New Test Calibration of a Subset of Low-Band 1 Data

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Here we show calibrated data from EDGES Low-Band 1 with the extended ground plane, which corresponds to Case 2 in report $\#094$, after refinements in the calibration. The refinements include: 1) improvements in the RFI excision routines, 2) correction of the length of the balun tubes, in the computation of balun loss, 3) polynomial modeling of the antenna reflection coefficient after initial removal of a delay, and 4) use of the Haslam map scaled to 76 MHz as spatial template of diffuse foregrounds for correction of beam chromaticity.

Details of data processing:

1. Dates: 2016-260 to 2017-091
2. GHA range: 5.5-18.5 hr
3. Frequency range: 61-99 MHz
4. Foreground model: 4-term EDGES polynomial
5. Maximum Sun elevation: $-10°$
6. Maximum Moon elevation: $0°$
7. Receiver calibration S11 file: s11_calibration_low_band_LNA25degC_2015-09-16-12-30-29_simulator2_long.txt
8. Receiver parameter polynomial terms: Cfit=Wfit=7
9. Antenna S11 file: S11_blade_low_band_2016_243.txt
10. Antenna S11 modeling: 10 polynomial terms after removal of delay
11. Balun loss correction: yes
12. Ground loss correction: yes, 0.5%
13. Beam correction: yes
14. Sky map: Haslam map projected to 76 MHz using $\beta = -2.5$
15. Beam model: azelq_blade9perf7low_g4w.txt, rotated to $\mathrm{AZ} = -7°$

The following points can be derived from the figures, resulting from this analysis and using the data and calibration described before:

1. There is suspicious structure in the residuals when fitting a flattened Gaussian with $\tau = 7$ in addition to the foregrounds, especially for the nominal average over GHA 5.5-18.5 hr. This structure is significant above the noise.

2. There is significant variation of the amplitude of the flattened Gaussian as a function of GHA.

3. The lowest signature amplitude is $a_{21} = 359$ mK, obtained at GHA=11 hr (average over range 10.5-11.5 hr).

4. Especially at GHA > 14 hr, the spectral structure becomes frequency-asymmetrical about $\nu = 78$ MHz, which complicates the fitting of a signature with tilt=0.

5. For the nominal average spectrum, over GHA 5.5-18.5 hr, the best fit amplitude is $a_{21} = 687 \pm 42$ mK. The residuals RMS goes from 79 mK with no signature, to 40 mK with signature.

6. We compute an additional spectrum average over GHA 9.5-14.5 hr where the signature is more stable and frequency-symmetric.

7. For this second spectrum, the best fit amplitude is $a_{21} = 527 \pm 34$ mK and the residuals RMS goes from 73 mK with no signature, to 35 mK with signature. The residuals when including a signature are somewhat flatter than in the nominal case, but also it has to be considered that the noise is higher.

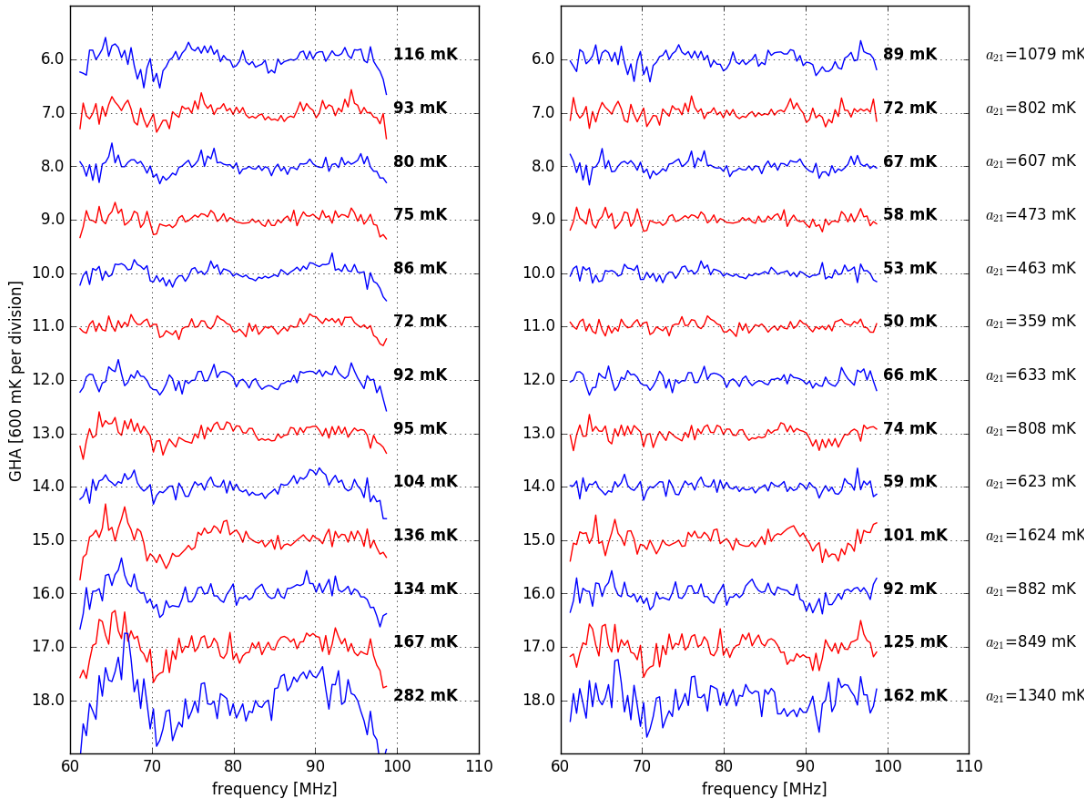

Figure 1: Residuals for data averaged every 1-hr in GHA. For instance, GHA=6 means that the data are averaged between GHA=5.5 hr and GHA=6.5 hr. The left panel shows the residuals to a 4-term polynomial fit, and the right panel includes the flattened Gaussian signature in the fit. In bold we show the residuals RMS. The best-fit signature amplitude (a_{21}) is shown on the extreme right.

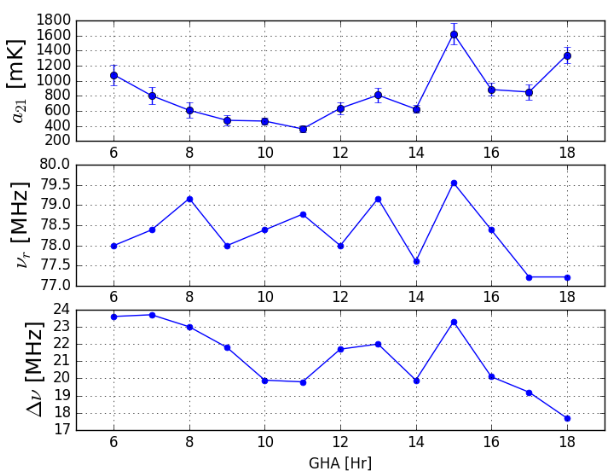

Figure 2: Best-fit 21-cm amplitude as a function of GHA, as well as the center or reference redshift (ν_r) and the FHWM ($\Delta\nu$) of the signature. Here, the best-fit signature is defined as the one that maximizes the SNR=a_{21}/σ_{21}, where σ_{21} is the amplitude uncertainty accounting for covariances and residuals.

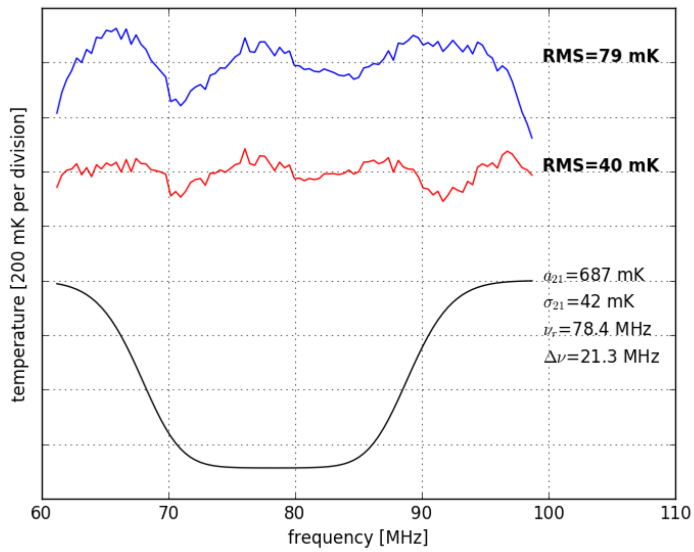

Figure 3: Residuals for nominal average over GHA $5.5 - 18.5$ hr, without (blue) and with (red) flattened Gaussian with $\tau = 7$ in the fit model.

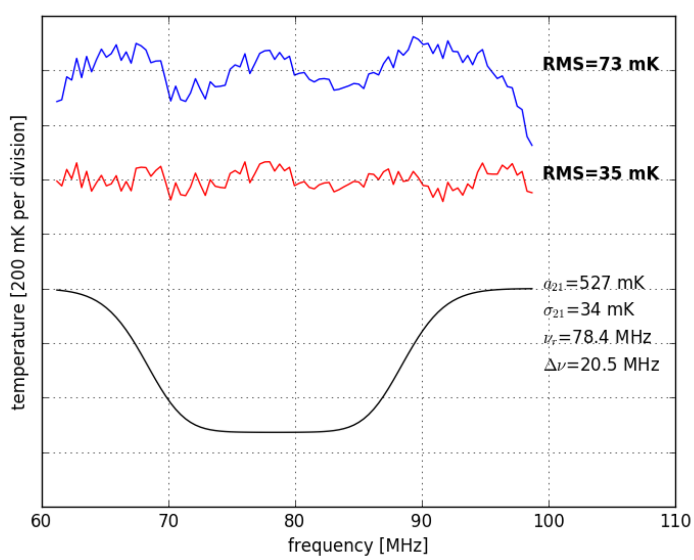

Figure 4: Residuals for second average, over GHA $9.5 - 14.5$ hr, without (blue) and with (red) flattened Gaussian with $\tau = 7$ in the fit model.