SAR Antenna Pointing Determination: Results from the Sentinel-1B Commissioning Phase and novel approaches  

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ABSTRACT  

Antenna pointing calibration is a major task for ensuring a correctly aligned SAR antenna radiation pattern. This combines both the accurate control and measurement of the attitude of the satellite as well as the electronic adjustment of the SAR antenna. For upcoming SAR missions, which use a reflector antenna design like ESA’s BIOMASS or DLR’s Tandem-L, the antenna pointing may no longer be fixed to the attitude of the satellite bus. Due to small deformations of the reflector or the boom, the antenna pointing may vary (i) over orbit, (ii) over season and (iii) due to aging. In such a case, novel approaches are required to ensure a continuous monitoring of the correct antenna pointing over non-homogeneous distributed targets.  

For the commissioning phases of Sentinel-1 A & B, the procedure of determining the antenna pointing was divided into two parts: (i) azimuth antenna pointing and (ii) elevation antenna pointing. Both cases rely on different measurement approaches. Antenna azimuth pointing determination has been based on ground receiver measurements of azimuth notch transmit patterns while antenna elevation was based on rainforest measurements of elevation notch patterns.  

For the innovative TOPS mode (“Terrain Observation by Progressive azimuth Scans”) of Sentinel-1, where the azimuth beams are steered from aft to fore, antenna patterns are compressed due to this steering. For this TOPS mode of Sentinel-1, practically each pulse is commanded with a different azimuth beam, using a very fine granularity in azimuth steering, with a total of around 800 steered azimuth beams per burst and with up to 5 subswaths. A precise prediction of this compressed azimuth pattern from the antenna model takes into account (i) the accurate knowledge of the imaging geometry (ii) the antenna excitation coefficients, and (iii) a precise knowledge of the right sequence of steered azimuth beams and scanned elevation beams together with the correct timing synchronization of the data. In principle, referencing modeled and measured TOPS patterns at one mainlobe, the mismatch of the position of the other mainlobes can be used for achieving a pointing characterization over the whole range of swaths covered by this TOPS datatake.  

In this presentation, we first discuss the pointing accuracy achieved both in azimuth and elevation during the S1B commissioning phase. We then investigate the usability of measured TOPS azimuth-patterns to facilitate the determination of the variation of the azimuth mispointing over elevation. Finally, we present a new approach using a combination of notch and regular beams which has been developed and tested using the aperture switching capability of the TerraSAR-X satellite. It allows the determination of the antenna elevation pointing even outside homogeneous distributed targets like the Amazon Rainforest.