# STATUS OF TECHNOLOGY PREPARATION FOR NEXT GENERATION DIGITAL BEAMFORMING SAR

(for: Special Session Advanced SAR Concepts and Missions)

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## 1. INTRODUCTION

We report work performed in the frame of technology preparation studies for next generation SAR missions using Digital Beamforming (DBF).

Under two ESA contracts, a Digital Beamforming demonstrator hardware and a conceptual design of an advanced (DBF) SAR instrument operating in C-band have been established. This kind of instrument including the advanced technology would be ready for launch in roughly 10 years from now [1].

A candidate for the first actual flight mission to be based on Digital Beamforming technology could be a German "TerraSAR Next Generation" mission (not yet confirmed), with an anticipated launch date around 2017. In preparation of such a mission, feasibility of the concept, in this case the so-called "High Resolution Wide Swath (HRWS)" instrument architecture, needs to be demonstrated, critical technology gaps need to be closed and expected performance, risk and cost to be defined. These are the goals of the DLR-funded "HRWS Demonstrator" project to be finalized 2011 [2].

## 2. NEXT GENERATION C-BAND INSTRUMENT

The key image performance requirements of the next generation C-Band instrument has been derived from the state-of-the-art GMES Sentinel-1 instrument. A continuous mapping mode like Stripmap or ScanSAR with arbitrarily long swath is envisaged, with the major difference between DBF-SAR and Sentinel-1 being an increase of swath width by a factor of 5. The access range has also been extended in far range. At the same time, the demanded instrument resolution and sensitivity has been left unchanged.

The requirement calls for a large receive antenna with digital beam forming capability, and a high level of transmit power. A trade has been performed between a bistatic antenna configuration (reflector transmit antenna and receive-only planar phased array antenna) and a monostatic antenna configuration (planar phased array antenna). The monostatic option has shown that a careful thermal design of the antenna will be necessary. Thermal models show that this can be handled, particularly if the material used for the radiators is aluminium. The bistatic option leads to a more power efficient instrument but requires the extra reflector antenna together with its deployment mechanism. Both options are feasible, not with off-the-shelf components, but with state-of-the-art technology. Also the accommodation in the Soyus launcher is possible in either case.

## 3. HRWS DEMONSTRATOR

For the preparation of the next generation X-Band SAR mission, a monostatic frontend architecture is favored as result of several trade-offs. The analog frontend architecture is similar to a phased-array, with digital beamforming functionality in receive realized in another hierarchical layer by partitioning the antenna in several panels (phase centers) in azimuth and multiple "tiles" (receive channels) in elevation. Radiators, T/R-modules and RF networks represent the analog part of a tile, followed by an RF Down-Conversion Unit (RFDCU) for amplification, filtering and down-mixing the receive signals and a Digital Beamforming Unit (DBFU) for IF signal digitization and "scan-on-receive" on-board signal processing [2]. Each DBFU operates in a serial chain and is connected to the previous and next DBFU via gigabit high-speed links. The actual signal is added to "partial beamforming sum" received from the previous DBFU and the result forwarded to the next DBFU. Thus, the output of the last DBFU of the panel reflects the beamformed pattern of the whole panel.

The HRWS Demonstrator corresponds to a single integrated antenna panel, comprising electronics for N = 8 tiles in elevation. It shall operate in X-Band up to maximum 600 MHz bandwidth and support dual linear polarization. At this time, Radiators, RFDCU and DBFUs are in the integration and testing phase. The T/R-module based frontend has been introduced recently as a major change after an initial baseline of a bistatic configuration (separate transmit/receive antennas), and is currently in the specification phase.

## 4. SUMMARY

Performance requirements to potential next generation German X-band and European C-band SAR missions are beyond the physical limitations of today's SAR instruments and call for the invention of DBF techniques. As a result, analog RF functionality of classical radar central electronics need to be distributed on the antenna and high-performance digital processing technology needs to be made available on-board the satellite.

In the full paper and the presentation, the current status of the Astrium technology studies regarding system design, performance and technological challenges and solutions for these instruments will be discussed in detail.

## 5. ACKNOWLEDGEMENTS

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## 6. REFERENCES

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