EDGES MEMO #286

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To: EDGES Group

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Subject: Weighted least squares signature using low and midband data.

Some foreground terms can be shared between different data sets while others are separate. Those that are "shared" are assigned the same basis function while those basis functions are allowed to take on a different coefficient for a specific data set are assigned the same functional form with another function index. The unshared data set are assigned a function equal to zero.

Figure 1 shows the signature search using the lowband p8 data from the Nature paper and the midband data from 2018_146 to 218_218. The foreground is modeled with 5 terms using

$\sum_{i=0}^{i=4} a_i f^{-2.55} \left(\log\left(f\right)\right)^i$ where f = frequency/75 from memo 278

For each band with the highest order term, i=4, shared between the 2 bands for a total of 9 terms.

A common signature terms with $\tau = 4$, which gives the best fit, is used in a grid search over center frequency and width. The best fit parameters are given in Table 1.

Term	Index	Midband (K)	Lowband (K)	Comments
0	0	1750.86	1777.37	Unshared
1	1	-31.01	28.36	Unshared
2	2	-71.13	-71.75	Unshared
3	3	26.51	199.22	Unshared
4	4	127.72	127.72	Shared
5	0	26.51		
6	1	59.37		
7	2	-0.618		
8	3	172.71		
9	-	0.68	0.68	signature

Table 1. Best fit values

Lowband values are sum of terms with common index.

Figure 2 shows the results of using 5 unshared terms for each band for a total of 10 terms to remove the foreground. These results have lower SNR but are very close to result using a common term for the highest order foreground term. Other methods of using more common foreground information are under study.

Correction to antenna s11 used for the midband data processing.

The antenna s11 for the midband data was processed using a load resistance value of 50.12 ohms for the male calibration load used in the lab to determine the internal SOL values in the receiver which are then used for the remote s11 measurements of the ambient, hot load and open and shorted cables which are attached to the receiver during calibration and the remote measurements of the antenna s11 in the field. The value of of 50.12 was for another load used in previous calibration and is incorrect. The value should have been 50.027 ohms was used for the receiver 1 calibration made in 2018 and documented in ASU memo 127 as the resistance of the "Male standard - Phil's Kit - 50.027 ohm (25 degC)". This error for the absorption search with separate foreground terms for lowband and midband shown in Figure 2 has been corrected for this case and the result is shown in Figure 3. The relatively small change in resistance results in large midband residuals below 60 MHz so that for the actual measured calibration load resistance the antenna s11 results appears to be a poor choice probably because the high value of antenna s11 for midband below 60 MHz makes VNA noise of some other systematic error more significant than the incorrect resistance value which was chosen by mistake in the processing used for figures 1 and 2. No correction has been made for figure 1 but is expected to be small if the midband range is limited to 60-120 MHz. More work is currently in progress to improve the accuracy of the antenna s11 measurements which are extremely critical for S11 higher than -6 dB which is the case for midband below 60 MHz.

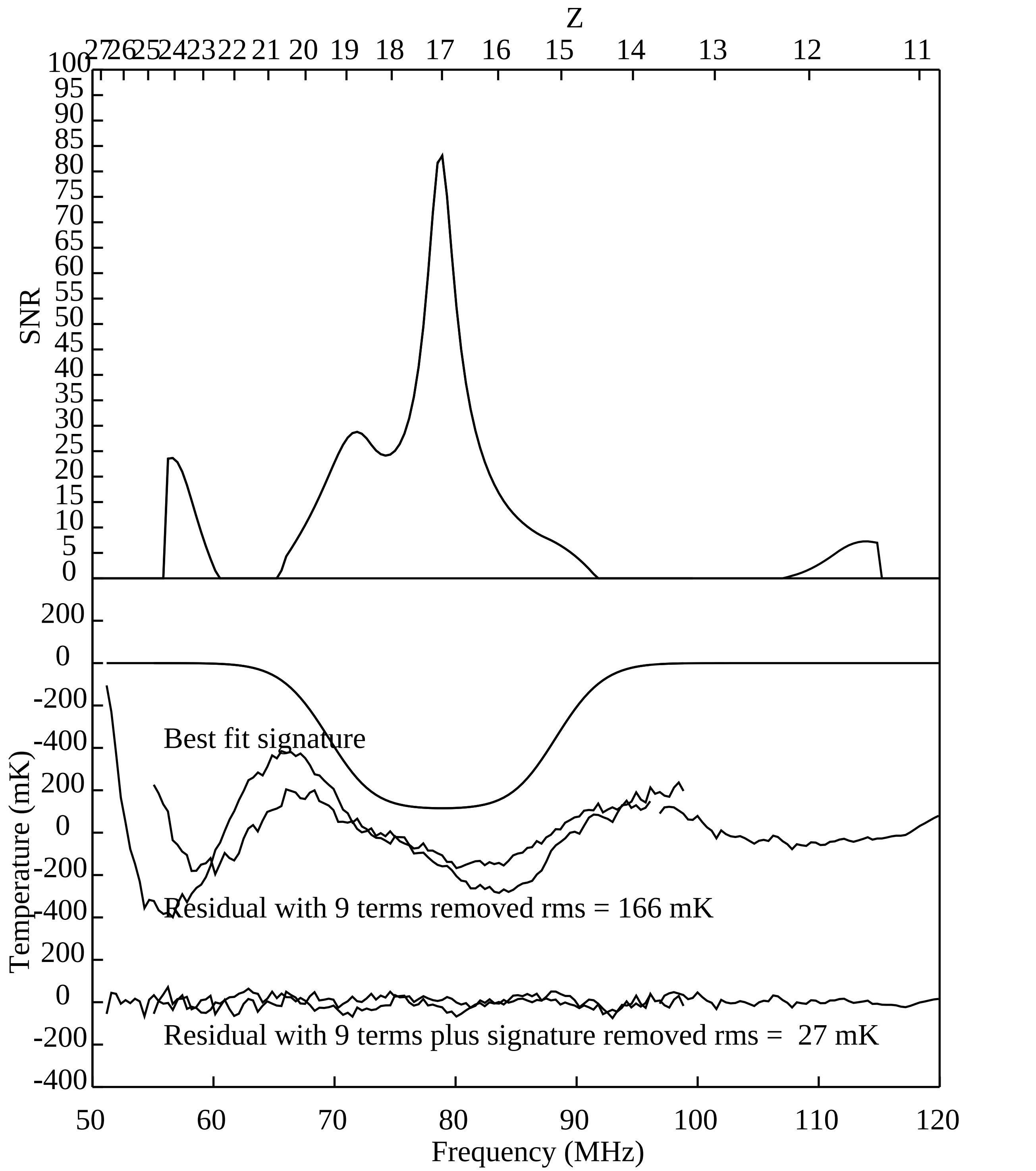

Figure 1. Signature search with one high order foreground term common to both low and midband data.

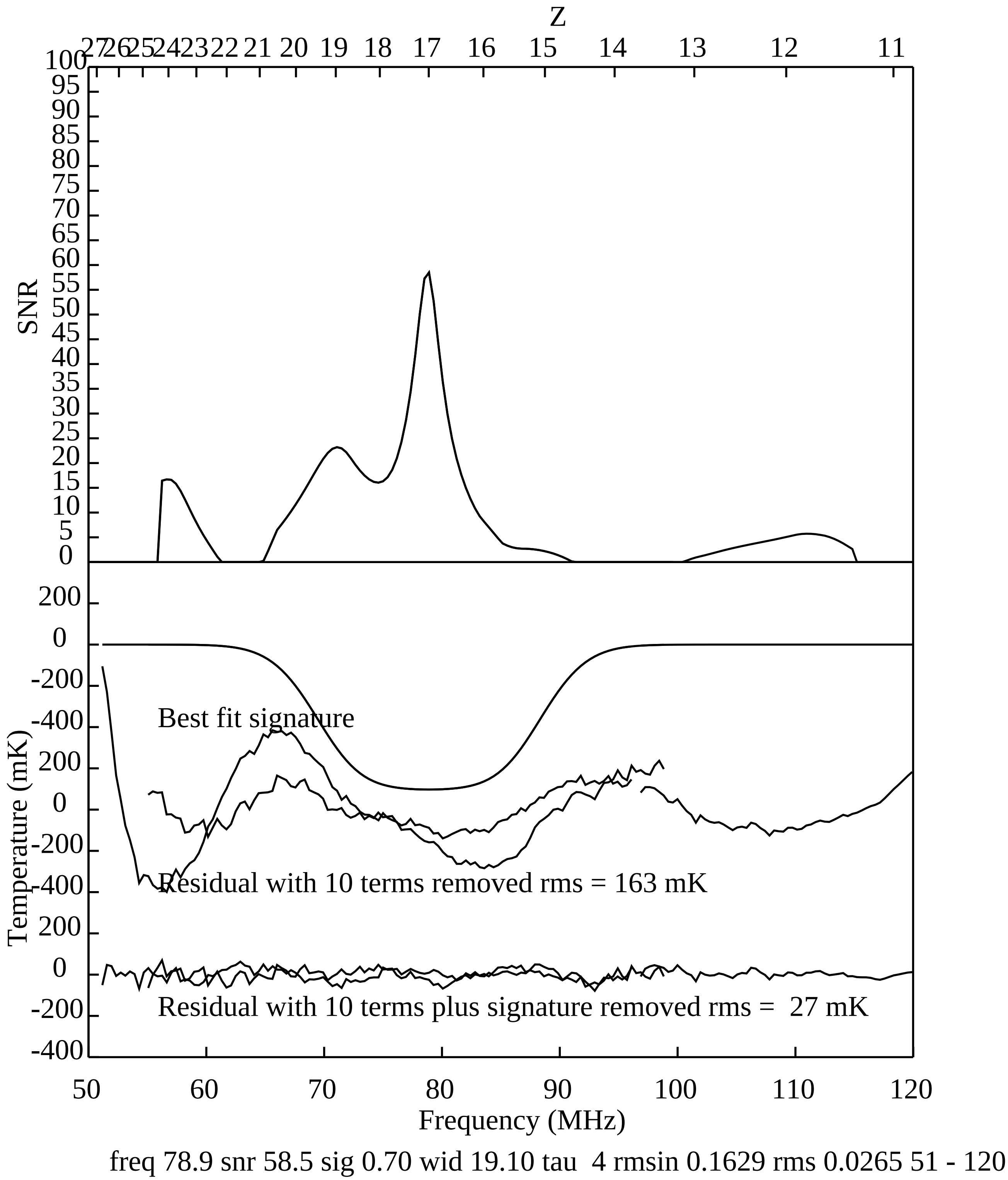

Figure 2. Search with separate foreground terms for lowband and midband.

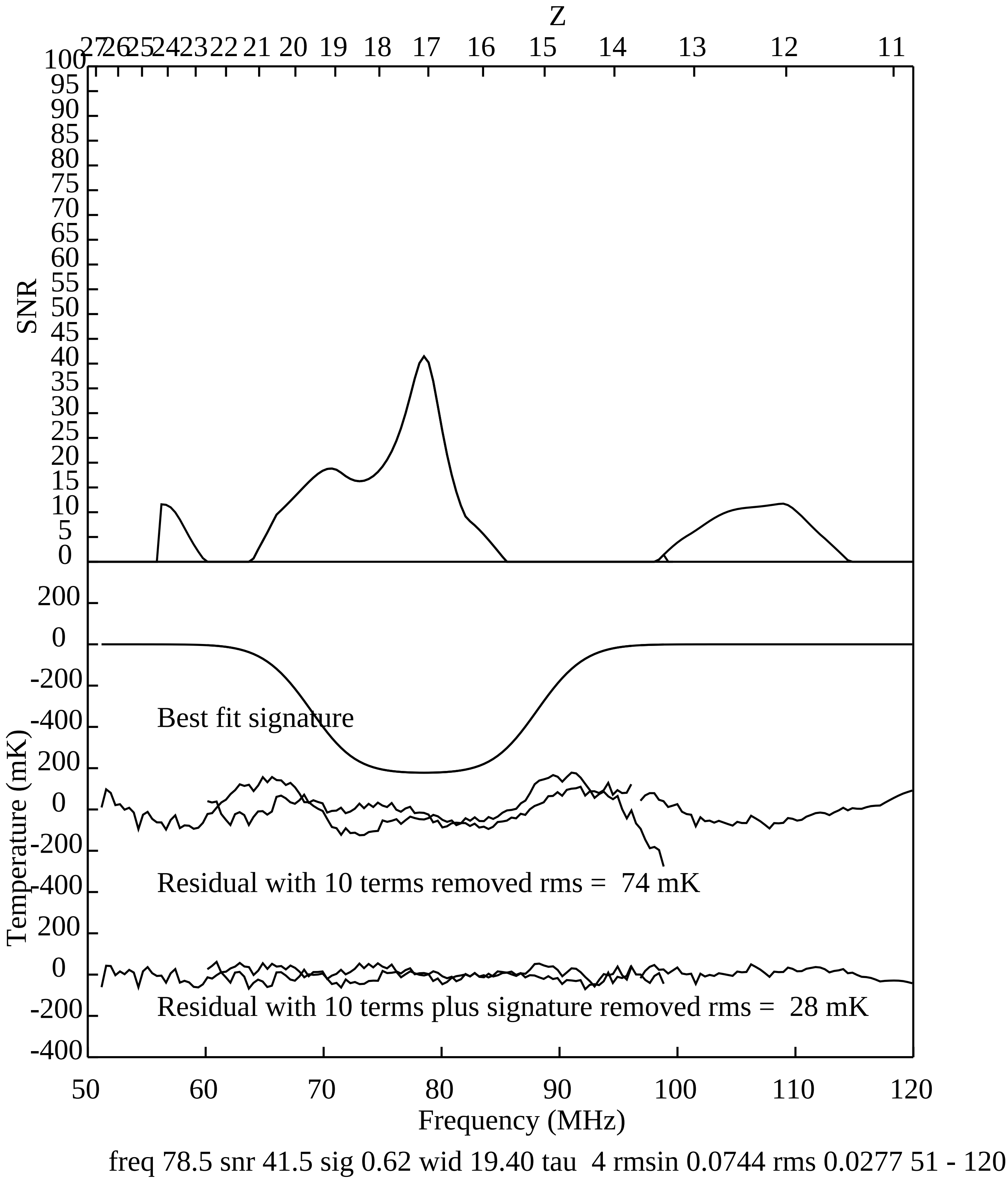

Figure 3. Same as figure 2 but with correction of calibration load resistance. Note that the midband frequency range is now limited to 60 – 120 MHz.