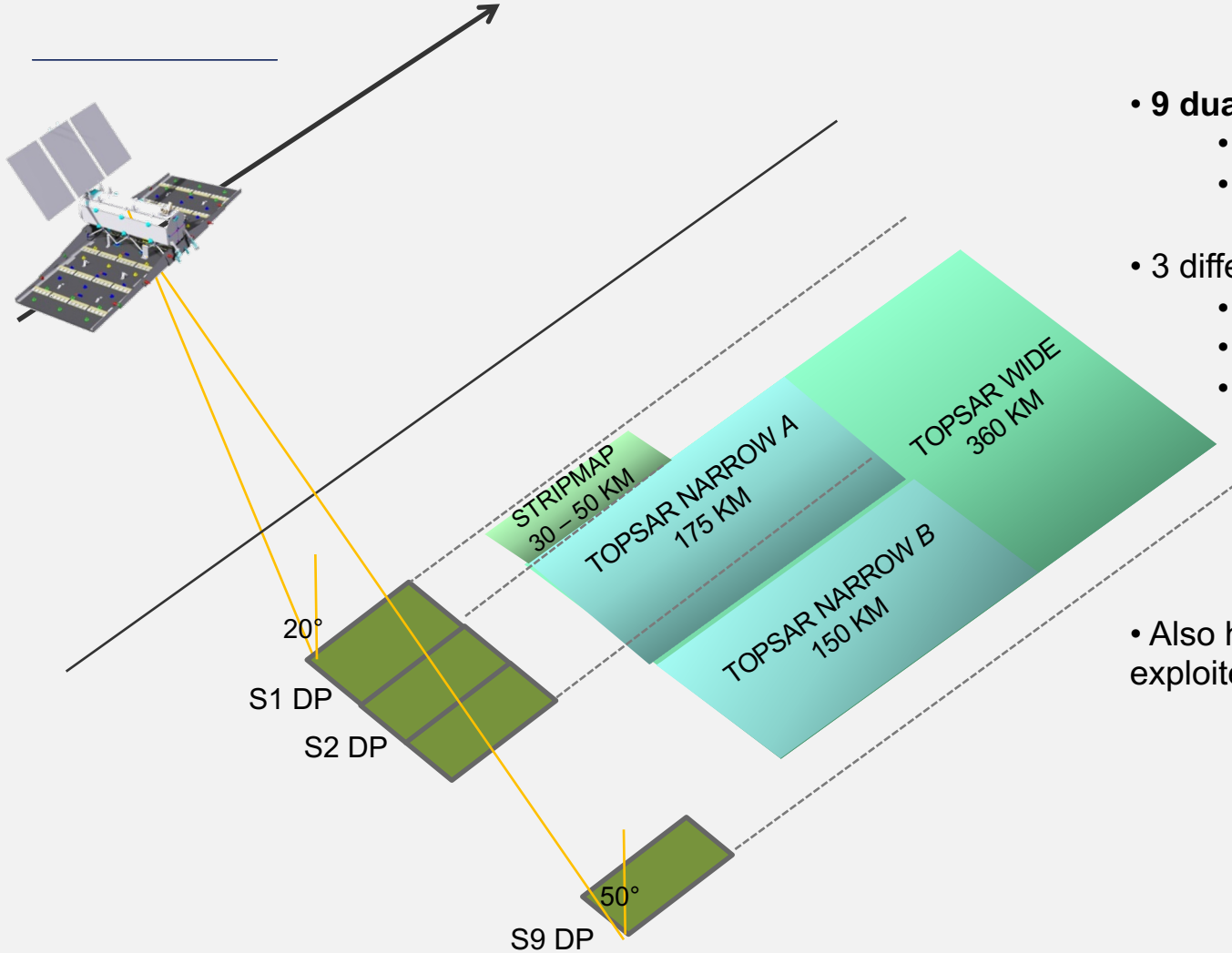


TOPSAR mode chosen to maximize coverage versus geometric & radiometric resolution

- **10 quad-pol beams** in elevation allow maximum coverage of 220 KM
- 3 different spatial resolutions [m]
 - 100 (az) x 10 (rg) WIDE
 - 50 (az) x 10 (rg) NARROW
 - 6 (az) x 10 (rg) STRIPMAP
- The TOPSAR mode is exploited :
 - LOW scalloping
 - Wide coverage
 - High resolution
 - Scanning timeline optimization possibility



The SAOCOM DUAL POL swaths: overview



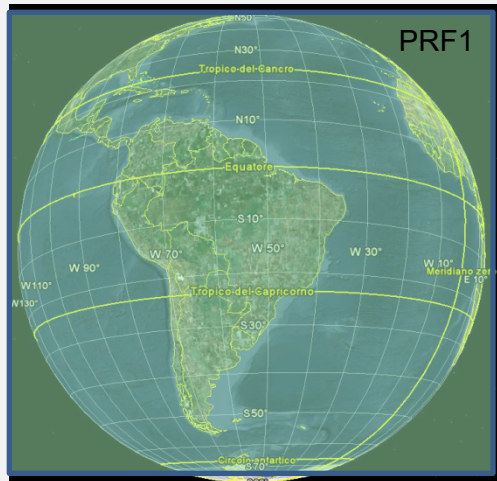
- **9 dual-pol beams** in elevation allow:
 - maximum coverage of 360 KM
 - total access 430 KM

- 3 different spatial resolutions [m]
 - 50 (az) x 10 (rg) WIDE
 - 30 (az) x 10 (rg) NARROW
 - 5 (az) x 10 (rg) STRIPMAP

- Also here the TOPSAR mode is exploited

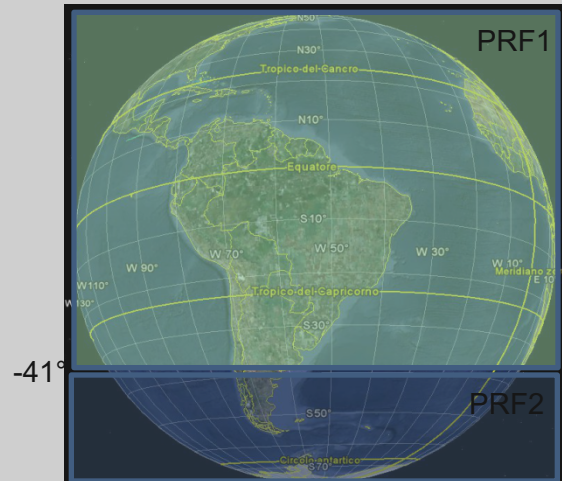
Radar timing design: PRF switch round orbit strategy

Solution A (PDR)



- ✗ With roll steering
- ✓ 1PRF round orbit
- ✓ Complete design available at PDR
- ✓ Simplest instrument operation
- ☞ ASTRIUM patent

Solution B

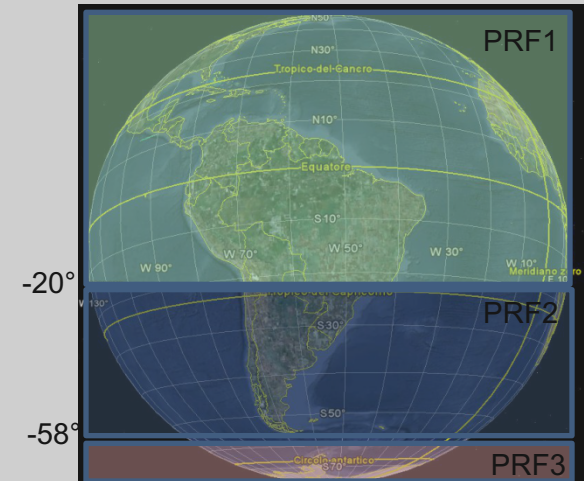


- ✓ No roll steering
- ✓ 2 PRFs round orbit
- ✓ Minimum PRF set without roll steering
- ✗ PRF switch over Argentina



Selected baseline

Solution C



- ✓ No roll steering
- ✗ 3 PRFs round orbit
- ✓ PRF switch over Argentina avoided

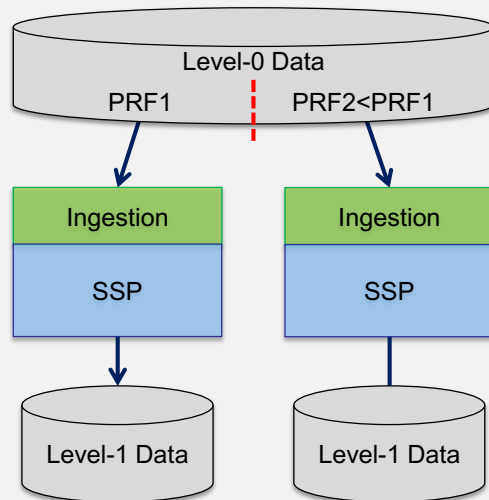
Very similar performances



Impact of PRF change on processing chain

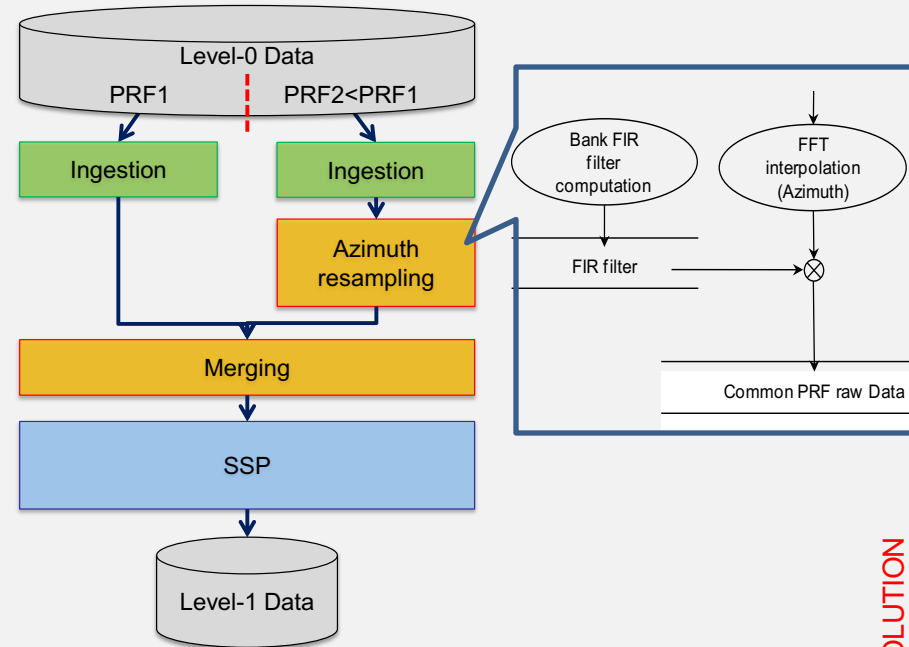
✓ Impact is only on STRIPMAP mode

Split product solution



- ✓ **Performance**
- ✓ **Simple solution**
- ✗ **Coverage loss at PRF switch boundaries (~15 Km)**

Data re-sampling solution



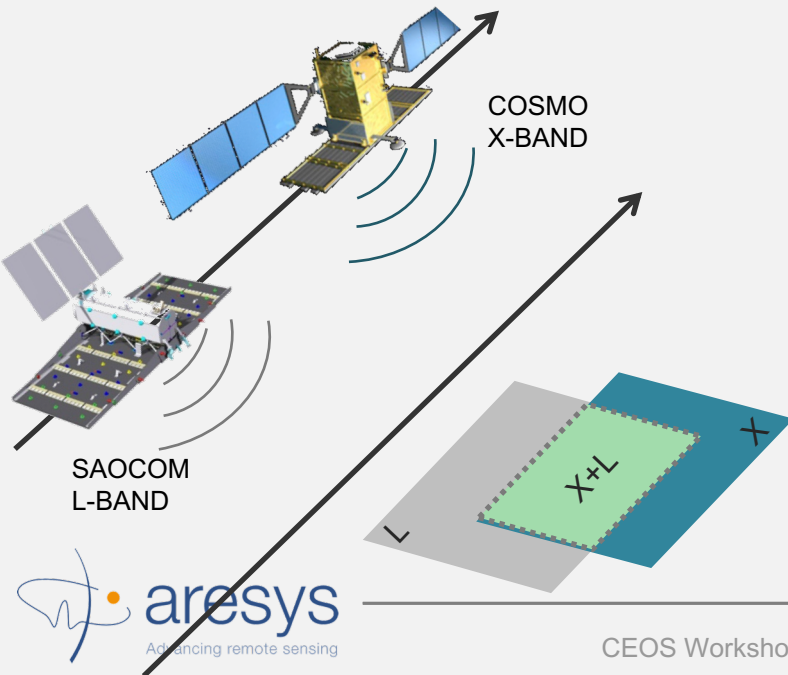
- ✓ **No coverage loss**
- ✓ **No splitting**
- ✗ **Performance, complexity**

IMPLEMENTED SOLUTION

SIASGE compatibility: requirements

SAOCOM and the italian COSMO-SKYMED shall cooperate to give joint "X+L" SAR products

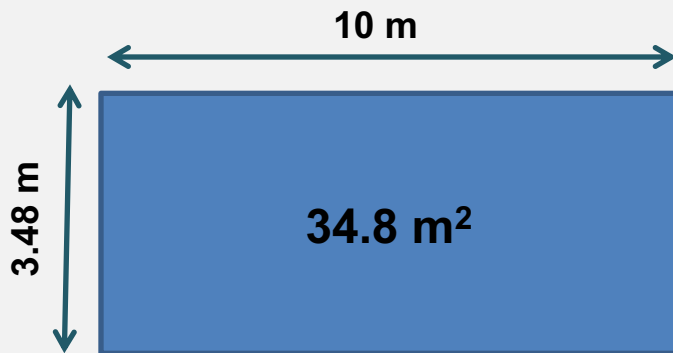
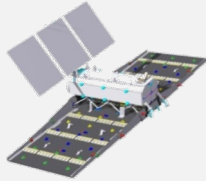
Requirement ID	Description
SIA-MRD-FUN-152	The SIASGE System shall be able to provide joint X+L products , taking into account the following mandatory constraints: <ul style="list-style-type: none"> • Minimization of the events time de-correlation by availability of SAR coherent images; • Minimization of the cross geometric distortion between the two sensors; • Maximization of the swath overlapping.
SIA-MRD-FUN-157	The Reference Acquisition Mode for both SAR Bands shall be given respectively by the following Stripmap Baseline Mode: <ul style="list-style-type: none"> • the Stripmap HIMAGE mode in X-Band and • the Stripmap High Resolution Single Polarization mode in L-Band.



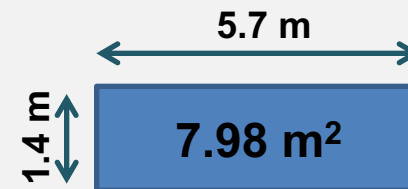
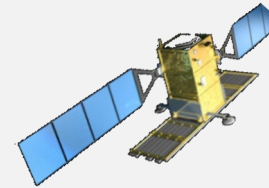
SAOCOM \ COSMO-SkyMed	Stripmap HIMAGE	ScanSAR Wide	ScanSAR Huge
	Stripmap DP/(QP) Mode	40/(30) x 40 Km ² 10 m resolution	N.A.
TopSAR DP/QP Narrow	N.A.	100 x 100 Km ² 50 m resolution	N.A.
TopSAR DP/QP Wide	N.A.	N.A.	200 x 200 Km ² 100 m resolution

COSMO vs. SAOCOM: the role of antenna size

SAOCOM



COSMO



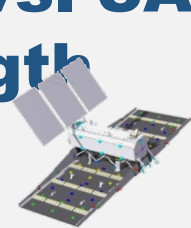
In a SAR, performances in terms of pixels imaged, are constrained by the antenna size.

$$\text{Resolution}^{-1} \times \text{Swath width} = k \times \text{Antenna Area}$$

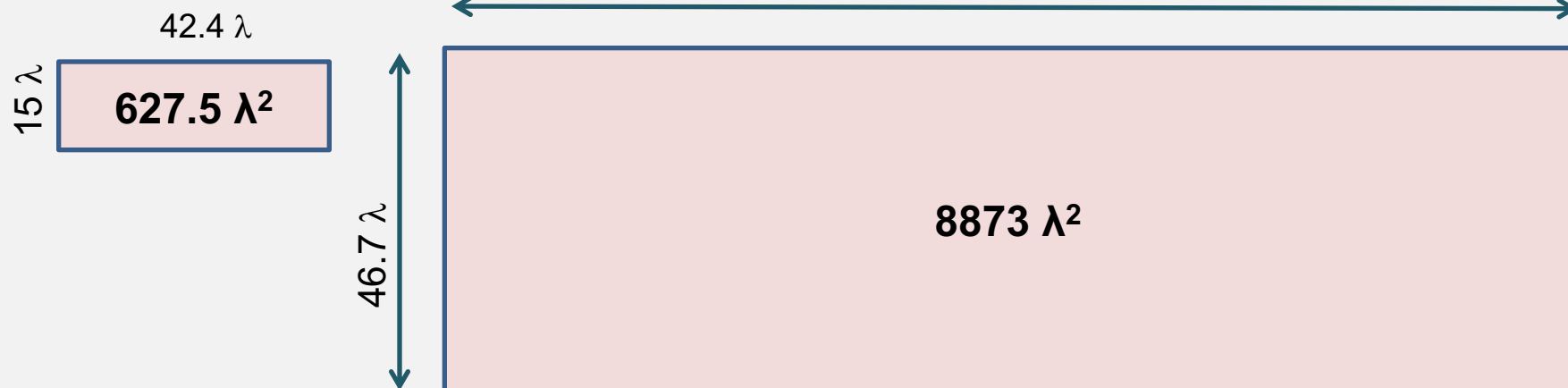
SAOCOM has huge size compared to COSMO, when measured in m² - FACTOR 3.4

COSMO vs. SAOCOM: the role of antenna size and wavelength

SAOCOM



COSMO

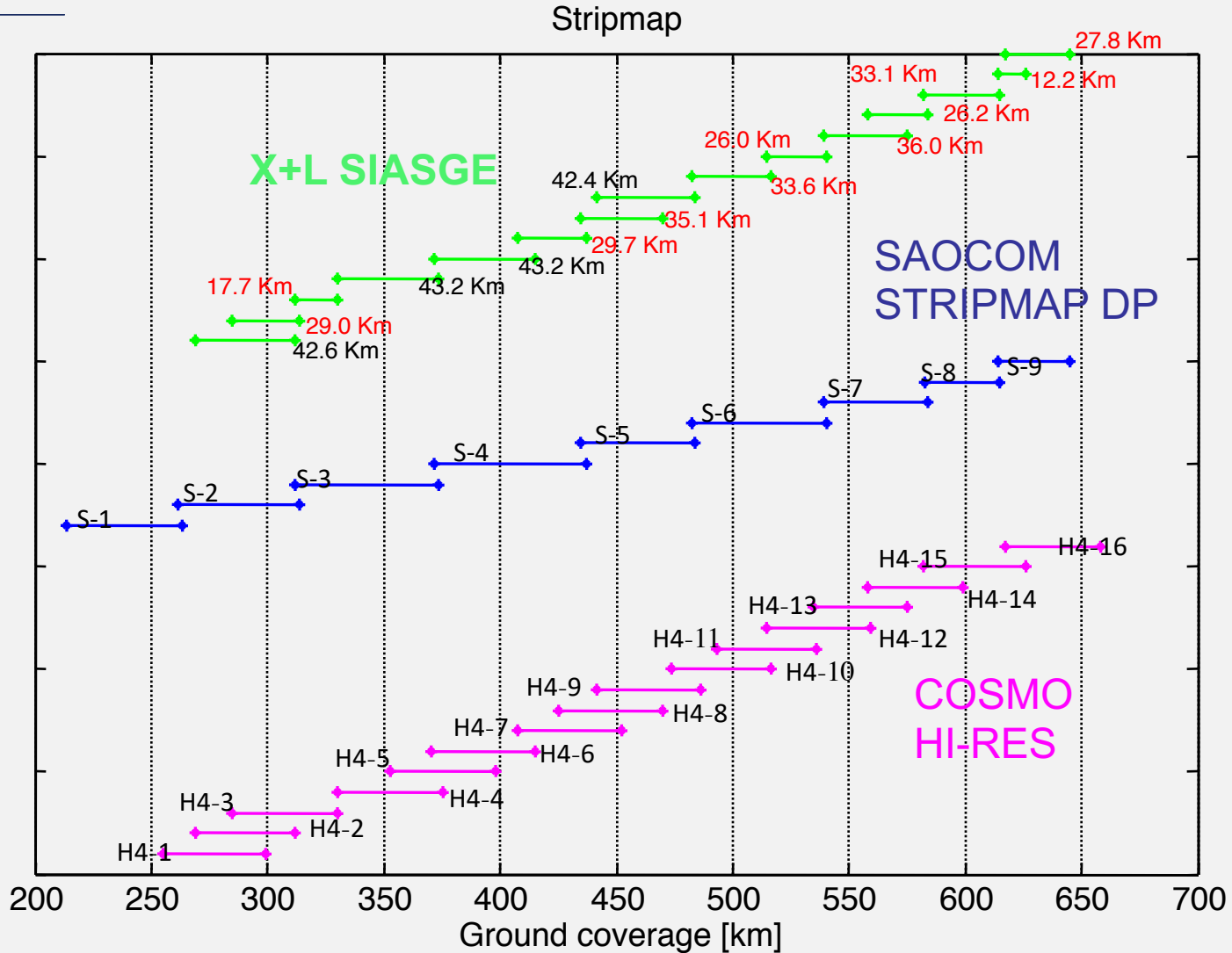


However when sizes are given in wavelengths, the proportions are by far favorable to COSMO. FACTOR 14.

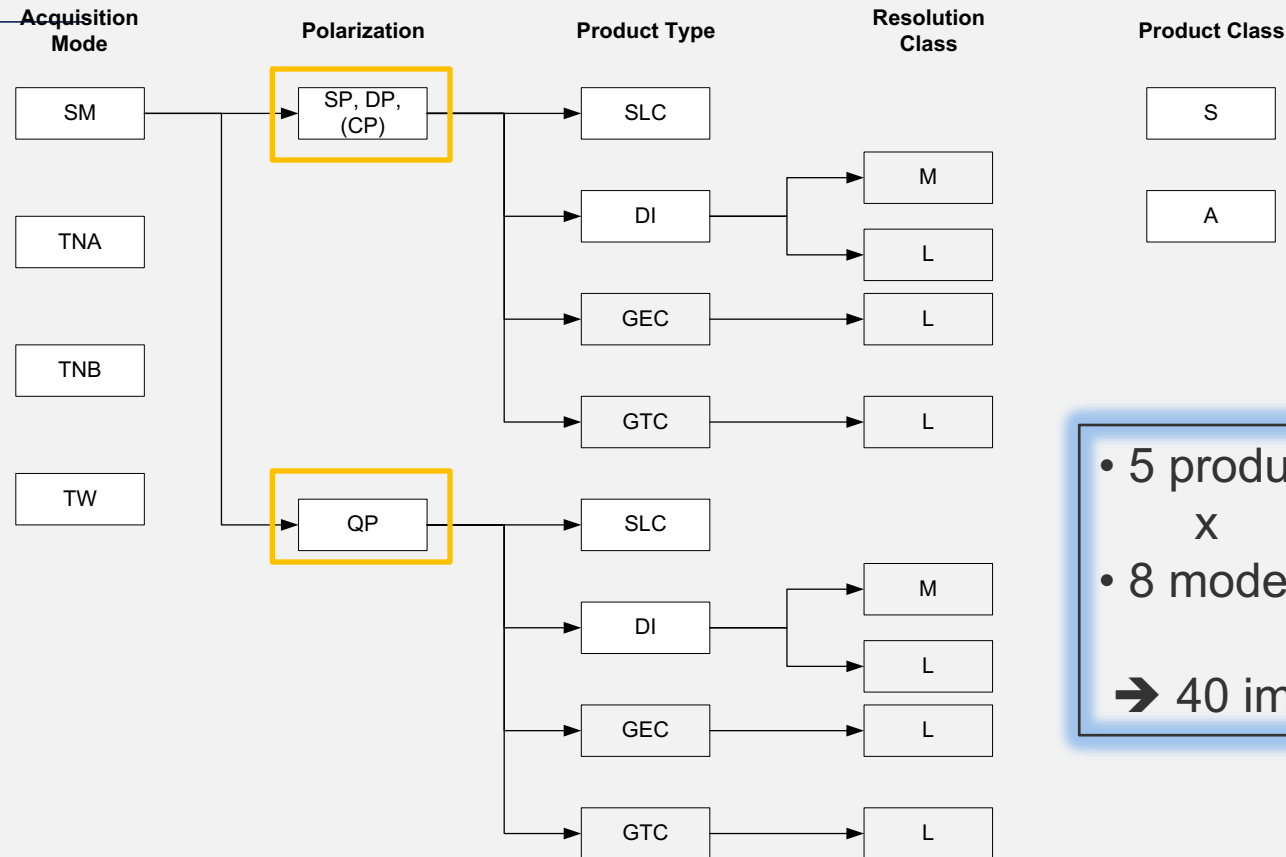
The Quad-Pol capabilities, reduce the equivalent size by an additional factor 2.

➔ In the SWATH / RESOLUTION tradeoff, **COSMO performs better by a factor 14, that becomes 28 to account for Quad-Pol.**

SIASGE compatibility: the Stripmap Dual-pol swaths



QUAD/DUAL POL data processing: basic-products overview



- 5 products per mode
- 8 modes
- ➔ 40 imaging products

SM: Stripmap
TNA: Topsar Narrow A
TNB: Topsar Narrow A
TW: Topsar Wide

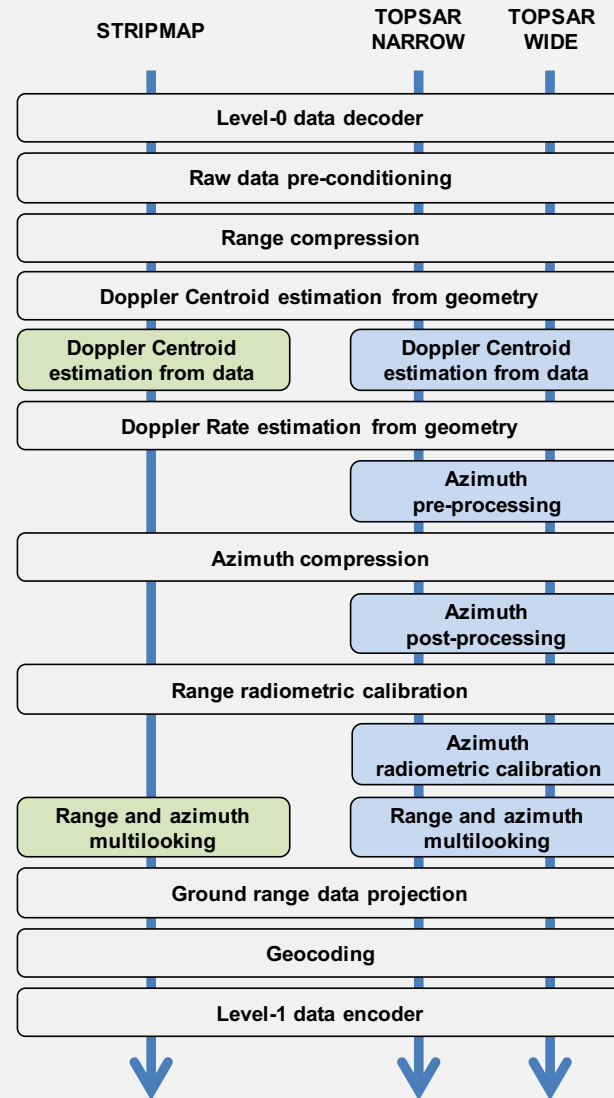
SP: Single Pol
DP: Dual Pol
QP: Quad Pol
CP: Circular Pol

SLC
DI (or GRD)
GEC
GTC

M: Medium
(Res ~ = 50x50m)
L: Low
(Res ~ = 100x100m)

S: Standard
A: Annotation

SAR Processing chain overview



SSP performance: the first datatakes

- SSP is integrated in the Cordoba Ground Segment (CUSS), providing SAR data processing from L0 to L1
- After launch, it is being exploited to process the acquired datasets

Item	Stripmap	TOPSAR	remarks
Number of processed scenes	20+	5	No notch and TOPSAR dual pol
Normal priority Issues		10	
High priority issues		1	L1D products generation
Blocking issues	None	None	

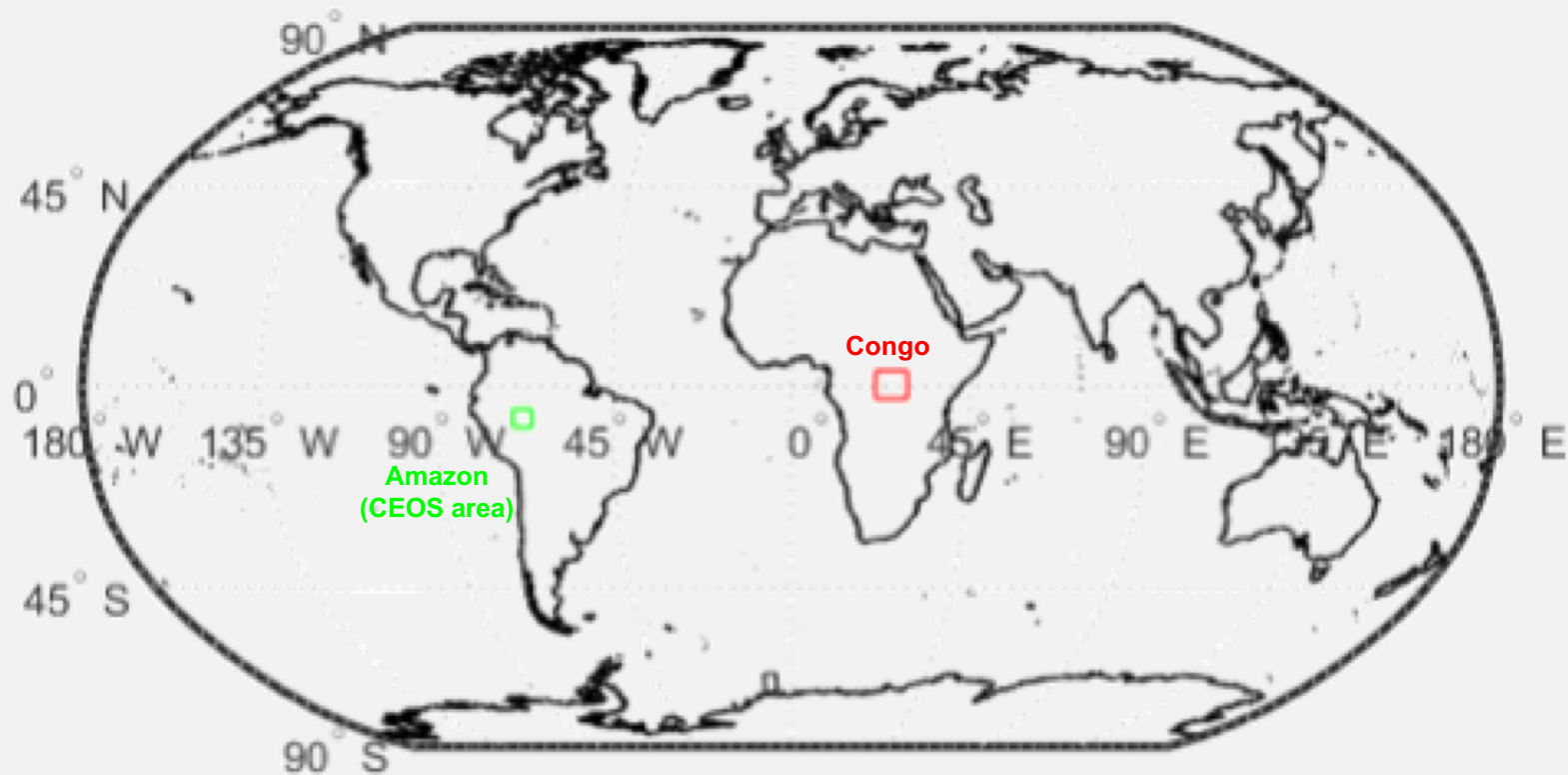
SAO-CP: Aresys tools for SECF

- Aresys has provided a set of tools to be integrated within the SAR Engineering Calibration Facility (SECF) framework:
 - **Elevation pointing tool:** a tool for the estimation of the roll mis-pointing from Notch acquisitions over homogeneous areas (e.g. Rain Forest)
 - **SAR modes design and performance tools:** a set of interactive tools for
 - i. Beam design optimization
 - ii. Antenna excitation coefficients optimization
 - iii. L1 Processing parameters optimization and L1 performance prediction
 - **Polarimetric calibration tool:** a tool based on a covariance matching approach (COMET) to estimate channel imbalance and cross-talk from full-polarimetric SLC data including a transponder

SAO-CP: Aresys independent assessment

- Aresys has been appointed by CONAE to perform an independent processing and analysis of the data during commissioning phase, providing an independent assessment of:
 - **Radiometric calibration:** absolute from point targets RCS analysis (CRs and transponder) and relative from distributed target areas such Rain Forest (Amazonia and Congo)
 - **Pointing calibration:** elevation pointing calibration from Notch acquisitions and azimuth pointing calibration from data Doppler Centroid estimates
 - **IRF analysis:** IRF parameters (resolution, side lobes, ...) from acquisitions over CRs and transponder
 - **Geometric calibration:** azimuth and range localization accuracy from acquisitions over CRs and transponder
 - **Polarimetric calibration:** co-registration offsets, channel imbalance and & cross-talk estimation

Rain Forest calibration areas



Region	NW Latitude [deg]	NW Longitude [deg]	SE Latitude [deg]	SE Longitude [deg]
Amazon Rain Forest	-4,99	-70,54	-9,13	-65,67
Congo Rain Forest	3,60	21,44	-2,64	29,26

Aresys CP activities plan

Image Type	Analysis	Calibration type	Notes
Point target	Spatial resolution	IRF analysis	
	Peak-to-Side Lobe Ratio	IRF analysis	
	Integrated Side Lobe Ratio	IRF analysis	
	Localization	Geometric	Comparison against known target location
Rain Forest	Elevation Antenna Pattern	Radiometric	Assuming flat γ -profile
	Azimuth scalloping	Radiometric	TopSAR data only
	Equivalent Number of Looks	Radiometric	
Elevation notch	Roll mis-pointing estimation	Pointing	
Full-pol data	Channel imbalance	Polarimetric	Data shall include PARC
	Cross-talk	Polarimetric	
Transponder data	Azimuth Antenna Pattern	Radiometric	Two way from the data, TX only from transponder records
Any data	Azimuth pointing estimation	Pointing	From data Doppler Centroid estimates

Summary and outlook

- ARESYS involvement in the SAOCOM mission and commissioning phase has been presented
- Today, SAOCOM SAR Processor is successfully running in the CONAE GS
- No blocking issues have been reported during the processing of the first acquisitions after launch
- We look forward to the start of the Commissioning Phase to start with the calibration tasks.