Contingency Mitigation Strategies for Reflector Based SAR Systems

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Abstract

A range of the latest concepts for next generation Earth observation using synthetic aperture radar (SAR) baseline instruments constructed as a phased array antenna feed paired with a large deployable reflector (LDR) / boom assembly. Reasons include operational constraints due to longer wavelengths such as L- or even P-band (e.g., Tandem-L, ROSE-L, NISAR) as well as conducting SAR measurements from higher low-Earth-orbits (e.g., Sentinel-1-NG) or even geosynchronous orbits (HydroTerra).

In comparison to traditional planar antenna array based instrument designs, employing LDR based instruments leads to a series of novel challenges which have to be addressed. One particular challenge is related to designing and implementing appropriate contingency mitigation strategies for dealing with potential failures of transmit-receive modules (TRMs). In contrast to planar antenna arrays, there is a direct correspondence between the emitted and received signals of single TRM channels and certain illuminated elevation regions on ground in the reflector case. While the inherent averaging of the feed element signals of a planar array allows for graceful degradation in case of the failure of a single or even a few TRMs, this situation is much more critical for a reflector-based system.

In this presentation we therefore focus on appropriate contingency mitigation strategies based upon the present reference scenario for Tandem-L, a current proposal for a future high performance SAR mission. In this context we assess in particular the potential for reflector shaping (e.g., a deliberate defocusing of the reflector) which opens a trade space which has to be carefully assessed. We find, that for a tolerable gain loss in receive in the nominal operational mode, the impact of TRM failures can be drastically reduced in a contingency case. For transmit, a re-optimization of the respective beamforming coefficients similarly allows to recover a well-shaped transmit pattern with minimal gain loss using a defocused reflector system. Based on these results, we discuss constraints and our suggestions for future reflector based SAR missions.

Keywords - Calibration of future missions