

Report from the Short Term Mission – STM

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Report:

1. TOPIC

[Participation in the next Sardinia Radio Telescope \(SRT\) holography campaign.](#)

Microwave holography, as applied to reflector antennas, is a technique that utilizes the Fourier transform relationship between the complex far-field radiation pattern of an antenna and the complex aperture distribution. The technique is based on connecting two antennas interferometrically and correlating the amplitude and phase response received from strong signals such as geostationary satellites. Consequently, resulting data can be used to characterize surface roughness, panel alignment and sub-reflector position.

This is crucial for the performance enhancement of a radio telescope. Collaboration and training on this topic directly feeds into scientific results for the SRT and the on-going African VLBI Network (AVN) project.

2. PROPOSED AND PERFORMED WORK

After the refurbishment of the SRT active surface, the photogrammetric measurement of its 64-m diameter reflector in August 2017 aligned the 1008 active panels to approximately 0.5 mm accuracy. This surface accuracy allowed the telescope to observe up to 38 GHz with an efficiency of about 50%. However, it is mandatory to improve such an accuracy to ensure the same efficiency when the higher frequency (under construction) receivers will operate on the SRT.

The main objective of the campaign performed during this visit was to align the surface panels better than 0.2 mm accuracy, an outcome which is hardly reachable on a large reflector such as the SRT by means of a photogrammetric measurement.

To that purpose, the actions performed in the first days in the week of 11-15 December were:

- Editing and testing a user-friendly procedure to perform a holographic run.
- Refining the on-axis holographic feed-horn position (focusing).
- Measuring an SRT far-field map around a geostationary satellite at 11.5 GHz (at 45°), before applying the photogrammetric look-up table (LUT).
- Processing the far-field data and calculating the deformations map (holographic map) by means of the holographic software package (HoP).

A high quality holographic map was acquired, both in terms of SNR (about 1000) and accuracy (about 0.1 mm), confirming a surface alignment of about 0.4 mm. Follow-up activities included:

- Applying the photogrammetric LUT to the actuators.
- Measuring again the SRT far-field map around a geostationary satellite at 11.5 GHz.
- Processing the far-field data and calculating the holographic map by means of the HoP.

The analysis of the second holographic map showed that during the far-field map acquisition two actuator lines of the active surface failed. A new holographic session will be scheduled when the two failures will be understood and fixed (eventually the two failures were fixed on January 10th). The remaining time was spent on understanding post-processing tools and interpretation of previous results.

3. CROSS-DISCIPLINARITY

Cross-disciplinary fertilization during this visit was found in understanding the fundamentals of performing a holographic campaign and how holography and photogrammetry are complementary tools to determine the alignment of the antenna. The AVN team is currently busy with its first conversion in Ghana where there is minimal knowledge of the alignment of the antenna structure or surface roughness. Also, within the AVN team there is limited experience in the microwave holography process. Specific knowledge transfer included:

- Procedure on optimizing scan settings to perform a holographic map.



- Focusing of the feed.
- Post-processing tools.
- Interpretation of holographic maps.

4. IMPACT

The impact of this visit we believe will be evident in upcoming holography campaigns in Ghana to improve performance of the AVN telescope at Kutunse. The AVN Holography System has already been qualified successfully at HartRAO (another EVN telescope) and we are confident that with the added experience gained at the SRT, we will have a successful campaign on the 32-m dish in Ghana. Specifically, young Ghanaian scientists and engineers will be involved with the campaign and we will therefore reach a wide Northern African community in radio astronomy.