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To: EDGES Group

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Subject: Effect of using receiver calibrations made at different temperatures

The lowband2 receiver was calibrated at 25 C in September 2016 and at 15 and 35 C in November 2016. The receiver LNA S11 was measured again at all 3 temperatures in March 2017. Using the spectral data and the 2017 receiver LNA S11 I derived calibration results for all 3 temperatures. The top 3 plots of Figure 1 show the results of simulating data at GHA 6 to 18 hours using the calibration at 25 C and processing the simulated data with the calibrations at 15, 25 and 35 C. The plots are the residuals to 4 polynomials removed. The bottom 3 plots are for real data from day 180 to 187 of 2017, during which time the receiver was operating at the MRO with temperature controlled at 25 C, processed using the receiver calibrations at 15, 25 and 35 C.

Figures 2 and 3 show the results of simulating data, with added 0.5 K absorption centered at 78 MHz with 20 MHz FWHP and $\tau = 7$ flattening plus 50 mK noise, at 25 C and processing with the 35 C receiver calibration. A grid search for the best fit signature with fixed $\tau = 7$ fails to detect the added signature with 4 or even 5 polynomial terms but the signature is detected, albeit with low SNR when 6 terms are used. This test shows that the change of receiver calibration is smooth enough to allow signature detection in long integrations by introducing additional polynomial terms provided the integration time is long enough and RFI levels are low enough to bring the noise under the required level which is about 50 mK in this example. In practice the receiver temperature errors are due to changes in internal heating which cause changes in internal temperature gradients are probably under 1 C. Efforts are underway to use maintain a constant heat load and improve thermal conductance between the thermal controlled heat plate and critical components like the LNA board.

Calibration temperature	Center freq. MHz	Amp K	Span MHz	rms fit mK
15 C	87.9	1.127	15.7	110
25 C	78.1	0.44	18.7	50
35 C	76.2	1.38	16.1	130

Table 1. Results of signature search using $\tau = 7$ for data plotted in Figure 1.

Table 1 shows the results of using calibration data made at 15, 25 and 35 C on data taken at the MRO with receiver at 25 C. Using the assumption that the effect of a temperature offset in the receiver calibration is linear the effect on the signature amplitude is about 0.1 K per deg C.

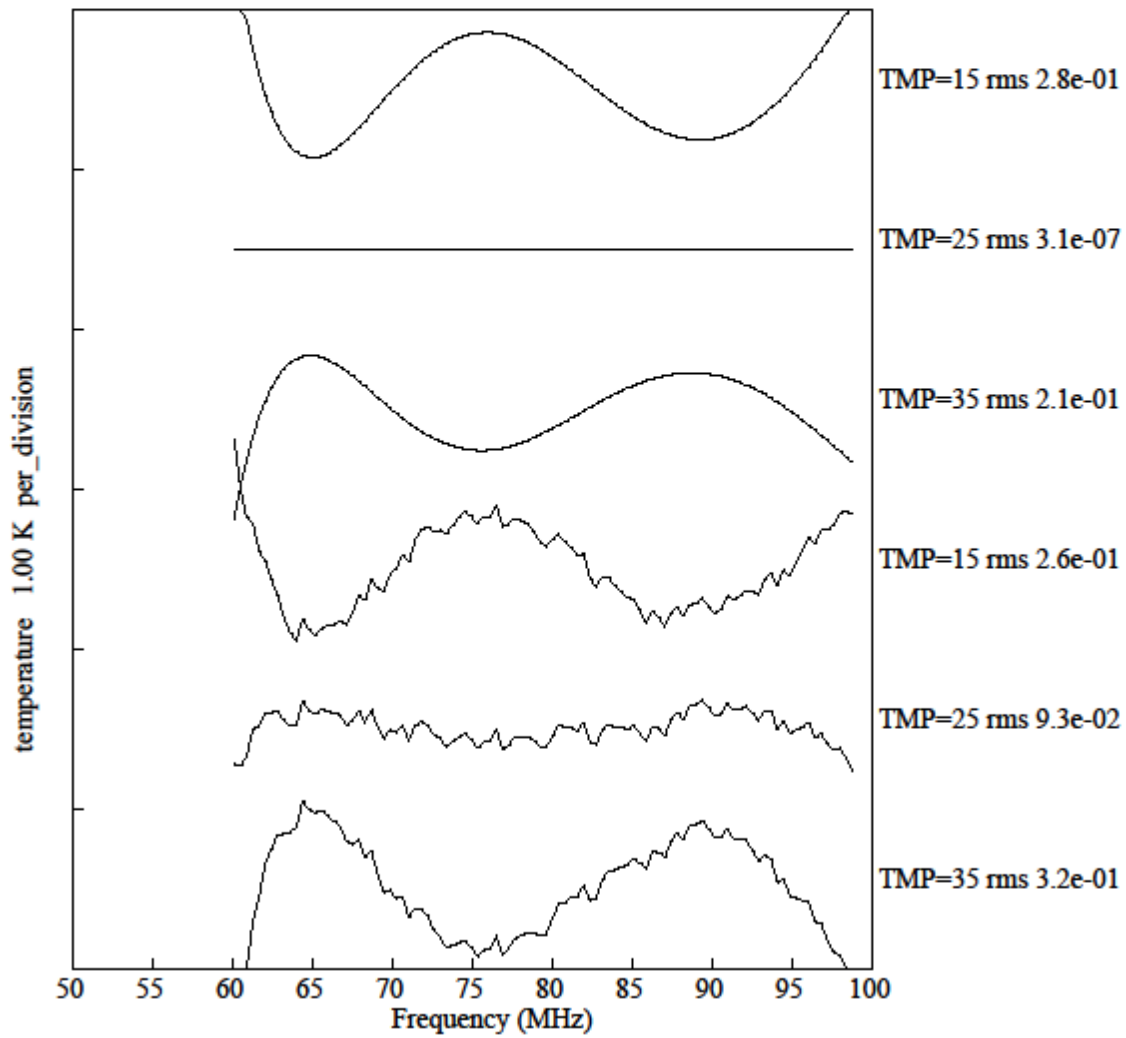


Figure 1. The top 3 plots are for simulated data at 25 C. The bottom three plots are for lowband2 data taken at 25 C processed with calibrations at 15, 25 and 35 C.

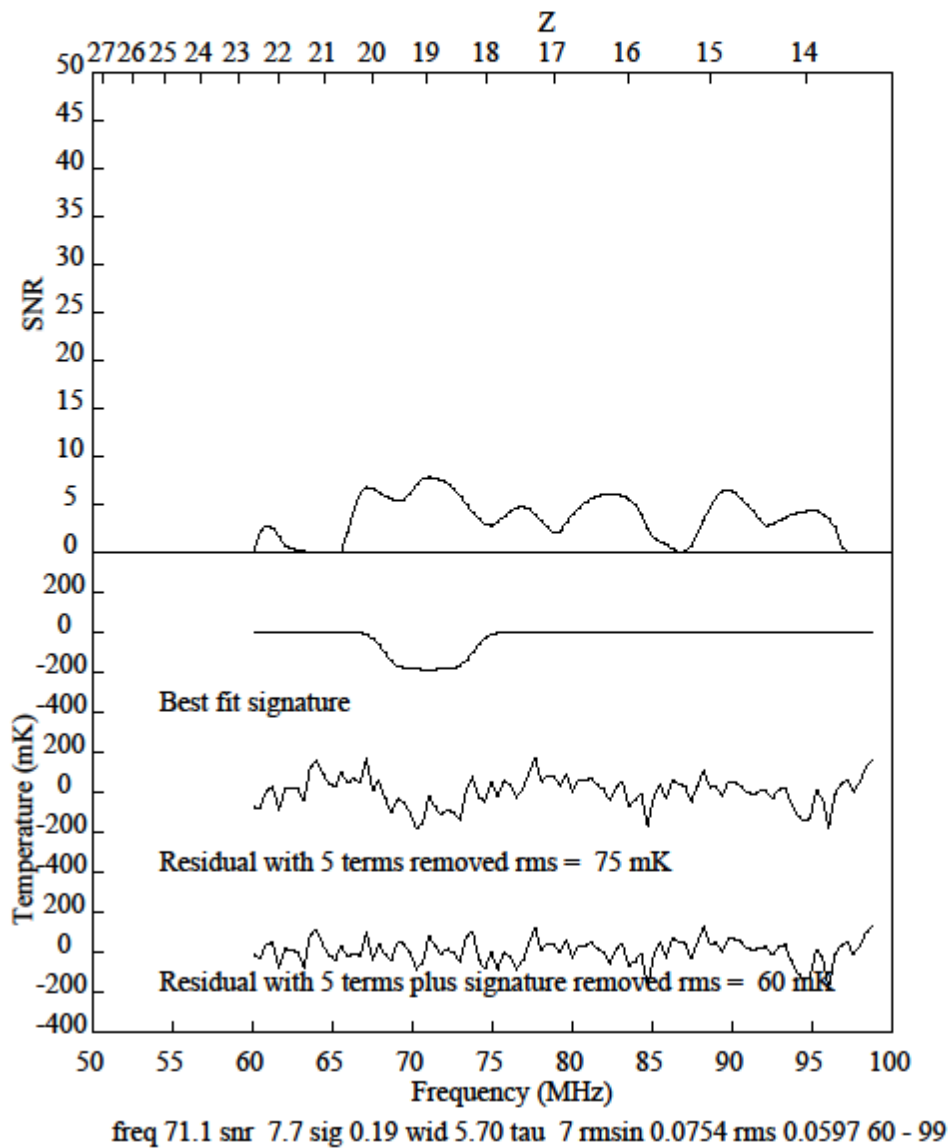


Figure 2. Signature simulated using 25 C calibration processed using 35 C calibration. With 5 terms a grid search fails to find signature.

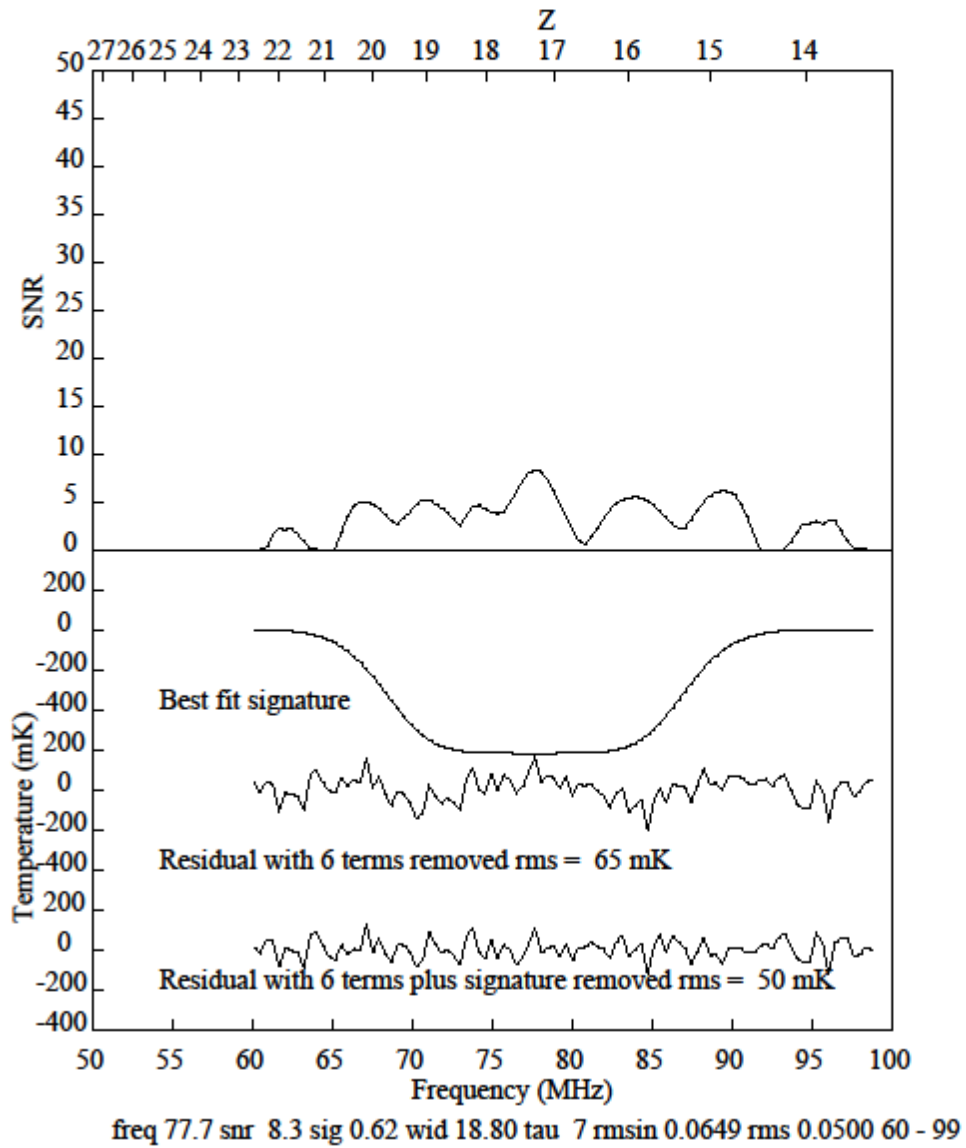


Figure 3. With 6 terms the signature is detected.