System Approach to Ka-Band Earth Station Beam Pointing Accuracy Verification

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Abstract – **In this paper an experimental setup for verification of Earth station antenna pointing accuracy is described. Collected experimental data for two cases is presented. Conclusions are delivered about the functionality of the experimental setup and the antenna pointing system.**

Keywords – **Ka band tracking, Earth station antenna, RF data collection, pointing accuracy.**

I. Introduction

Recent development in broadband satellite communications brought to use the very promising Ka frequency band. However due to exceptional requirements to Earth Station Antennas pointing, the successful tracking of the spacecraft is impaired by variety of problems of mechanical and electrical matter. In order to verify the consistency of the tracking system, a reference setup, described in the paper, has been developed and successfully tested.

One of the most important features of the medium (3-9m) and large (9-18m) Earth Stations is the pointing accuracy. It is widely recognized that pointing accuracy within 0.5 dB is considered as good. However it puts challenges to the pointing mechanics and also to the instrumentation to prove that accuracy [1-4].

II. The Measurement Setup

The measurement setup is depicted on Fig, 1. It consists of a Large Earth Station (9m Antenna Under Test), Small size (3ft) reference antenna, RF Switch with integrated LNA, Spectrum analyzer and PC With Labview platform to collect the measurement data and control the switch. Similar setups are defined by other authors [2]

The size of the reference antenna is selected in order that Antenna Pattern is broad enough to accommodate the diurnal satellite drift within 0.05 dB down from the antenna beam peak. Therefore the signal coming from this antenna can be used as reference for the signal from AUT.

The other parameters are as follow: Data acquisition rate - 2 sec., Duration of full data cycle - 24h (86 400 sec.), Spectrum Analyzer settings: 1.5 MHz span, 801 points per sweep, LNA Noise temperature: 105K@20GHz. LNA Gain 53dB, AUT Gain 62dBi. On Fig.2 two approaches of data collections are displayed. The Blue line represents Beacon peak value over time, the red one represents integrated channel power (beacon included) over time. Due to scintillations reduction, the second approach was selected to perform the measurement.

The reference antenna is used to provide a stable reference beacon level, independent of the satellite movement. The antenna has small aperture size and therefore broad main beam. The satellite movement in the box will not cause signal variation due to pattern slope more than 0.05dB.

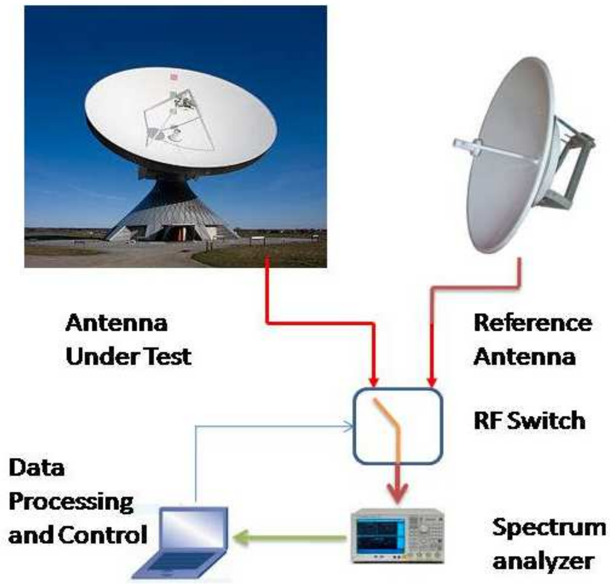

Fig. 1. Data Acuisition system (antenna photos are exemplary)

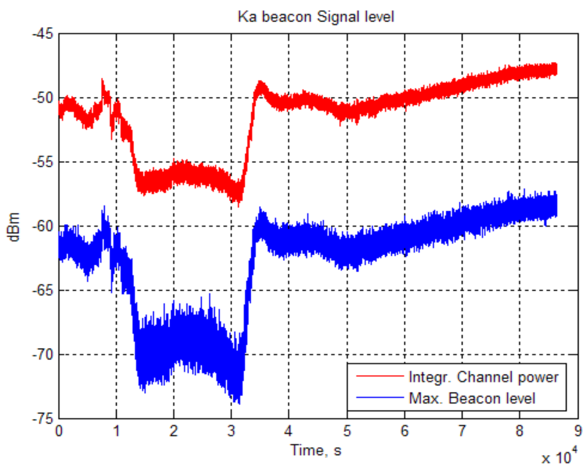

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Fig. 2. Satellite beacon reception level

III. The Experimental data

The real conditions measurement data is displayed on Fig. 3. Every second the switch flips back and forth and spectrum analyzer reads AUT channel or Reference Antenna channel either. One full data cycle takes 86 400sec (24h).

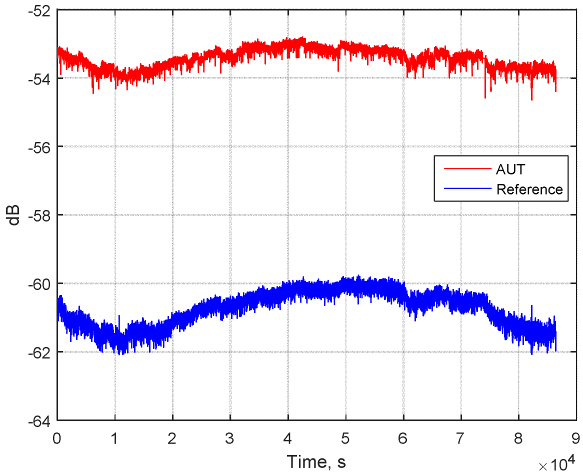

Fig. 3. Measurement Data (Both channels)

The difference (pointing accuracy) is displayed on Fig. 4. For verification purposes, the tracking function of the AUT was switched off. It is clearly evident that despite the exceptional 3D stabilization, the satellite shows a diurnal drift of about 1dB in signal level for the selected AUT.

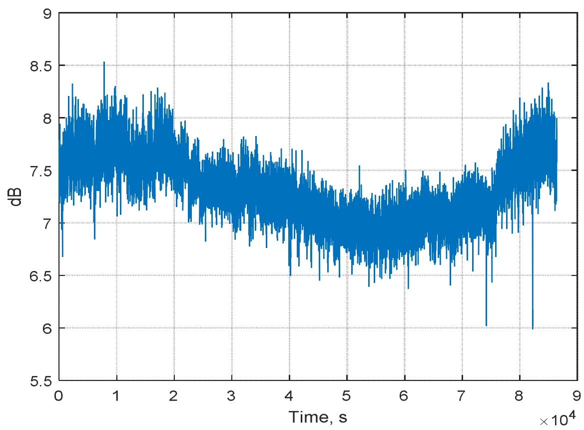

Fig. 4. The pointing accuracy (AUT tracking system turned off)

On the next set of test cycle the AUT tracking system was turned on (at approx. 15 000-th second on Fig. 5). The Mispointing error immediately fell below 0.5dB which is

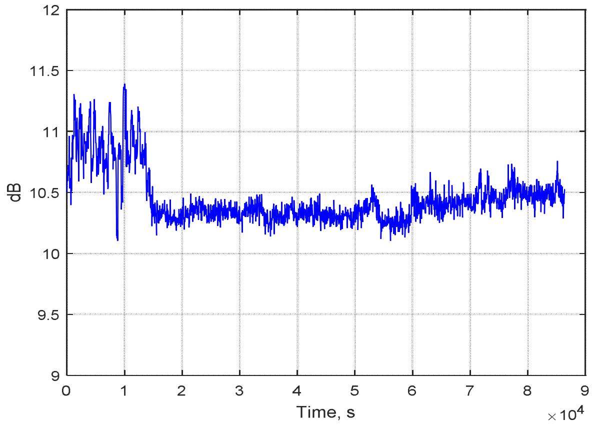

Fig. 5. The pointing accuracy (AUT tracking system turned on)

within the requirements for Earth station pointing accuracy and keep the same level until the end of the test cycle. Despite the rainy weather conditions the tracking system kept the AUT well pointed toward the satellite. It must be mentioned that the original setup was provided with complex weather station, measuring ambient temperature, wind speed and solar radiation for the purposes of in-depth structural analysis. However such analysis is not the purpose of this paper and therefore not included here.

The measurement data is collected and stored with a Labview application and eventually processed in Matlab. Simple moving averaging is applied for the cases presented here. However it is clearly evident that there is a need of more sophisticated data processing.

IV. Conclusion

From the measurement results and data presented above it can be concluded that:

1. Data collecting and verification system is feasible enough to deliver continuous and consistent tracking data and completely fulfils measurement accuracy requirements.
2. Earth station tracking system completely fulfills the requirements for pointing accuracy.

References

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