EDGES MEMO #274

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To: EDGES Group

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Subject: Evidence for intermittent antenna S11 for lowband2 data

Lowband2 data from 2017_181 to 2018_074 shows evidence of random changes from one state to another. Figure 1 shows the residual spectra with 3 physical terms removed from 2017_270 to 2017_360 processed with S11 from 2018_046. The plots show occasional jumps back and forth from one state to another. Figure 2 shows residuals from simulated data for which

NUM	Antenna S11
0	S11_blade_low_band_2017_291_a.txt
1	S11_blade_low2_band_2018_046_e.txt
2	S11_blade_low2_band_2018_046_a.txt

(the case of NUM=0 is for low2 – despite 2 missing in the file name).

NUM=0 was used as the reference. Note that NUM=0 taken on 2017_291 agrees fairly well with NUM=2 taken on 2018_046 but is quite different than NUM=1 which was taken 15 minutes later than NUM=2. (see email from Raul 22 Feb 2018)

Figure 3 shows the residuals plotted with S11 NUM=1 compared with using NUM=2 for Figure 1. Note that the changes are reversed from which I conclude that whatever caused the change in S11 measured with the build-in VNA measurement also caused the changes in the calibrated spectra. This eliminates the 3-position switch as the cause as it is not in the circuit path of the VNA measurement and leaves the VNA switch on the antenna as the cause of the intermittent changes. An attempt is made to correct the intermittent antenna S11 by processing every day with the following S11 measurements:

S11_blade_low_band_2017_180_NO_SHIELD.txt

S11_blade_low_band_2017_291_a.txt

S11_blade_low_band2_2018_046_a.txt

S11_blade_low_band2_2018_046_e.txt

and using the spectrum with lowest rms with 3 physical terms removed. The residuals to these spectra are shown in Figure 4. However, the best data is from 2017_181-2017_245 when there was little if any intermittent change and I find I cannot improve on the analysis of ASU memo 109 and my conclusion is that we need to check and find the source of the intermittent S11. I suspect a loose connection to the receiver, or possible a loose top cap. All mechanical parts need to be checked for tightness. It would be useful to first apply a little force to the antenna with a

long plastic rod to look for indications of looseness visually and while watching the S11 with a VNA.

Figure 5 shows the rms residuals with 4 physical terms removed filtered to accept only residuals below 300 mK each day. The resulting bestfit signature parameters are

# terms	center MHz	SNR	amp K	width MHz
4 phys.	82.5	21	0.52	22.4
9 poly	78.9	12	0.45	20.7

Originally it was thought that the intermittent S11 results were due to the antenna but a test done in April 2020 suggests that at least the change in the S11 measurements made on 2018 day 46 were the result of an intermittent in the VNA calibration path to the internal load.

To locate the probable location of the intermittent connection the spectrum data from 2018 day 46 from 15 UT to 18 hours UT with lab calibration from 2017 was processed with S11 data from the same day and the residuals with 3-physical terms removed and plotted in Figure 6. The traces labeled NUM= 0 through 4. The top trace (NUM=0) used the 4 s1p.files input1,2,3,4 which correspond to s11 data from from

2018_046_16_06_13_input1.s1p,input2.s1p,input3.s1p,input4.s1p respectively

while NUM=1 through 4 correspond to taking one of the s1p files from a calibration done 72 seconds later. NUM=1,NUM=2,NUM=3,NUM=4 correspond to taking the internal open,short,matched load and antenna s1p data from

2018_046_16_07_25 respectively.

Only the substitution of the s1p from the internal match taken 72 seconds later makes a significant difference and "fixed" the S11 error. The conclusion is that either the internal load is intermittent, the connector is loose or the switch which selects the load.

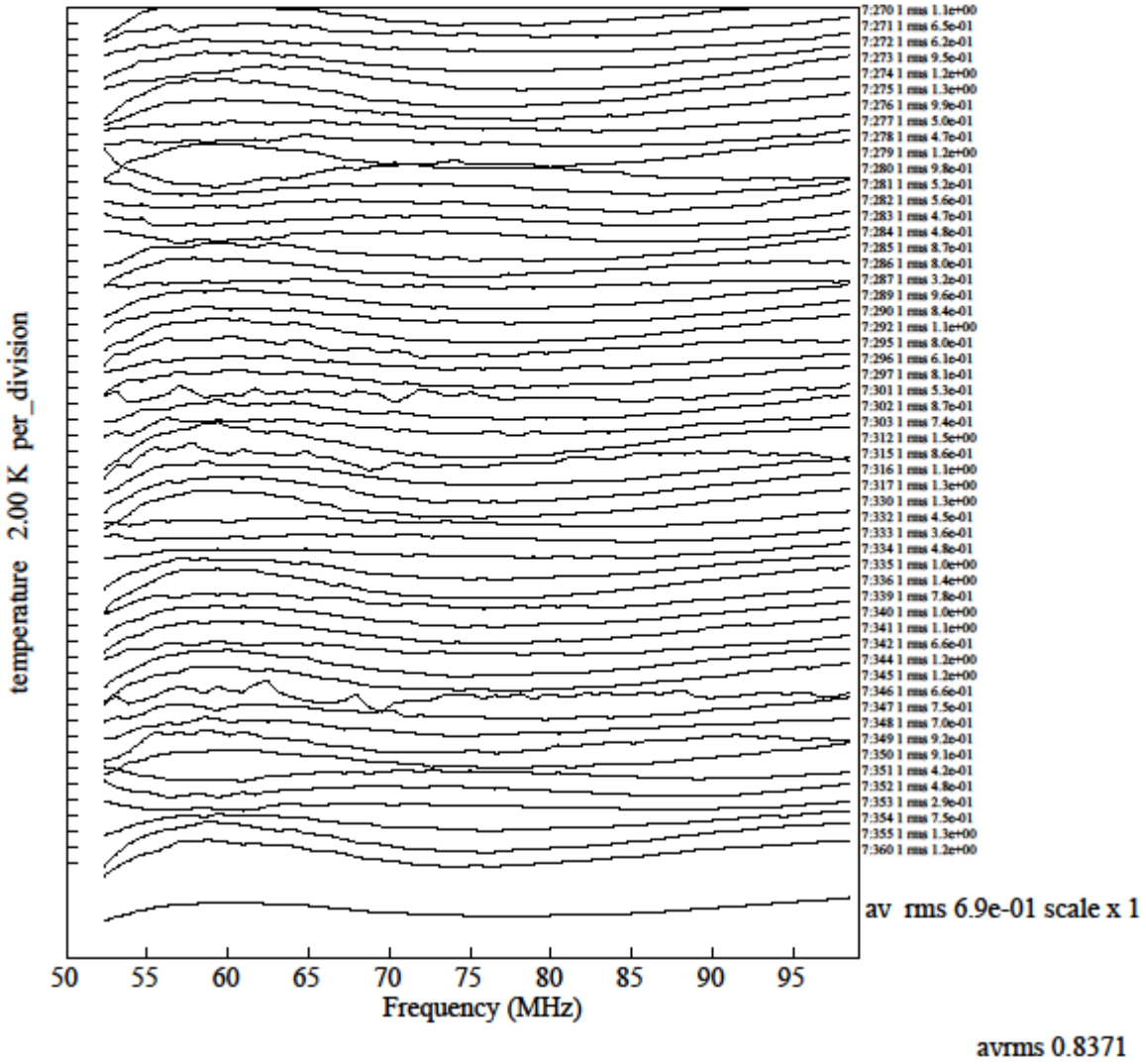

Figure 1. Residuals with 3 physical terms removed using NUM=2 S11.

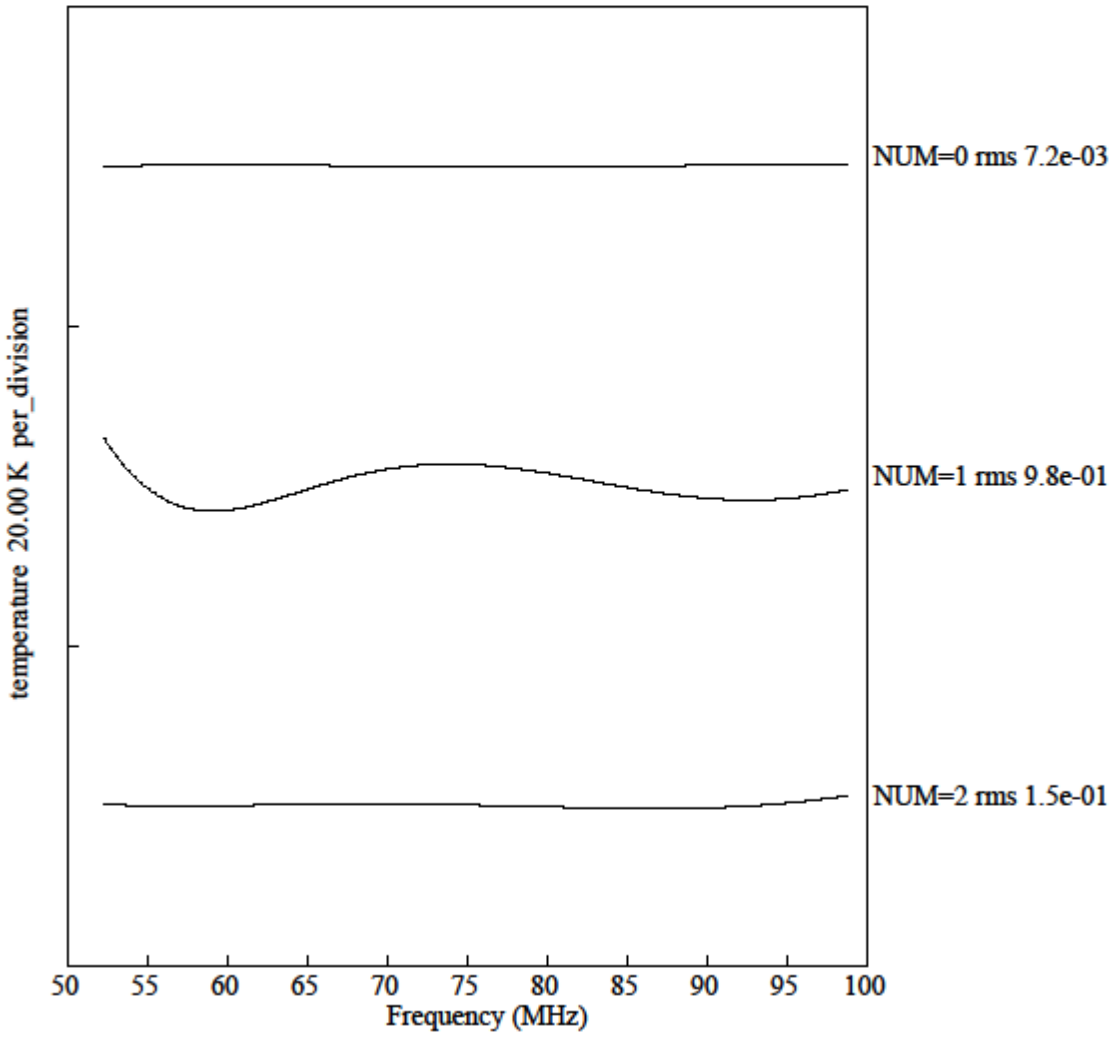

Figure 2. Differences in antenna S11 measurements 0, 1, 2 – see table.

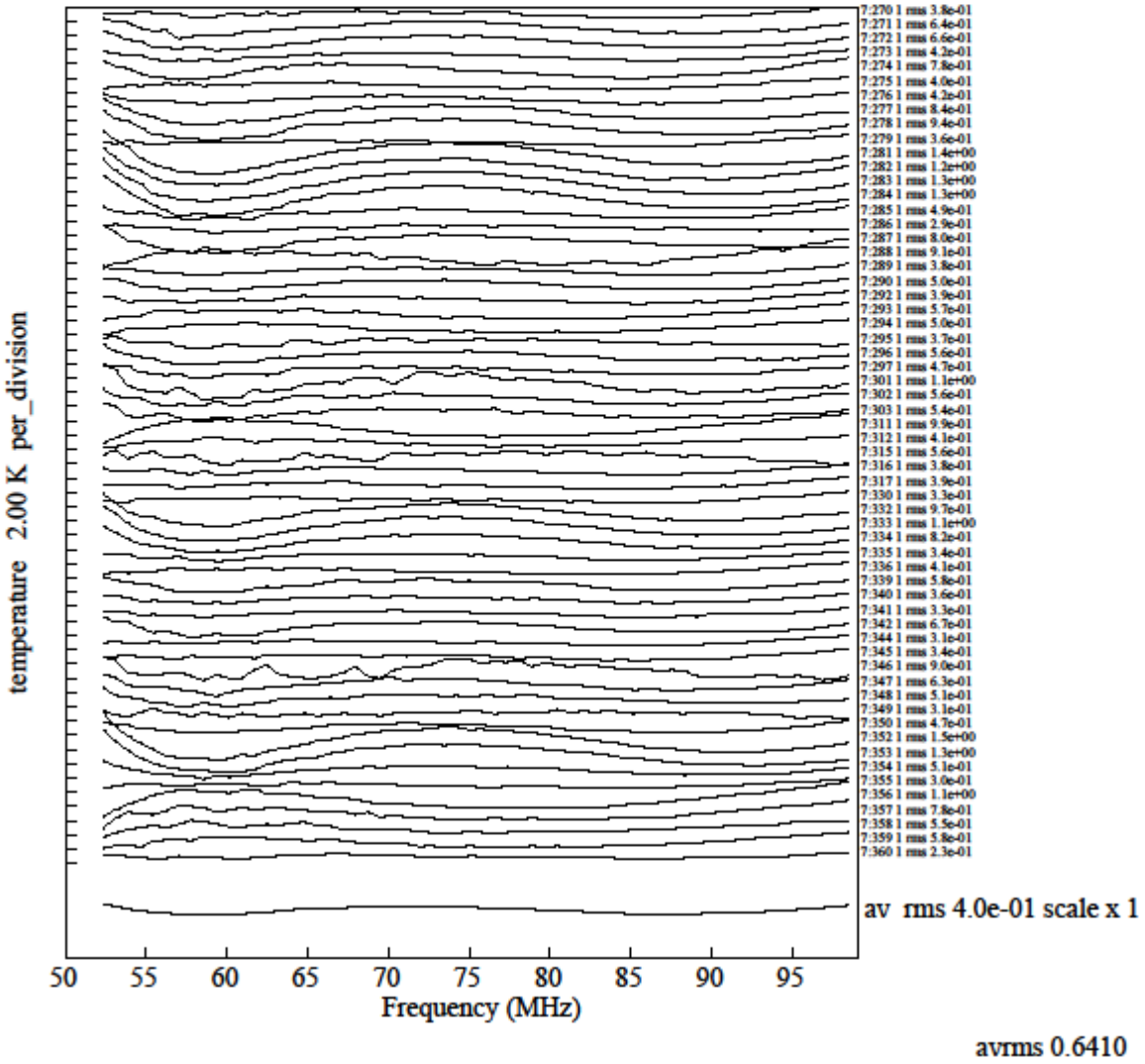

Figure 3. Residuals with 3 physical terms removed using NUM=1.

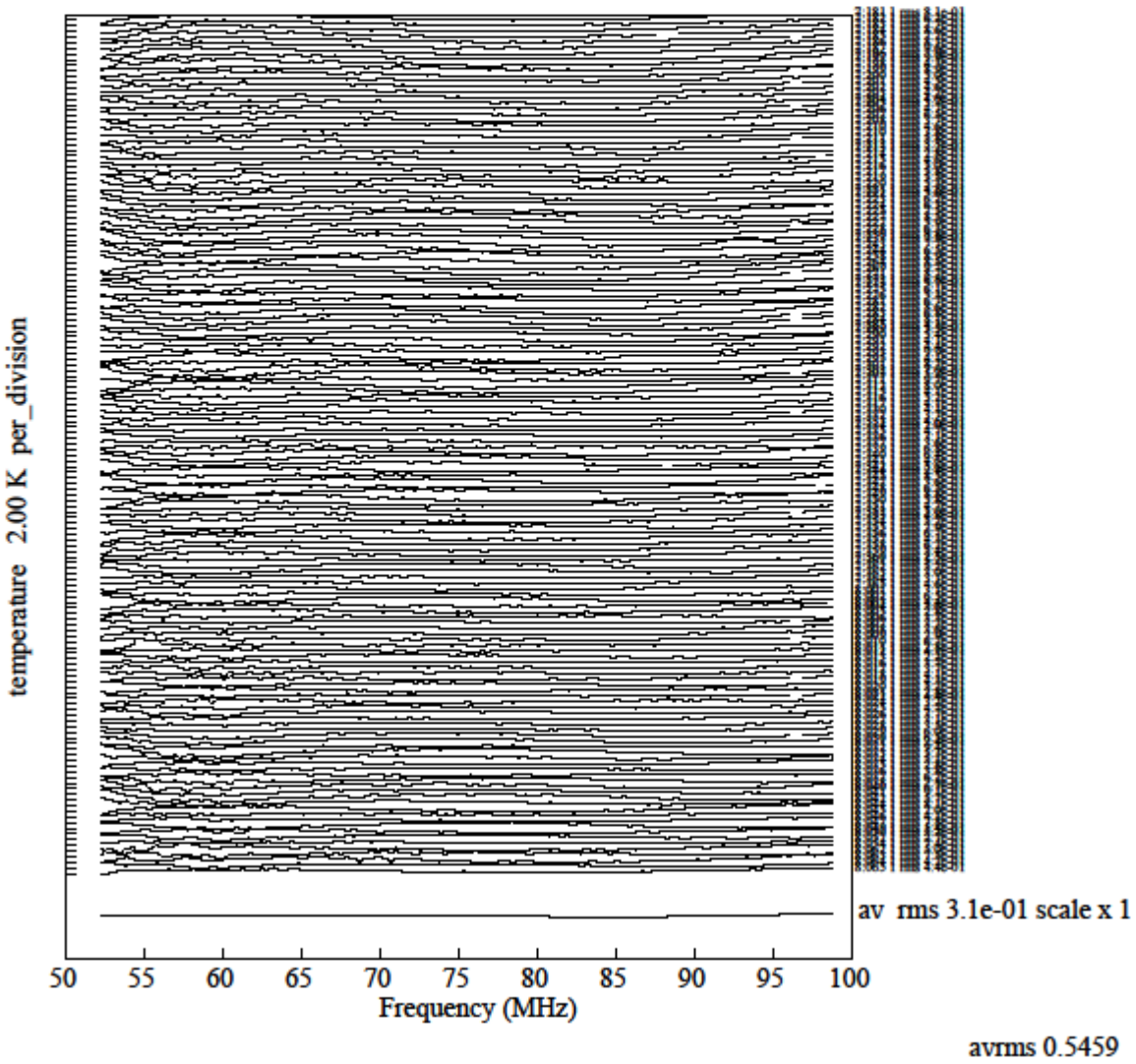

Figure 4. Residuals with 3 physical terms removed in which the S11 which gives the lowest rms was selected. Note that the lower average rms is lower than in Figures 1 and 3.

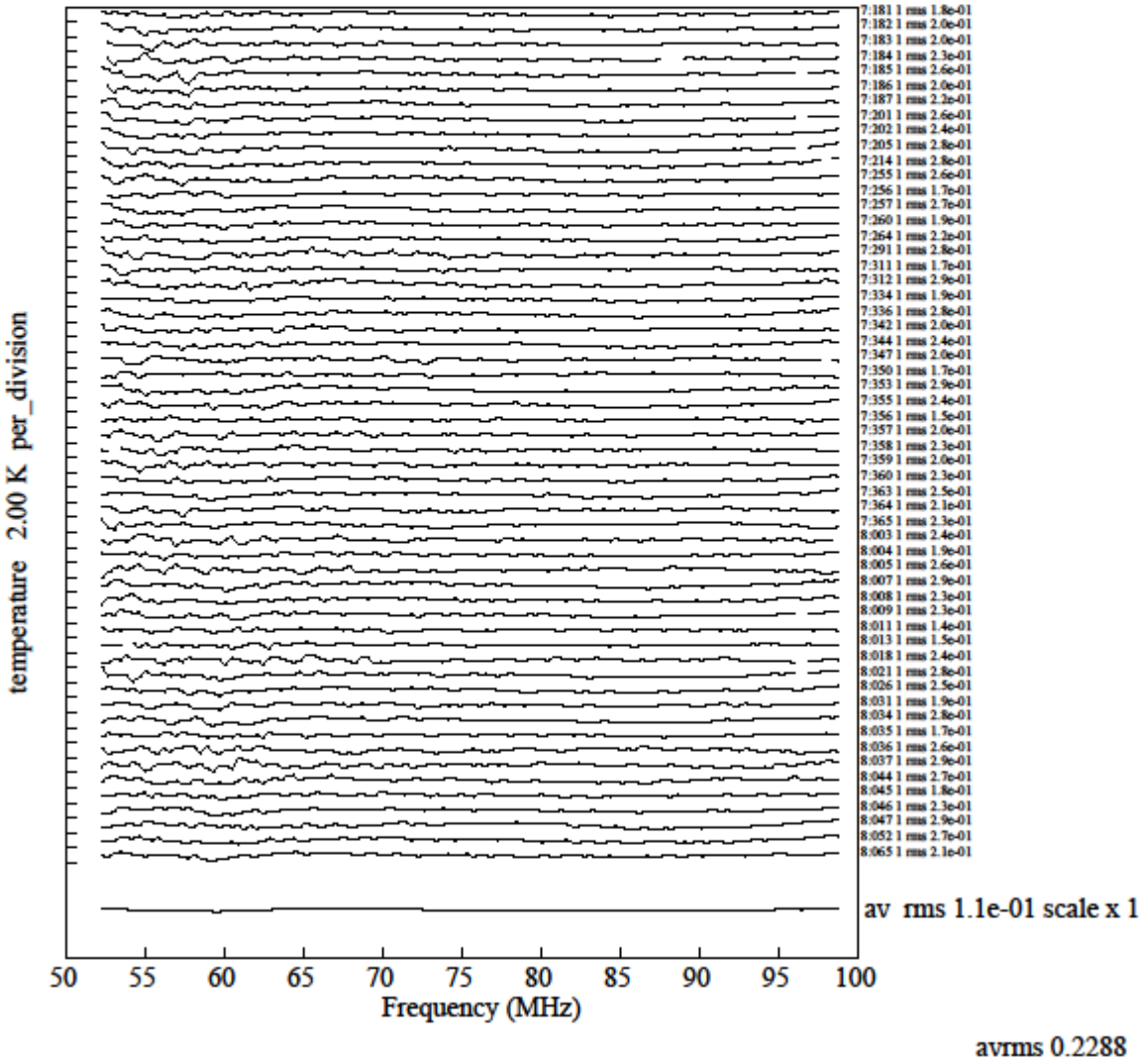

Figure 5. The residuals with 4 terms removed for the best data.

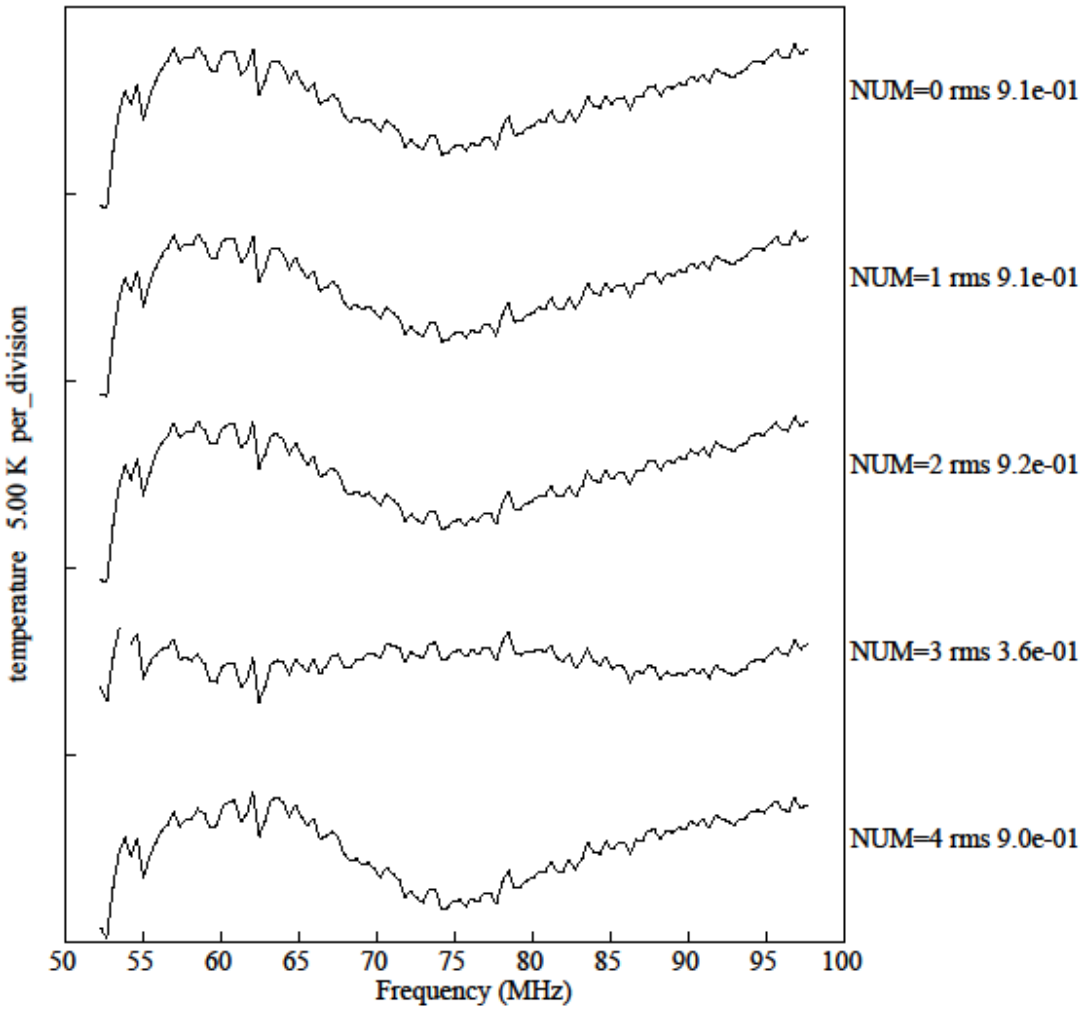

Figure 6. Residuals to 3-physical terms using antenna S11 measurements from different combinations – see text.