The Biomass Mission, status of the satellite system

M. Arcioni, P. Bensi, M. Fehringer, F. Fois, F. Heliere, **K. Scipal**

PolInSAR/Biomass Meeting 2015, ESRIN

29/01/2015

1. Key facts (lifetime, duty cycle etc, launcher)
2. Data policy slide

Biomass products

Above-ground biomass (tons/hectare)

- 200 m resolution
- 1 map every 6 months
- global coverage of forested areas
- accuracy of 20%, or 10 t ha^{-1} for biomass < 50 t ha^{-1}

Upper canopy height (meter)

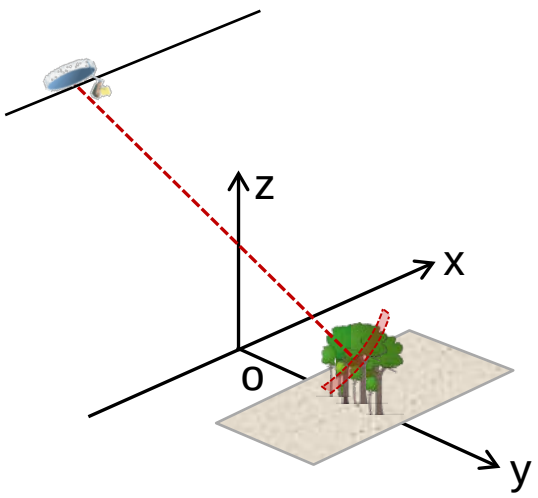
- 200 m resolution
- 1 map every 6 months
- global coverage of forested areas
- accuracy of 20-30%

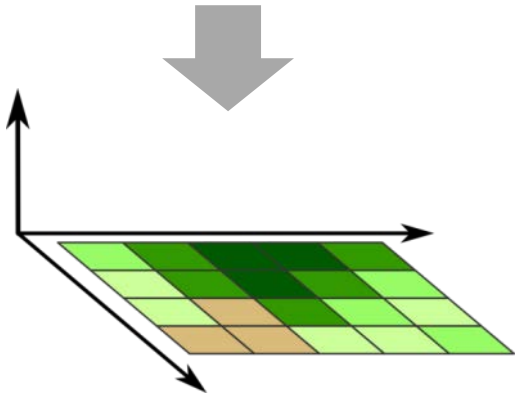
Areas of forest clearing (hectare)

- 50 m resolution
- 1 map every 6 months
- global coverage of forested areas
- 90% classification accuracy

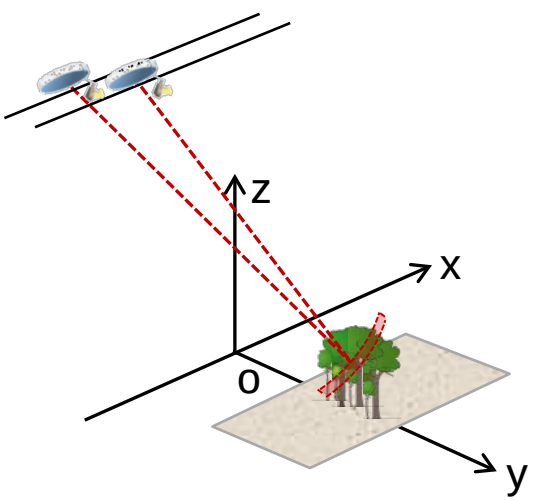
Biomass will deliver 3 independent types of information

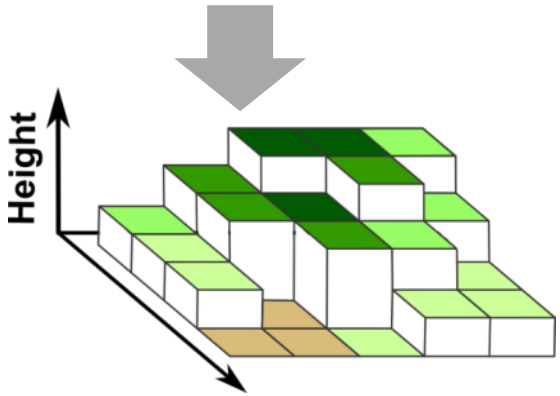
PolSAR
(SAR Polarimetry)



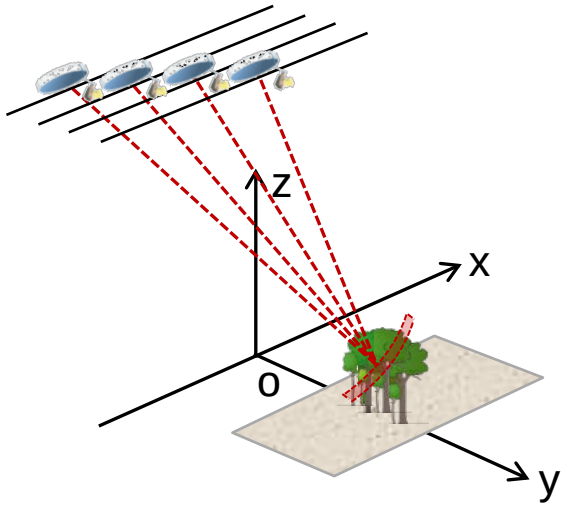


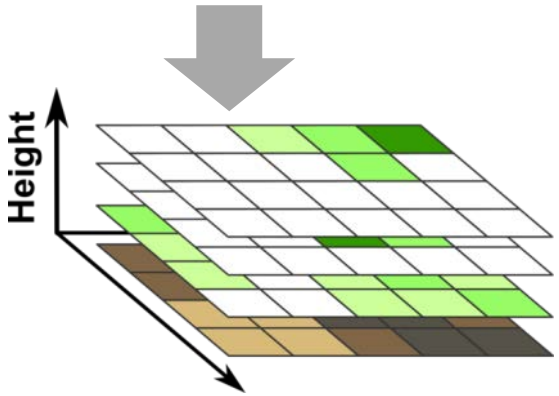
PolInSAR
(Polarimetric SAR Interferometry)





TomoSAR
(SAR Tomography)





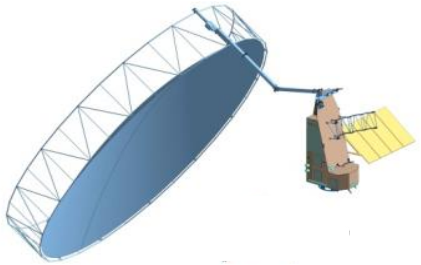
Key driver requirements

Cover high biomass forest

Single Satellite Mission

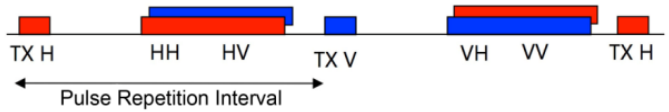
- Low frequency **435MHz**
- Large swath (coverage), resolution, ambiguity

Large antenna (11m-12m), low power (200-300W SAR peak power)



SPACE SEGMENT
Single Spacecraft
Mass: ~1200 kg
Power: ~1500 W

- Full polarimetric mode of operation
- Interferometry
- Good cross-polar isolation



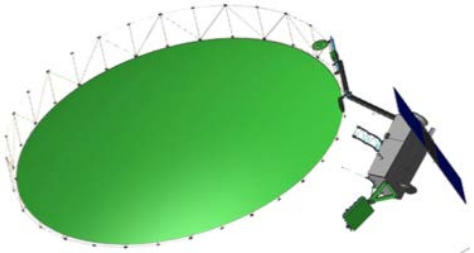
Stripmap mode, satellite roll for beam repointing, polarisation pre-compensation technique for the feed

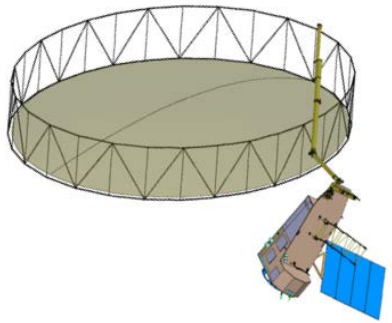
- Radiometric stability, bias

Calibration (internal and external calibration)

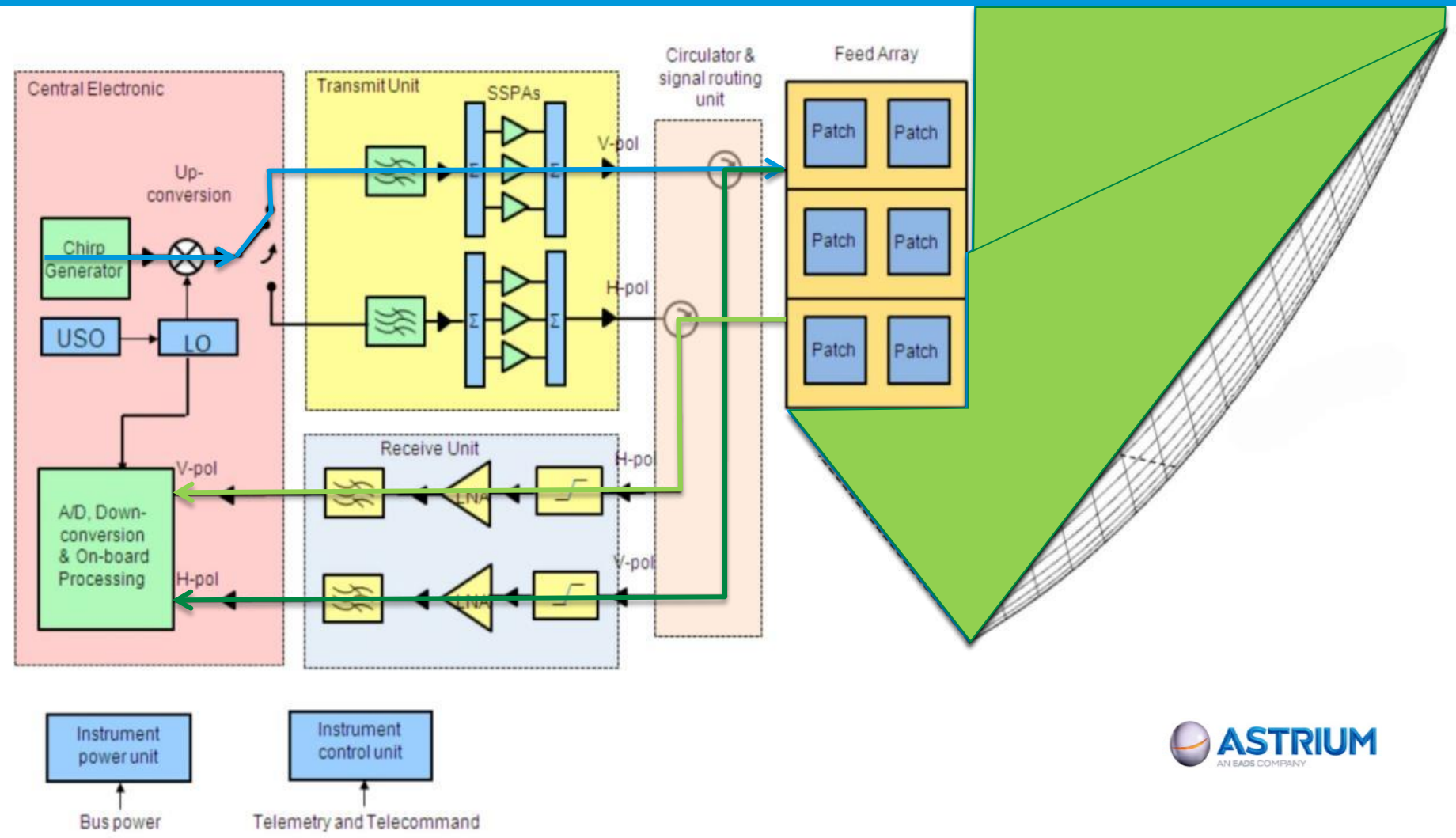
BIOMASS Requirements

Parameter	Requirement
Instrument type	P-band full polarimetric SAR
Centre frequency	435 MHz (P-band)
Bandwidth	6 MHz (ITU allocation)
Incidence angle (near)	Threshold: 23°; Target: 25°
Cross-talk	≤ -30 dB
Spatial res. (≥ 6 looks)	≤ 60 m (across-track) x 50 m (along-track)
Noise equivalent σ0	≤ –27 dB
Total ambiguity ratio	≤ -18 dB
Radiometric stability	0.5 dB RMS
Abs. radiometric bias	1.0 dB
Dynamic range	35 dB

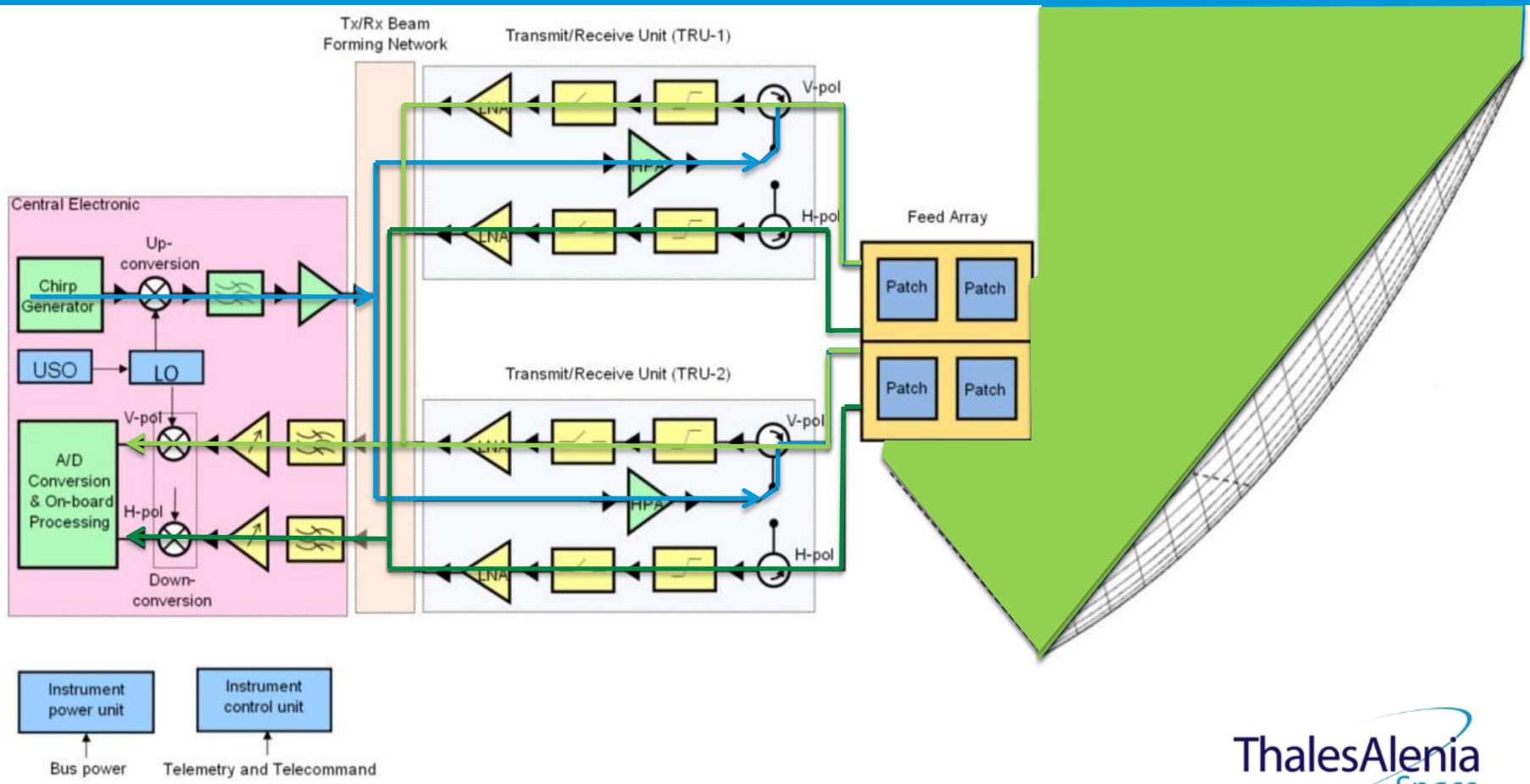




Payload Functional Architecture

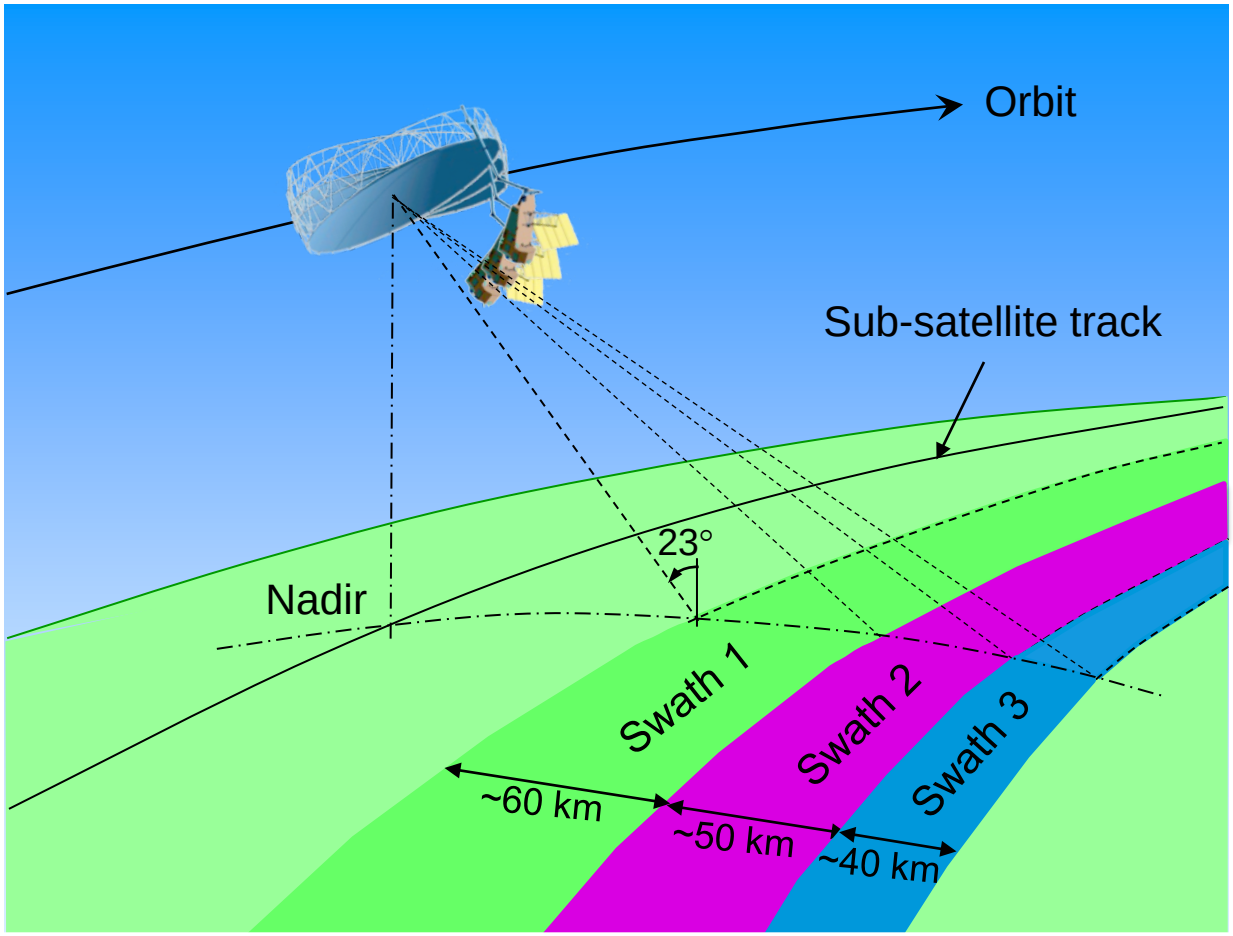


Payload Functional Architecture



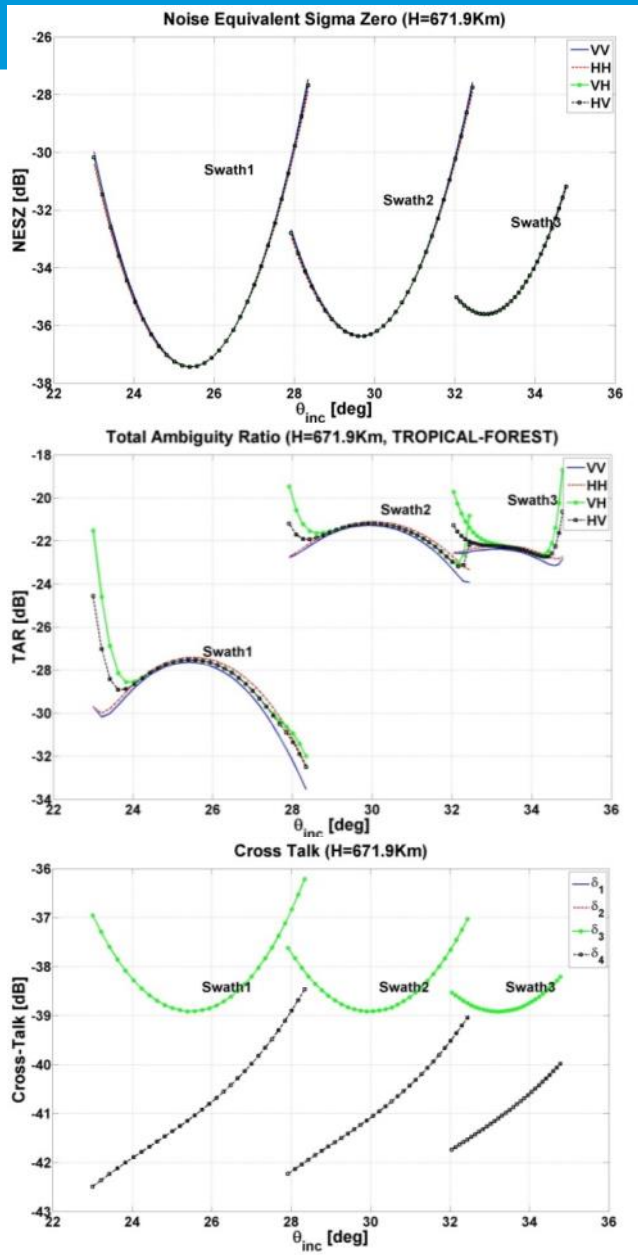
Stripmap acquisition mode

- Single antenna beam
- Stripmap mode
- Satellite roll for beam repointing



System performance at Level 1B

Key Parameters	Requirement	Concepts A and B
Sensitivity (NESZ)	≤ -27 dB	≤ -27 dB ✔
Total Ambiguity Ratio	≤ -18 dB	≤ -18 dB ✔
Geometric Resolution	≤ 60m x 50m	≤ 60m x 50m ✔
Effective Number of Looks	≥ 6	≥ 6 ✔
Radiometric Stability	≤ 0.5 dB	≤ 0.35 dB ✔
Absolute Radiometric Bias	≤ 1.0 dB	≤ 0.45 dB ✔
Crosstalk	≤ -30 dB	≤ -30 dB ✔
Dynamic Range	35 dB	35 dB ✔



Calibration

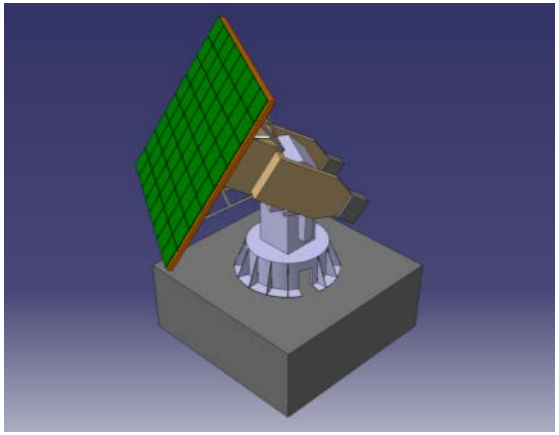
Achievement of the radiometric performance requirements is ensured by:

- *On-ground characterisation* of the Biomass payload prior to launch
- *Internal calibration* to monitor the power level and gain of the radar electronics
- *External calibration* using transponders for the characterisation of the end-to-end radar measurement chain

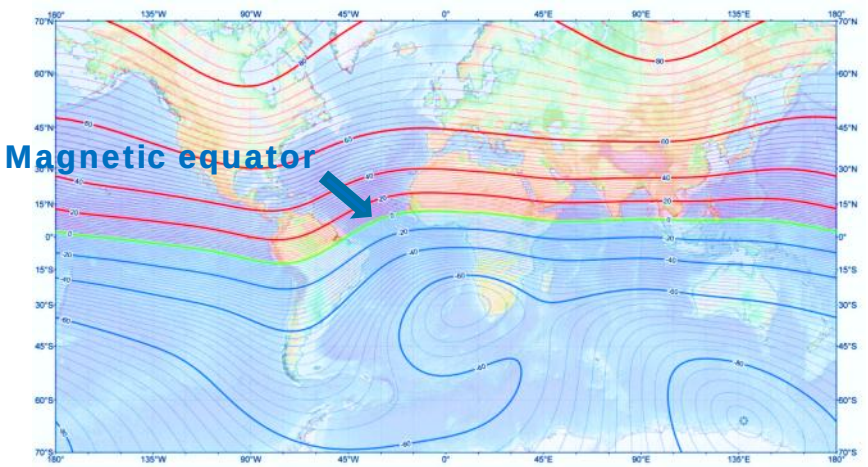
Transponder concept:

- Polarimetric with a single 4 m × 4 m planar antenna (re-generative with time-delays), mechanical satellite tracking, receive function and polarisation agility

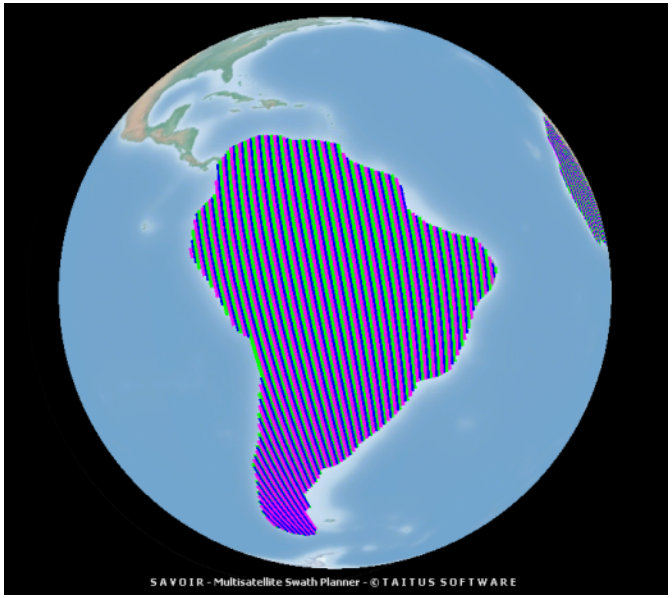
One transponders placed on the magnetic equator and one at higher latitudes

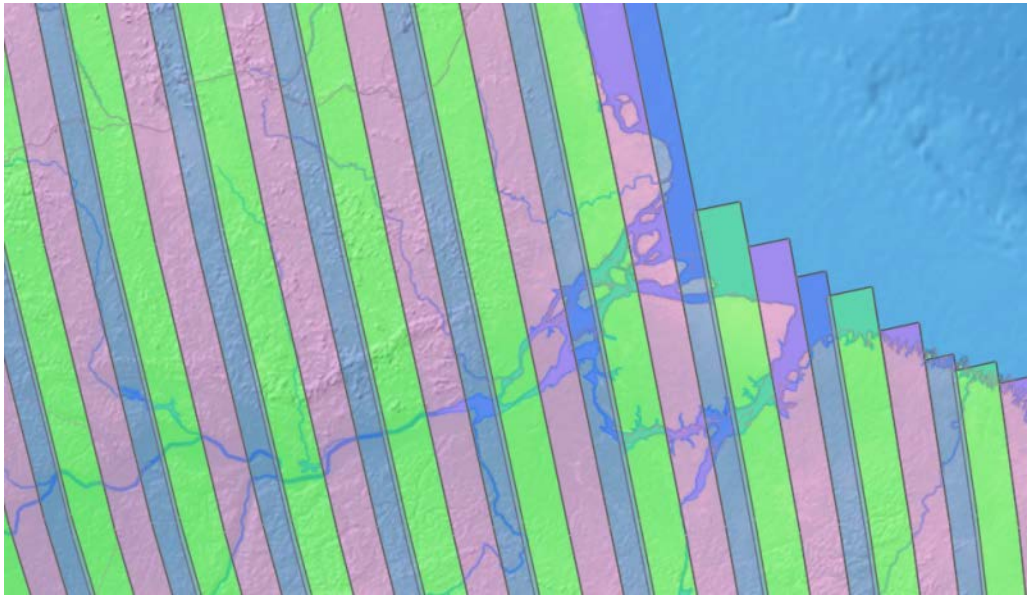


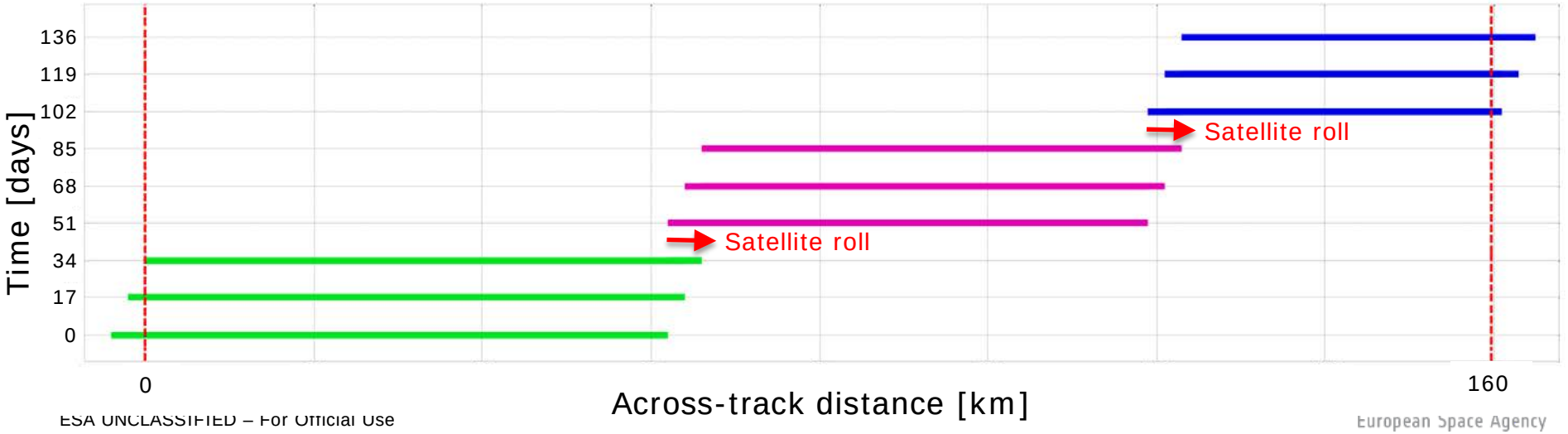
Transponder concept



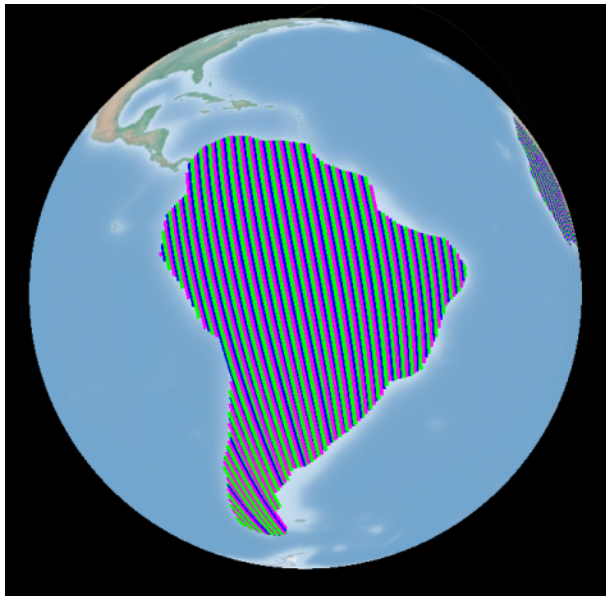
Coverage Strategy (Interferometry phase)

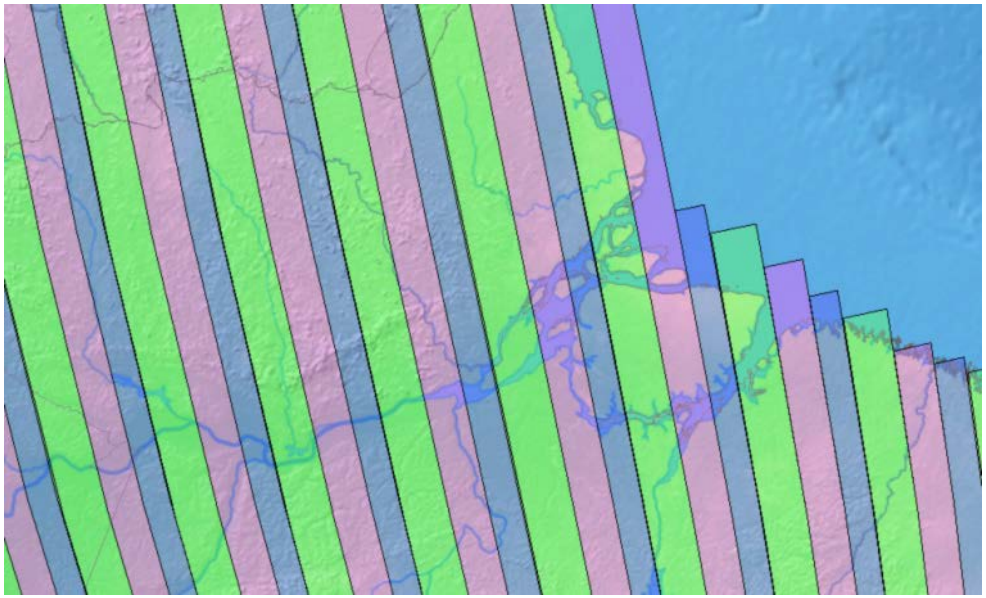


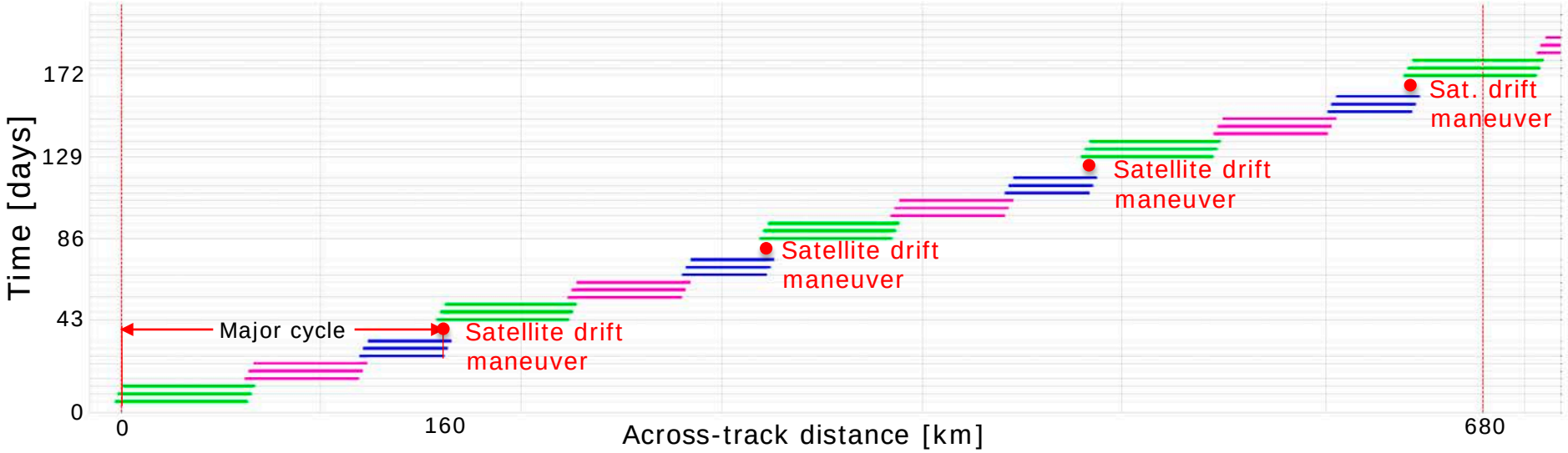




Reducing the repeat cycle time

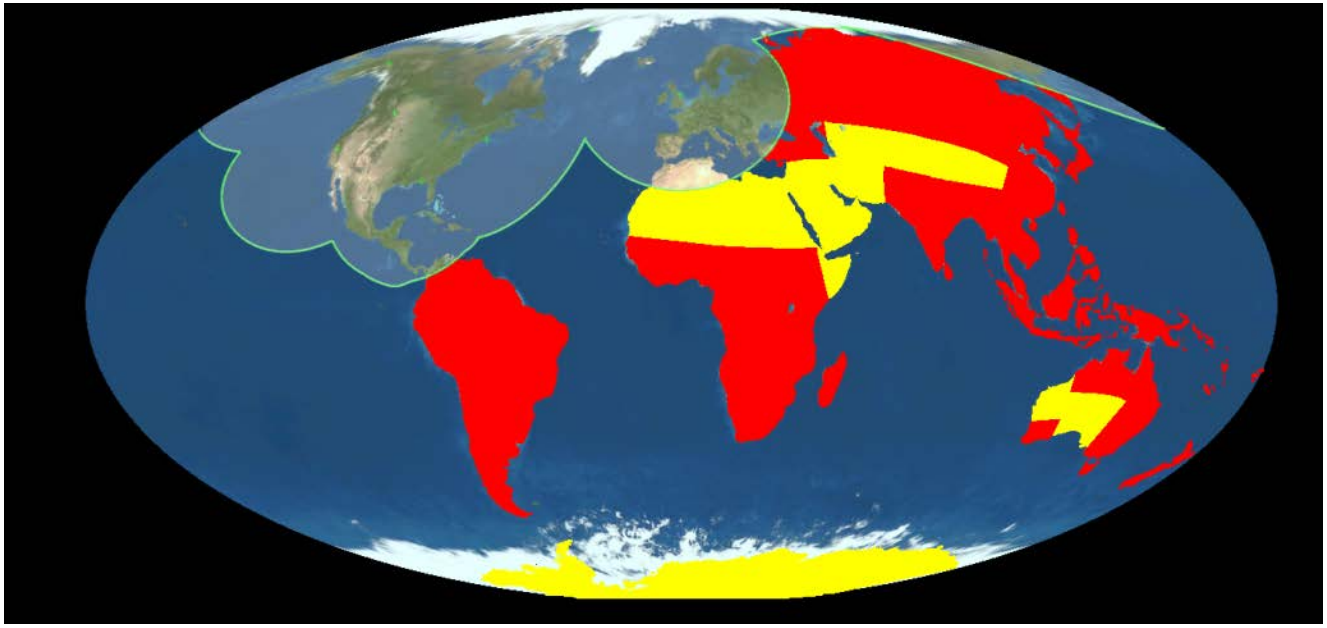






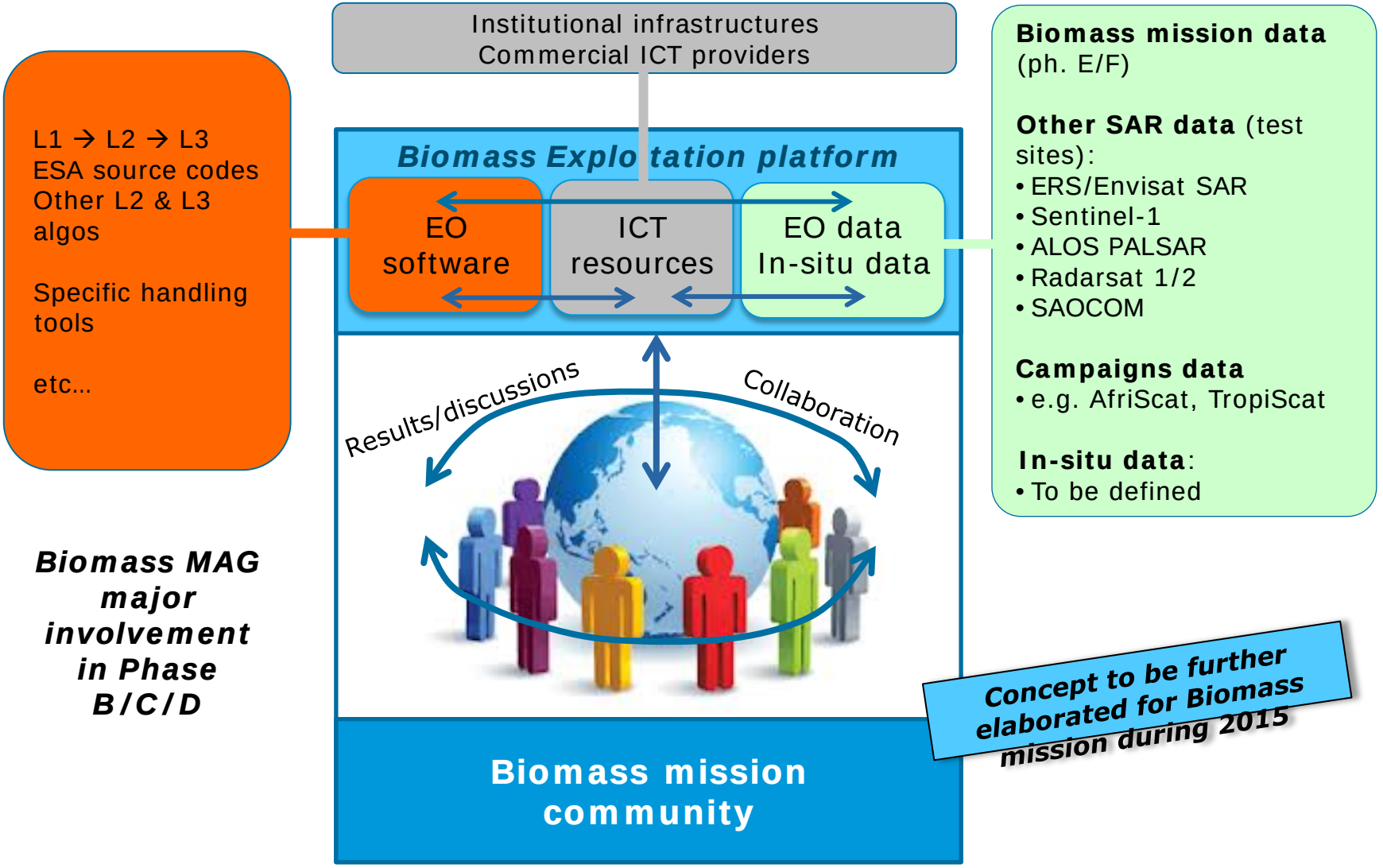
Coverage

1. Acquisition mask restricted by US Space Objects Tracking Radar (SOTR)
2. Systematic Acquisitions
3. Acquisition in both ascending and descending passes
4. Two mission phases:
   - **TOM** Tomography with 7 acquisitions for a given location (1st year)
   - **INT** Interferometry with 3 acquisitions for a given location (2nd-5th year)



(Red = Primary objective coverage mask, Yellow = Secondary objective coverage mask)

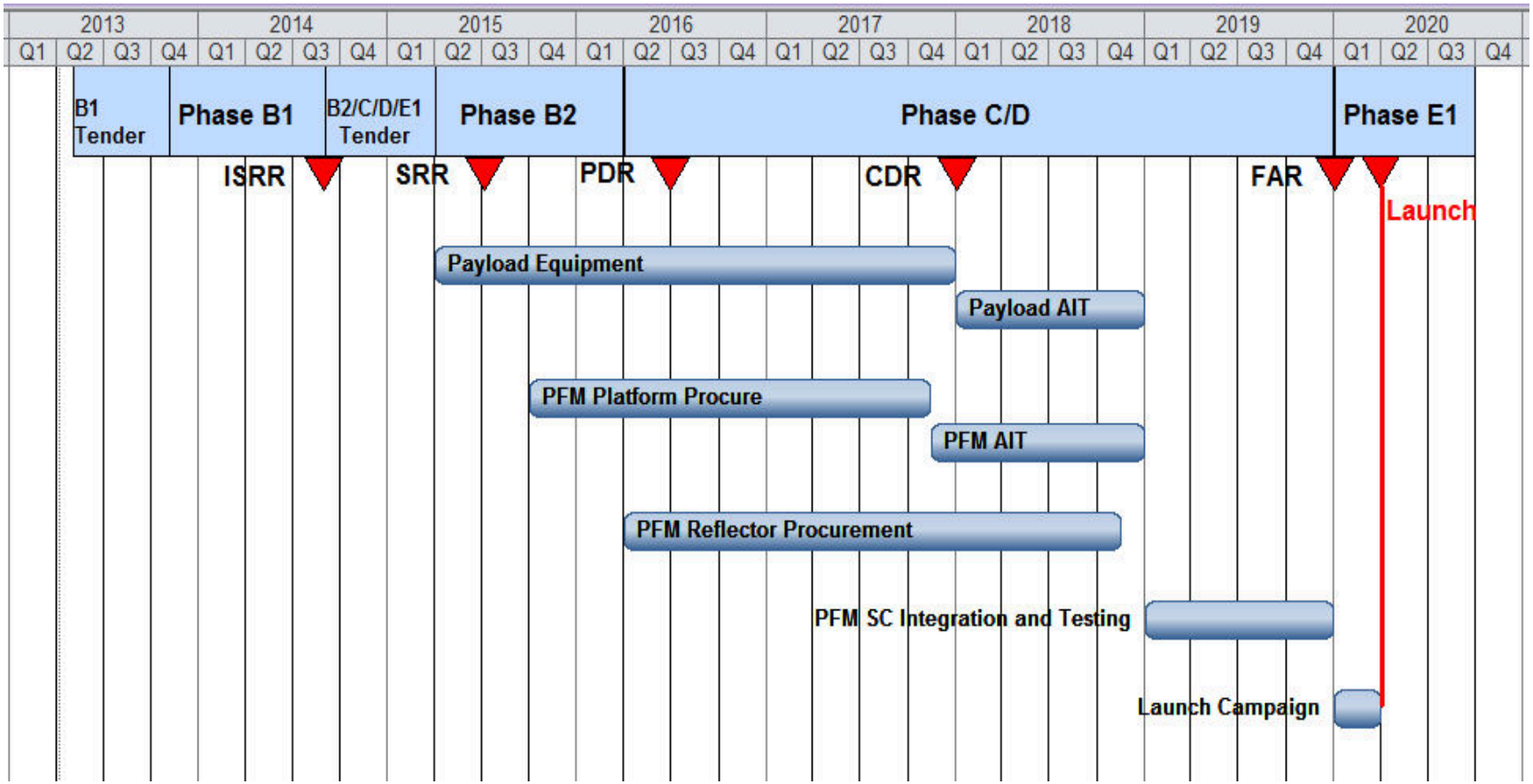
Example: Biomass Exploitation Platform → *a very preliminary approach*



Status Biomass Activities

1. ESA Earth Observation Program Board will decide on go ahead for Biomass in February 2015 based on overall technical and programmatic evaluation.
2. Industrial Activities
    a. Two competitive Phase B1 System studies have been closed successfully in 2014 (with the Intermediate System Requirements Review). No major criticalities have been identified.
    b. Invitation to Tender for Phase-B2 currently prepared. Plan to go out at the end of Q1 2015. Implementation phase B2/C/D expected to start in Q3 2015
3. Science Activities
    a. L2-Retrieval Precursor activity currently running
    b. Biomass Calibration Study (KO in Q1 2015)
    c. AfriSAR: P-band airborne campaign in Gabon in July 2014 and January 2015
    d. AfriScat: P-band TomoSAR tower experiment in Ghana
    e. BorealScat: P and L-band tower experiment with Chalmers Univ.
    f. International Forest Biomass Network (KO Q1 2015)

Biomass development schedule



Summary

1. Biomass is the first P-band and first radar tomographic space mission; it is a true Earth Explorer.

2. Biomass addresses urgent scientific, political and societal issues: its products can be immediately exploited by the global community of carbon cycle and climate scientists, the UN, carbon traders and resource managers.

3. The new unique vision of Earth from Biomass will extend beyond forests and into measurements of ice, sub-surface geomorphology, topography and the ionosphere.