ANS #2 on Receiver 02 - Lab & Field Data. Investigation of the 60 MHz dip seen in the field data

Nivedita Mahesh, Leroy Johnson

ASU

This report summarizes the results of the test carried out using the Alan Noise Source connected to the receiver02. We compare two sets of data of the ANS#2 connected to the Receiver02: 1.) from the field, 2.) from the same setup in the lab. This test was done to eliminate the possibility that the EDGES feature was due to the response of the receiver chain. By taking a measurement when the Alan Noise source was connected to the receiver in the field we are making sure we have included all spurious effects to the receiver chain that may be present in the field. Since we don't see the feature or anything similar to the feature from the ANS measurement in the field we have clearly eliminated that concern.

The residues to the fits of the field data show a dip at 60 MHz that was not seen in the lab data initially. After some investigation and a few tests we were able to reproduce the dip in the spectra obtained from the lab by loosening the last attenuator in the backend. Also shown in the report is that the residues from the field are qualitatively matched with those residues obtained in the lab.

1.) Lab Data

The lab data was taken in October 2018.

The Receiver calibration coefficients and the LNA S11 used are shown in Memo 128. These were applied to the ANS#2 spectra obtained in the lab and calibrated as shown below:

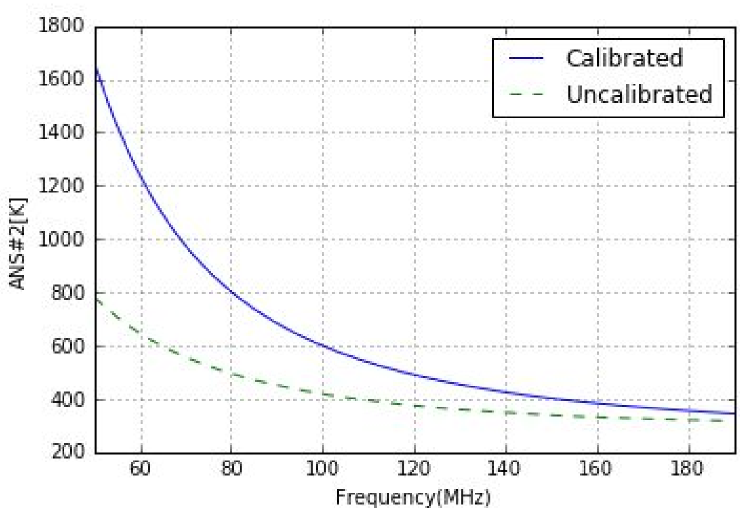


Figure1: Spectra obtained from ANS#2 when connected to receiver2 in the lab. The dotted line corresponds to uncalibrated spectra and the solid line is calibrated with the Lab measurements shown in memo128

The obtained calibrated spectra was then fitted with different foreground models (N=5terms) and the residues were plotted:

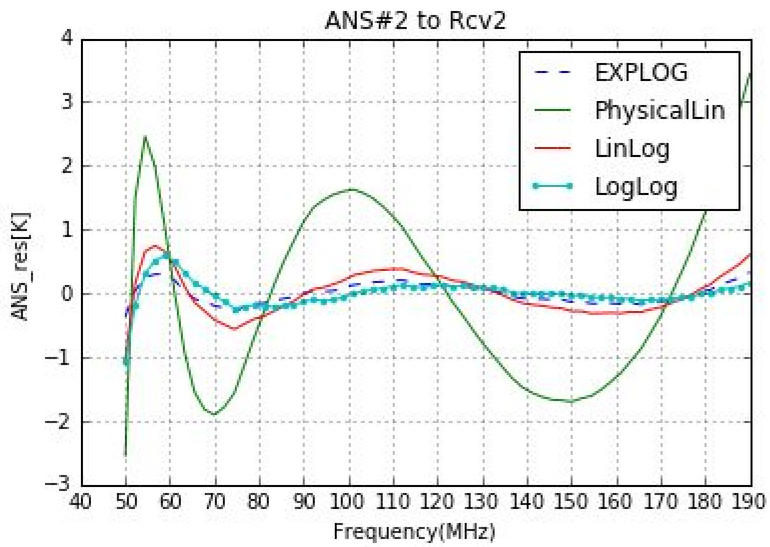


Figure2: The residues obtained on fitting different foreground models to the calibrated data of ANS#2 connected to receiver2 in the lab.

2.) Field Data

The field data that was used corresponds to the following days:

2018_149 to 2018_177.acq

**File 2018_149* has RFI hence eliminated in the integration*

The ANS#2 was still connected to the receiver beyond day 177 but on day 178 data acquisition was switched from PXSPEC to FASTSPEC. Hence only data upto day 177 was analysed.

The ANS s11 used is the data in: low2_alans_noise_source_20180601

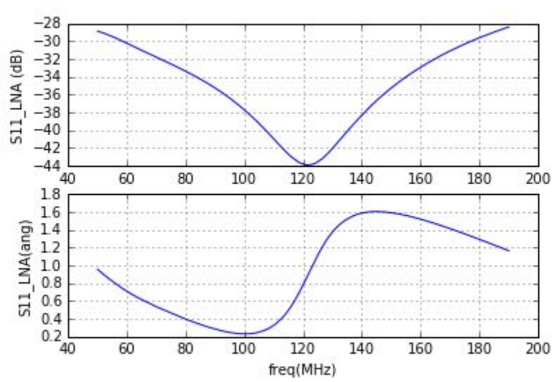


Figure3: The magnitude and phase of the corrected S11 of ANS#2 when it was connected to the Rcv2 in the field.

The data was calibrated with calibration coefficients and LNA s11 from Report 128 (same as above) and the S11 from the field.

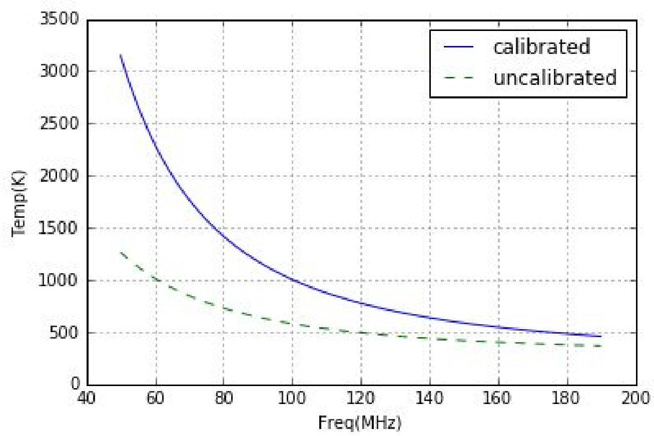
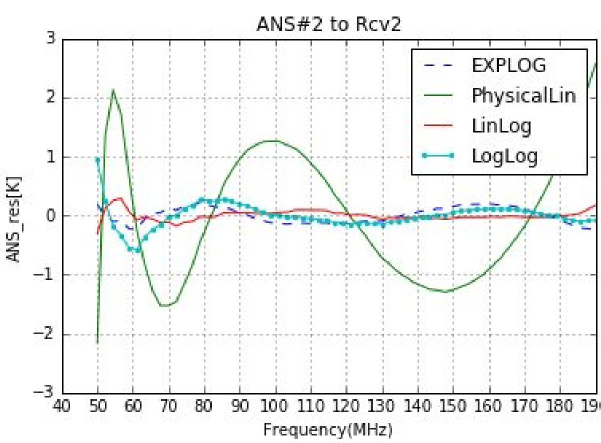


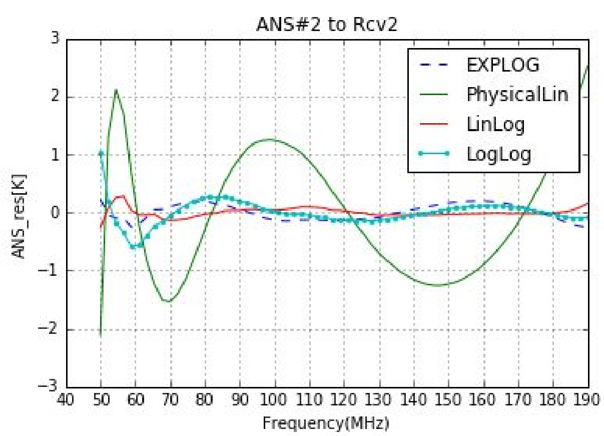
Figure4: Spectra obtained from ANS#2 when connected to receiver2 in the field. The dotted line corresponds to uncalibrated spectra and the solid line is calibrated with the Lab measurements shown in memo128

Similar to the lab data, the obtained calibrated spectra was then fitted with different foreground models (N=5terms) and the residues were plotted:

Day 150-154



Day 150-159



Day 160-169

Day 170-176

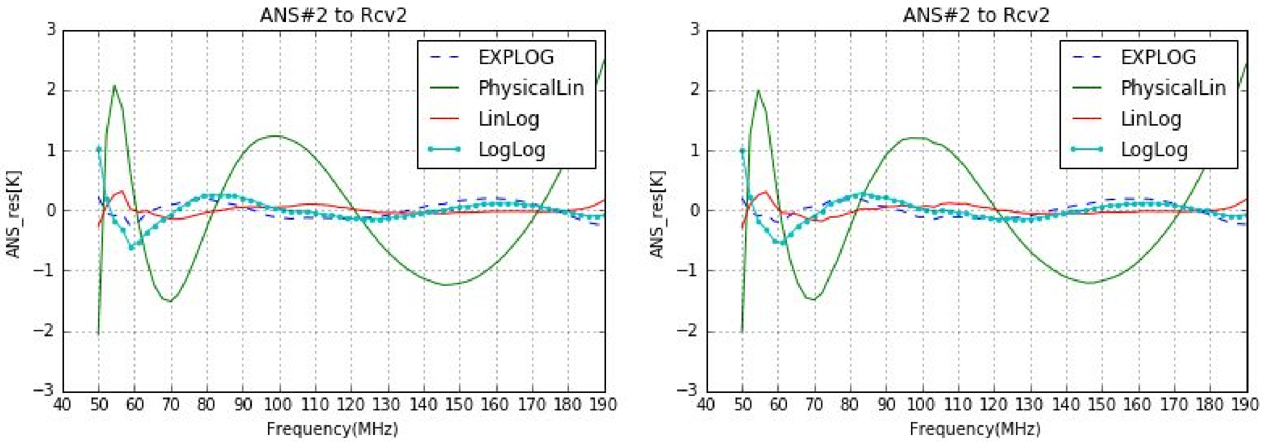
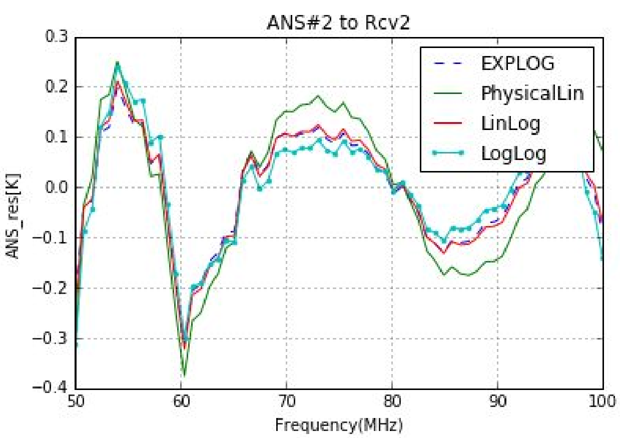


Figure5: The residues obtained on fitting different foreground models to the calibrated data of ANS#2 connected to receiver2. The different figures correspond to different days processed.

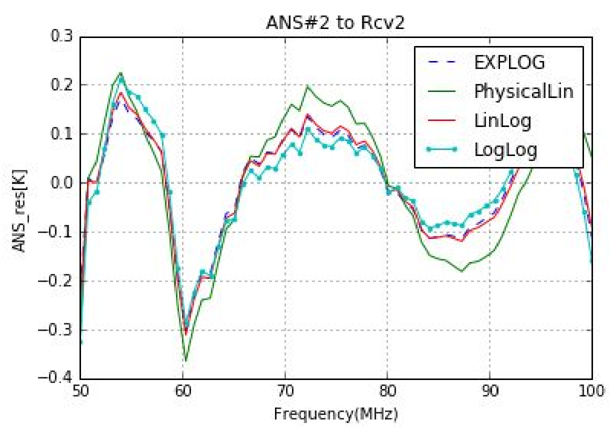
A clear dip at 60 MHz is seen in the residues of the data obtained in the field. So we do the following tests to investigate it. As this was not seen in the lab data (ref Fig2)

To investigate the 60 MHz dip, we did the fitting over a narrower range - 50 -100 MHz.

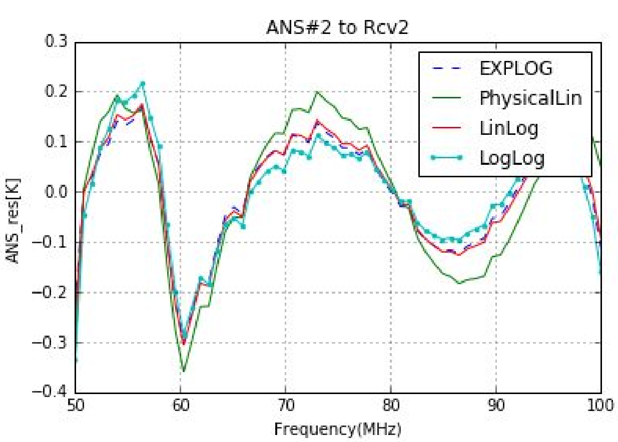
Day 150-154



Day 150-159



Day 160-169



Day 170-176

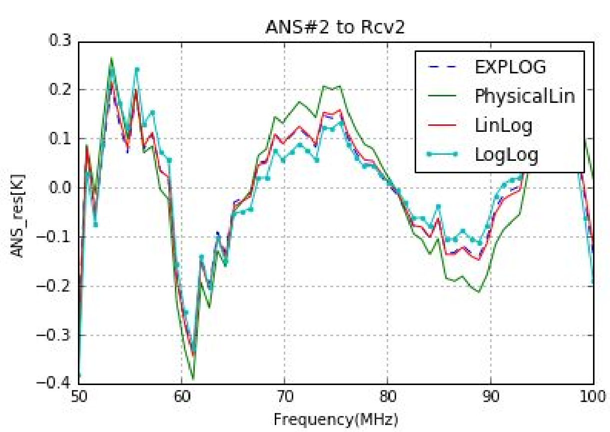


Figure6: The residues obtained on fitting different foreground models to the calibrated data of ANS#2 connected to receiver2. The different figures correspond to different days processed.

Notes:

- On comparing the Calibrated ANS#2 spectra from the lab and field, it is seen that the noise temperature obtained from the setup in the lab is higher. This indicates we aren't using the same value of attenuation.
- PhysicalLin (or the equation from the Nature paper) gives the highest value of residues.
- In the residues obtained from the field data, one can see a dip at 60 MHz.

<u>Tests to explain the 60 MHz dip in the field data:</u>

1.) Replacing the backend to the one that was used in the field:

One difference between the setup for the lab data and field data acquisition is the back end. Hence we reacquired the ANS#2 spectra from the lab using the back end that was employed in the field. The data was calibrated using the same calibration coefficients as before.
Similar to what was done before, the lab data was fit with different foreground models (N=5) and the residues are shown below:

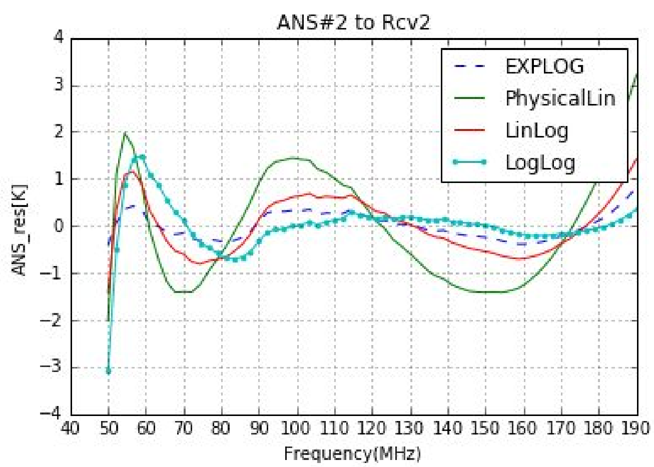


Figure7: The residues obtained on fitting different foreground models to the calibrated data of ANS#2 connected to receiver2 in the lab using the backend from the field.

Still no 60 MHz dip is seen in residues from the lab measurement.

2.) Loosening the attenuator in the old back end.

We realized in the field the attenuator in the backend was loose when the data was collected between the days 154 -177. So we loosened the attenuator of the backend in the lab too and the spectra was reacquired.
Similar to what was done before, the lab data was fit with different foreground models (N=5) and the residues are shown below:

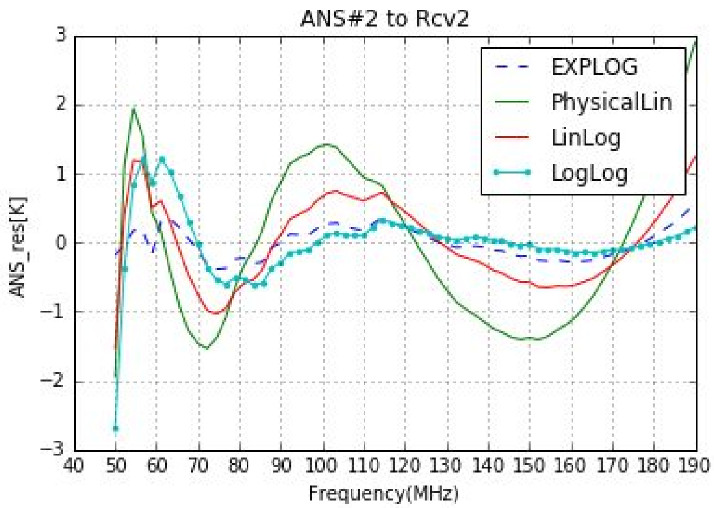


Figure8: The residues obtained on fitting different foreground models to the calibrated data of ANS#2 connected to receiver2 in the lab using the backend from the field and loosening the attenuator. A dip at 60 MHz is visible which was not seen in the data before.

To examine it more carefully, we did the fitting to a narrower frequency range and the residues are shown below:

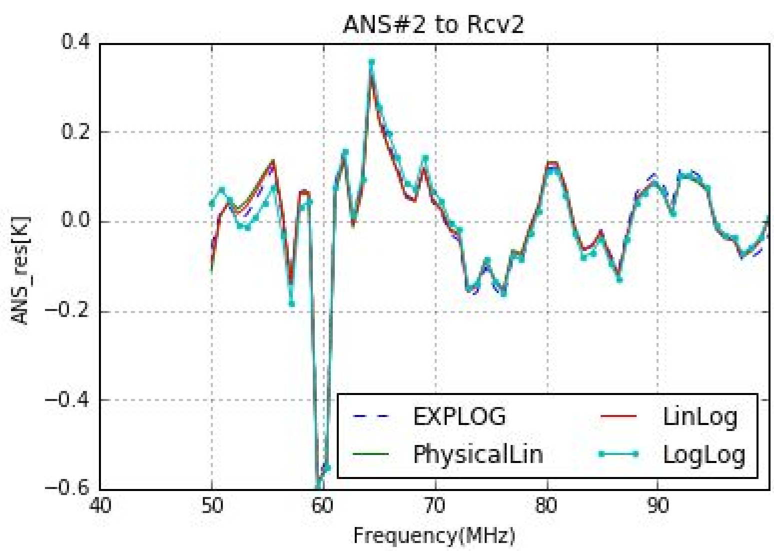


Figure9: The residues obtained on fitting different foreground models to the calibrated data of ANS#2 connected to receiver2 in the lab using the backend from the field and loosening the attenuator. A dip at 60 MHz is visible which was not seen in the data before.

SUMMARY:

- The loosened attenuator is likely the cause of the 60 MHz dip due to the reproducibility in the lab
    - It is seen in figures 8 and 9.
    - In Figure 9 we reduce the frequency range and the dip is more noticeable since the large undulations are reduced
- The dip was not seen in the lab data before the attenuator in the backend was loosened (Figures 2, 7)