SPACEBORNE P-BAND SAR FOR BIOMASS MISSION

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1. INTRODUCTION

Among the future Earth Explorer Core missions, BIOMASS mission objective deals with global measurements of forest biomass and extent. It will provide a better understanding of Carbon cycle and forest contribution. This mission enters now the Phase A selection process.

The BIOMASS space segment will consist of a satellite carrying a P-band SAR in side-looking geometry with full polarimetric and interferometric capabilities. Due to the long wavelength (0.7 m), the need for full polarimetric capability and the global coverage within the required repeat period, its antenna dimension is expected to be several times larger than those of the known spaceborne SAR satellites (surface greater than 60m² at least). This large structure needs to be folded for launch, deployed and kept stable in orbit. Hence, a particular attention is accorded for mitigating risks associated with developing and flying such a very large antenna.

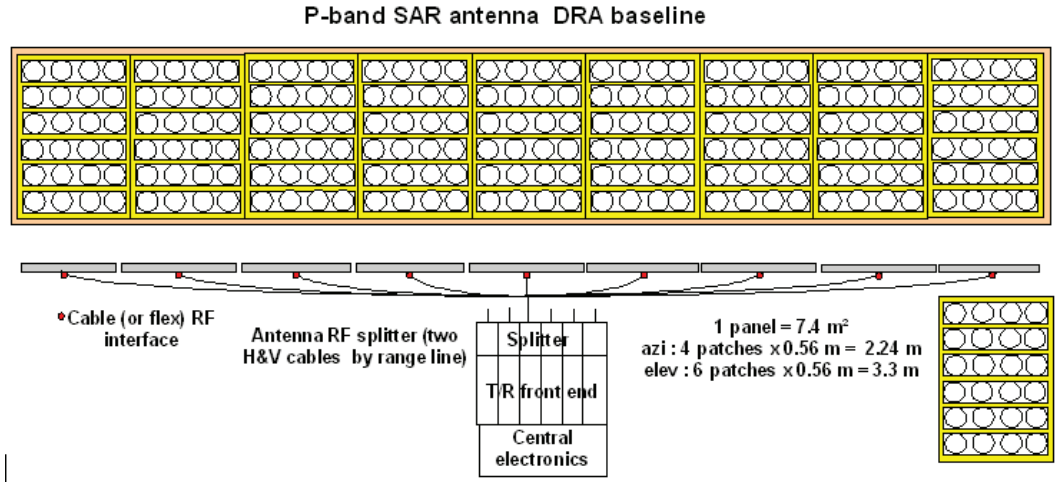
In the frame of BIOMASS phase 0 funded by ESA, several concepts have been addressed. One of them supported by Thales Alenia Space is a DRA (Direct radiating Array) antenna solution composed by deployable rigid panels. The panel and the deployment system designs take advantage from a strong solar array heritage and this solution is considered quite mature. RF design is optimized for full-polarimetric operation and validated now by successful breadboarding. Mass and volume are minimized exploiting RF components (such as honeycomb substrates or CFRP layers) for structural and mechanical purposes.

In this paper, the expected performance of a P-band SAR instrument based on such antenna will be addressed, as well as its architecture and the accommodation on the platform.

2. P-BAND SAR CONCEPT

The P-band SAR instrument is an active RF instrument operating at 435 MHz with 6 MHz bandwidth. It is composed of a dual polar antenna with its RF harness, a transmit/receive front-end sub-system and a central electronic including the IF/RF/ digital stage and the radar management unit.

The antenna baseline solution is a Direct Radiating Array (DRA), with 9 identical deployable rigid panels based on a solar panel technology. The antenna dimensions, defined after the performance/accommodation trade-off are 3.4 m x 20.2 m (one fixed panel on the payload bus plus two wings of deployable panels), giving a large radiating surface of 67 m² necessary to operate in full polarimetric mode. The Compact polarimetric mode (Circular in Tx; dual-linear in Rx) is also possible and included in the design. Transmit/receive sub-system, azimuth splitters and the Centrals Electronics are located inside the Payload module. This antenna is passive with a row-fed RF amplification / distribution by range lines, providing a limited steering capability in elevation (phase in Tx and amplitude/phase in Rx) in order to meet ITU and ambiguities requirements. The P-band SAR instrument is displayed below showing the antenna RF architecture with its 216 cavity backed annular slots.



3. P-BAND SAR PERFORMANCE

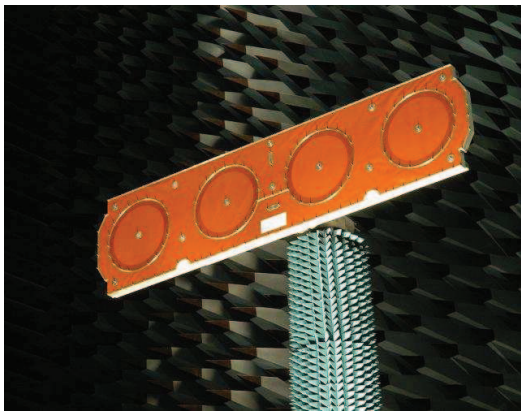
The table below shows the expected main performance of this P-band SAR, which are in line with the BIOMASS mission requirements. The large swath allows a revisit time of less than 35 days, which makes possible the interferometric mode. The selected orbit is a sun-synchronous one, at the altitude of 640 km.

Performance	Value
Polarisation mode	Full-Polarimetric and Compact polarimetric
Cross-polarisation isolation	≥ 30 dB (beyond requirement objective)
Incidence angle	23°- 25° for the near range
Swath width	60 km – 80 km in Full pol Stripmap; > 110 km in Compact pol Stripmap
Spatial resolution	50 m x 50 m (with number of looks > 4)
Noise equivalent sigma0	< -27 dB
Total ambiguity ratio	< -20 dB
Radiometric	Absolute bias < 1.0 dB Stability < 0.5dB

4. REALIZED P-BAND DEVELOPMENT

RF performances measurement of such antenna architecture have been realized by Thales Alenia Space in the frame of the GSTP ESA contract Passive Subarray Technological Development, funded by CNES. Subarray mock-ups have been realised and tested leading to very good results for both conducted and radiated performances.

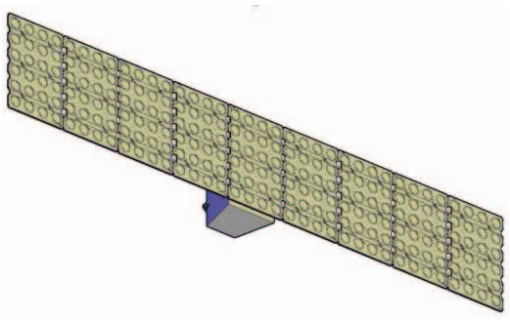
The results are highly encouraging and validate the RF design approach for this antenna solution, in particular the excellent cross-polarization ratio better than 30 dB. This performance benefits greatly to Biomass full-polarimetric algorithms because it allows to correct simply the Faraday rotation (not negligible at this frequency).



5. SATELLITE CONCEPT

The satellite architecture proposed for BIOMASS will be outlined. The main accommodation issues will be addressed including launcher fairing. The mass and power budget will be given. As indication, the envisaged platform is PRIMA, which has demonstrated its capability for Radarsat 2 and Cosmo Skymed.

The Soyuz launcher has been selected for the instrument baseline.



6. REFERENCES

[1] J. Lorenzo, Shadi Khureim-Castiglioni and Cyril Mangenot , “Very large space antenna apertures for future earth observation missions”, antenna workshop, 2009, Tbilisi, Georgia

[2] ESA, SOW for the Phase 0 study of the six Candidate Earth Explorer Core Missions, issue 1 revision 0 - EOP-SFP/2006-09-1240, 2006