EDGES MEMO #405

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To: EDGES Group
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Subject: Further analysis of EDGES-3 on 48x48m ground plane at the MRO

Figure 1 shows the calibrated spectra from days 319 - 332 and 349 - 361 with 5-terms removed and averaged over nighttime data. The residuals are a minimum around day 332. Figure 2 shows the residuals with 2-terms limited to 60 - 90 MHz. With 3-terms it is found that the ionosphere absorption at 75 MHz is a minimum of about 2% at day 332 and reaches 8% at maximum curvature in the 2-term residuals shown in Figure 2.

Based on Figures 1 and 2 it looks like the large absorption of the ionosphere is probably the reason for the broad bump at 75 MHz or at least contributing to the broad bump which explains why the residuals in figure 8 of memo 403 are not closer to those seen by lowband shown in figure 10 of memo 403.

In addition to the absorption tests made in memo 403 a test using day 332, which has the minimum ionospheric absorption, is shown in Figure 2 using 4-physical terms is shown in Figure 3. An offset of +2dB and -200 ps was made to the LNA S11 to minimize the residual prior to fitting for an absorption. The LNA adjustment or some other equivalent calibration adjustment needs more work to justify. A simulation of the Nature 2018 absorption using 4-terms 58 - 110 MHz with added noise predicts 119 mK residual prior to fitting absorption. The noise in Figure 3 is clearly non-gaussian and contains some residual RFI some of which maybe local. Examples of 3 and 4 term fits to lowband data are shown in memo 245.

A comparison of the relative sensitivity of lowband and EDGES-3 using simulations in Table 1 using 5-physical terms and fixed tau = 7.

band	error	center MHz	SNR	amp K	width MHz	rms1 mK	rms2 mK
Low 60-99	no beam correction	78.1	84	0.55	18.8	52	6
Low 53-99	“	77.7	91	0.63	19.0	95	11
EDGES-3	“	78.1	171	0.51	19.0	51	3
“	“	78.1	331	0.52	19.0	85	3
Low 60-99	LNAS11 offset 1dB -100ps	78.1	107	0.55	18.8	55	5
Low 53-99	“	77.7	84	0.67	19.0	146	15
EDGES-3	“	77.7	31	0.41	19.5	37	11
“	“	77.0	19	0.63	20.1	98	48

Table 1. Simulations of the Nature feature using lowband and EDGES-3 on 48x48m ground plane

These show that especially for EDGES-3 in the second entry in each case, which is for 53 to 99 MHz, that EDGES-3 is much more sensitive to an error in LNA S11 and an offset of 2dB and -200 ps, not listed in Table 1, fails to center on the Nature feature for the 53 to 99 MHz. In the current installation, which has poor temperature control and large diurnal temperature swings the LNA s11 is quite uncertain. Improvements should occur as the outside temperature drops as fall approaches. In the

meantime the installation of a mini-split or a better air-conditioner in the hut would help to lower the air circulation fan temperature and keep its temperature more constant.

EDGES-3 is sensitive to antenna S11 error at the level of 0.02 dB and 50 ps for 53 – 99 MHz whereas these levels of antenna S11 error have much smaller effect on lowband. While the current EDGES-3 should get down to 55-99 MHz I have looked at extending the low end of EDGES-3 and initial FEKO simulations of adding metal rod extensions to increase the effective length of the boxes. However while the added rods lower the S11 below 60 MHz it is difficult to get a S11 as smooth as lowband. A better solution is to increase the box size by a factor of 1.15 in length and width. Maintaining the current box height is best but it is necessary to raise the height of the antenna boxes of the ground by the same factor. The added height needed only very slightly raises the beam chromaticity.

In summary the data from EDGES-3 is not of the same quality as the lowband EDGES-2 data for reasons that are not yet understood although the ionosphere is is clearly more active than it was in 2017 and 2018 and the temperature control of the front-end is not as good as it was for EDGES-2. Getting below 60 MHz is difficult and EDGES-3 needs some design changes to lower the antenna S11 below 60 MHz.

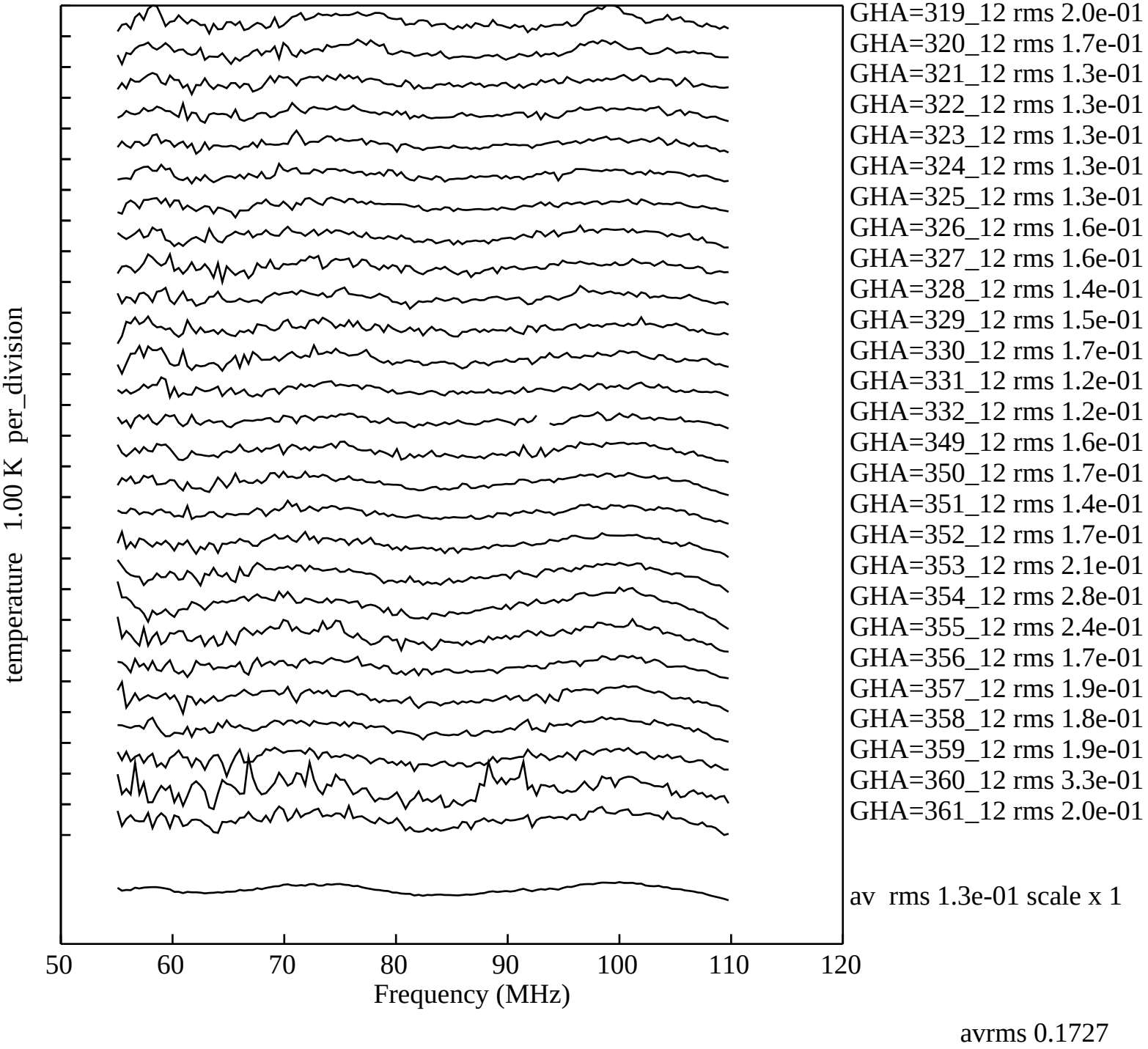

Figure 1. Calibrated spectra from days 319 - 332 and 349 – 361 with 5-terms removed and averaged over nighttime data.

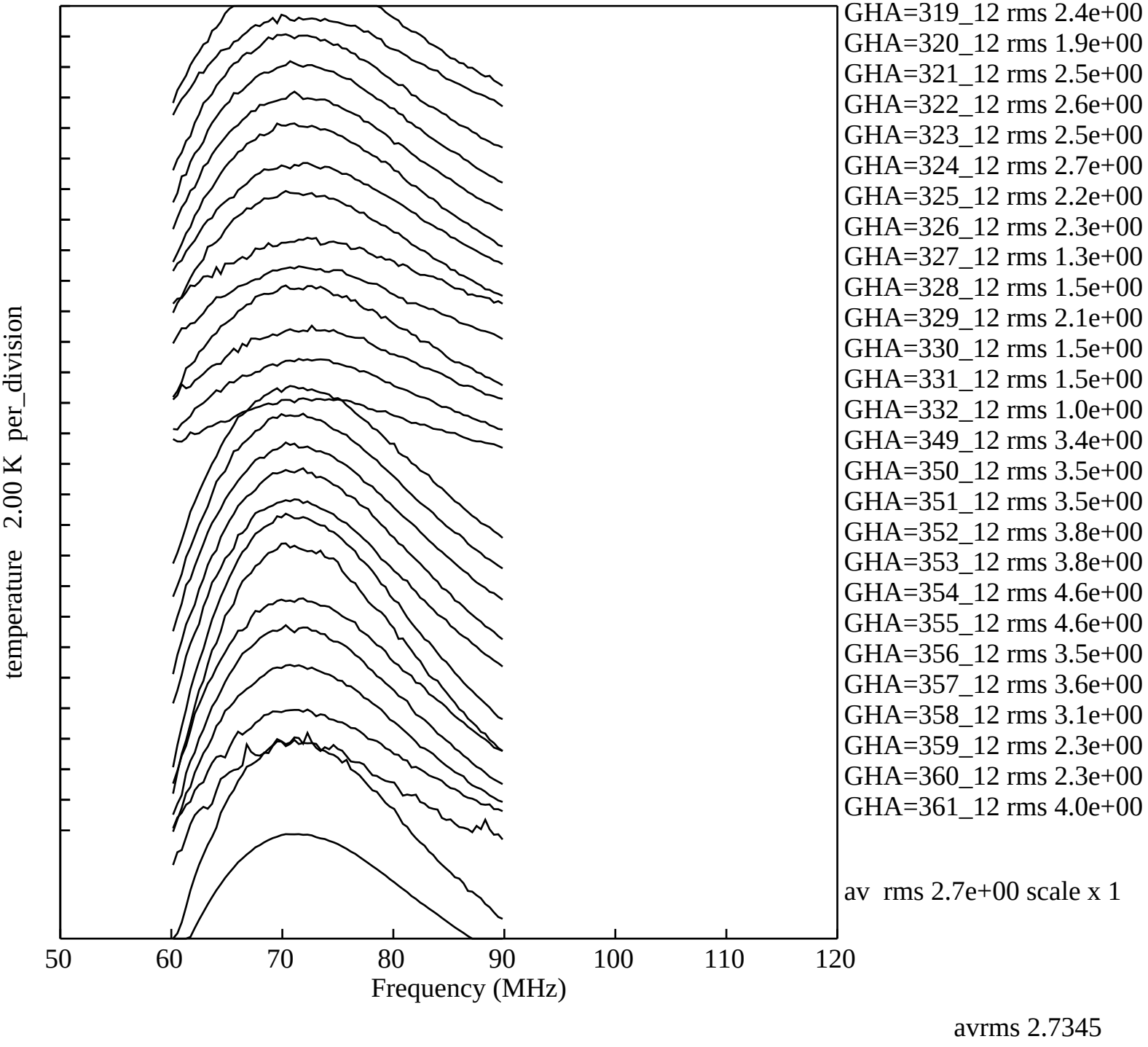

Figure 2. Same as in Figure 1 but with 2-terms limited to 60 – 90 MHz.

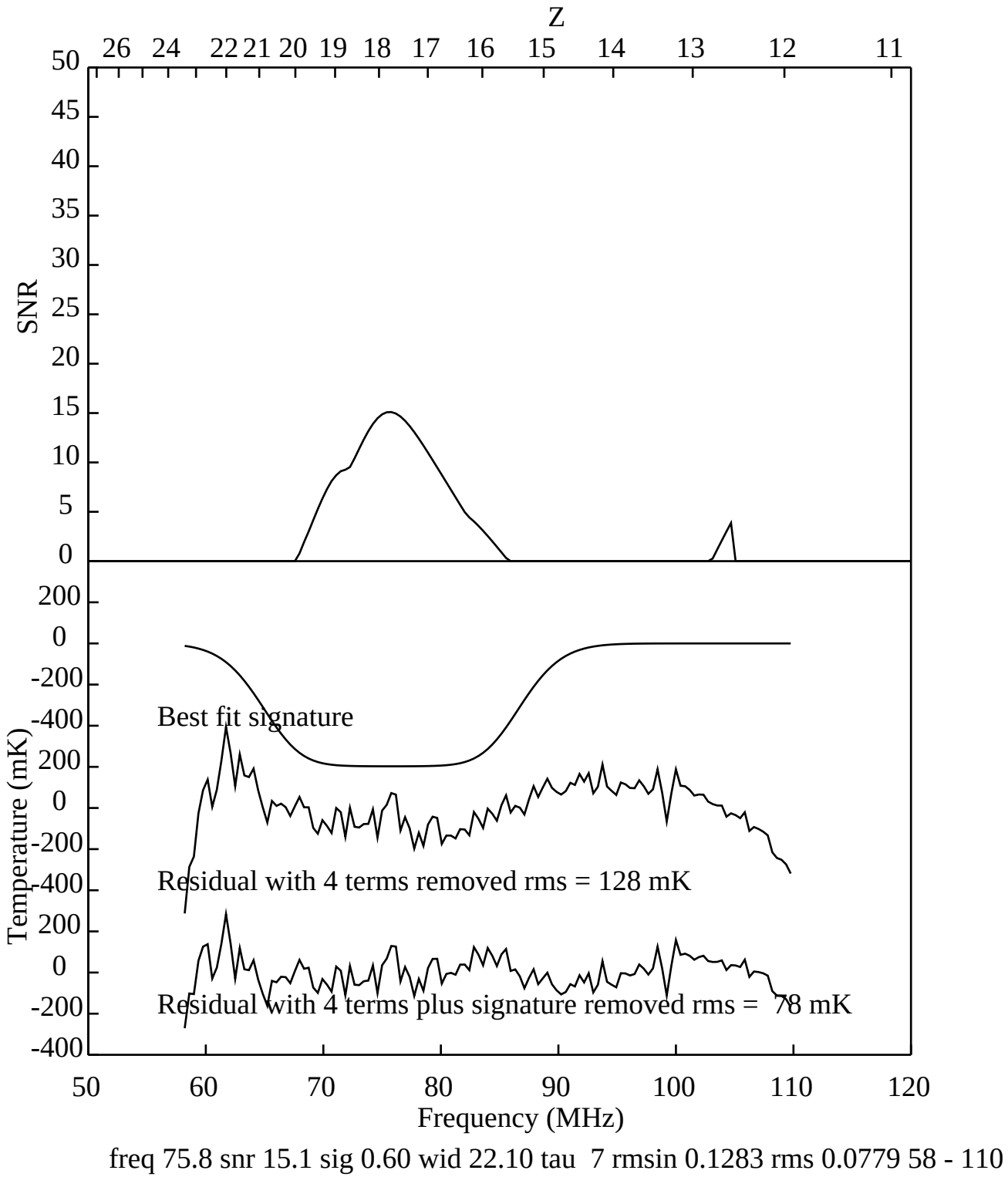

Figure 3. Grid search for an absorption with fixed tau = 7 is derived using day 332 and 4-physical terms and adjustment of LNA S11.