

# In-Orbit Calibration of both TanDEM-X Satellites

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The primary object of the TanDEM-X mission is to generate a highly accurate digital elevation model (DEM) with never achieved accuracy on global scale [1]. But in addition to this DEM acquisition realized by a helix constellation of two satellites, nominal TerraSAR-X operation shall be available anymore, i.e. the bistatic TanDEM-X mission and the monostatic TerraSAR-X mission have to be operated in parallel with both satellites. Consequently the second satellite TDX, successfully launched in June 2010, has to achieve the same accuracy and performance as those of the first satellite TSX, already in-flight since 2007. For this purpose, the commissioning phase (CP) of the TanDEM-X mission was separated into two phases, at first the monostatic phase in order to calibrate the TDX satellite with the same accuracy as achieved for TSX and then the interferometric phase in order to match both satellites for a bistatic constellation and consequently to ensure DEM acquisition during the whole lifetime of the TanDEM-X mission.

The main part of all calibration activities, especially of measurements executed against precise reference targets, was concentrated on the monostatic CP for deriving all calibration parameters. The activities executed during the interferometric CP were concentrated on the verification of all these parameters, i.e. whether they are still valid in bistatic constellation and enable consequently a precise synchronization of both systems. Nevertheless, the calibration effort and consequently the duration for commissioning the whole TanDEM-X system could be optimized by the experience and the results which had been achieved for TSX since launch in 2007 [2]. This was the baseline for executing the TanDEM-X commissioning phase as fast as possible. Thus, a maximum overlap of the lifetime of both satellites required for the global DEM acquisition could be achieved.

The absolute geometric offset between the TDX and TSX SAR system is smaller than half the wavelength. The radiometric offset is only in the order of one tenth of a dB. Thus, each SAR system could not only be accurately calibrated individually, but also to each other. TDX and TSX are adjusted and calibrated with the accuracy of laboratory equipment. All requirements and/or goals have been achieved improving the predictions in most cases.

The measurements and the analyses performed during the interferometric CP were focused on bistatic operation, i.e. one satellite is operated as transmitter and receiver and the other satellite only as a receiver. For this purpose, a bistatic replica, the bistatic geometry, the bistatic elevation patterns and the radiometric characteristics for both bistatic and monostatic operation in close formation were investigated.

Based on a short overview of different calibration procedures the paper discusses the calibration results achieved for both monostatic and bistatic constellation of the whole TanDEM-X system, successfully in-flight since June 2010.

## References

- [1] G. Krieger, A. Moreira, H. Fiedler, I. Hajnsek, M. Werner, M. Younis, and M. Zink, "TanDEM-X: A Satellite Formation for High Resolution SAR Interferometry," *IEEE Trans. on Geoscience and Remote Sensing*, vol. 45, no. 11, pp. 3317-3341, Nov. 2007.
- [2] M. Schwerdt, B. Bräutigam, M. Bachmann, B. Döring, D. Schrank, and J. H. Gonzalez, "Final TerraSAR-X Calibration Results Based on Novel Efficient Calibration Methods," *IEEE Transaction on Geoscience and Remote Sensing*, Vol. 48, No. 2, February 2010.