

Summary of Data Analysis: Low-Band 2, East-West Antenna, With Balun Shield

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Here we show results for the analysis of data from the Low-Band 2 instrument with the antenna in the E-W orientation, with the balun shield installed. Equivalent reports for other Low-Band datasets can be found here:

http://loco.lab.asu.edu/loco-memos/edges_reports/report105.pdf
http://loco.lab.asu.edu/loco-memos/edges_reports/report106.pdf
http://loco.lab.asu.edu/loco-memos/edges_reports/report107.pdf

Nominal choices and calibration settings:

1. Dates: 2017-155 to 2017-171
2. Sun cut: none
3. Moon cut: none
4. Receiver calibration S11 file: `s11_calibration_low_band_LNA25degC_2017-03-02-02-53-40.txt`
5. Receiver parameter polynomial terms: Nfit=6, Wfit=5
6. Antenna S11 file: `S11_blade_low_band_2017_153_INPIT.txt`
7. Antenna S11 modeling: 9 polynomial terms after removal of delay
8. Balun loss correction: yes
9. Ground loss correction: yes, 0.5%
10. Beam correction: yes, using beam file *newniv* rotated to $AZ = +87^\circ$, and Haslam sky map scaled to 76 MHz using $\beta = -2.5$.

The results are summarized in the following figures.

The first seven figures (after Figure 1 described below) provide a overview of the data.

- Figure 2: daily residuals to 7-term polynomial over 50-100 MHz, for all days considered. The GHA range is 0-24 hr.
- Figure 3: residuals for 4-hr GHA averages, to 7-term polynomial over 50-100 MHz.
- Figure 4: residuals for 6-hr GHA averages, to 6-term polynomial over 61-95 MHz.
- Figure 5: residuals for 6-hr GHA averages, to 6-term polynomial plus 21-cm signature, over 61-95 MHz. The signature center and duration are not fixed, but found by maximizing the SNR.
- Figure 6: amplitude of 21-cm signature as a function of GHA for 6-hour averages, in parallel to the total sky temperature. The signature center and duration, different from case to case, are shown at the bottom.
- Figure 7: residuals and model for average over GHA 0-24 hr, to 1) 6-term polynomial over 50-100 MHz; 2) 6-term polynomial over 61-95 MHz; 3) 6-term polynomial plus 21-cm signature over 61-95 MHz.
- Figure 8: residuals and model for average over GHA 9-15 hr, to 1) 6-term polynomial over 50-100 MHz; 2) 6-term polynomial over 61-95 MHz; 3) 6-term polynomial plus 21-cm signature over 61-95 MHz.

The next three figures show the results for the nominal data average, and compare them with those obtained for different data cuts and calibrations. All the cases correspond to data averages over GHA 9-15 hr and 61-95 MHz, modeled with a 6-term polynomial plus a 21-cm signature. In these cases, the frequency and duration of the 21-cm signature, as well as its amplitude, are found by maximizing the ratio $SNR = |a_{21}/\sigma_{21}|$.

- Figure 9: residuals and 21-cm signature for three alternative receiver calibrations: 1) Nfit=6, Wfit=5, at 23°C, 2) Nfit=6, Wfit=5, at 27°C, and 3) Nfit=7, Wfit=7, at 25°C.
- Figure 10: residuals and 21-cm signature for three alternative antenna S11: 1) 2017-152-1 (before balun measurement), 2) 2017-152-2 (after balun measurement), 3) 2017-153-2 (VNA in hut, not inside pit).
- Figure 11: residuals and 21-cm signature for two alternative corrections: 1) applying no ground loss correction, and 2) applying no beam correction.

Finally, Table 1 presents the amplitude estimates for the different data cuts and calibration alternatives, and Figure 1 shows the values.

Table 1: Signature amplitude estimates for all the cases considered. In all cases, the GHA range is 9-15 hr. The frequency range is 61-95 MHz and, in addition to the signature, the fit model includes six polynomial terms.

Case	Description	Amplitude estimate [mK]
0	Nominal	434 ± 103
1	recv cal2017, Nfit=6, Wfit=5, 23°C	433 ± 106
2	recv cal2017, Nfit=6, Wfit=5, 27°C	402 ± 103
3	recv cal2017, Nfit=7, Wfit=7, 25°C	428 ± 105
4	2017-152-1 (before balun measurement)	353 ± 96
5	2017-152-2 (after balun measurement)	376 ± 100
6	2017-153-2 (VNA in hut, not inside pit)	398 ± 103
7	No ground loss correction	405 ± 99
8	No beam correction	369 ± 100

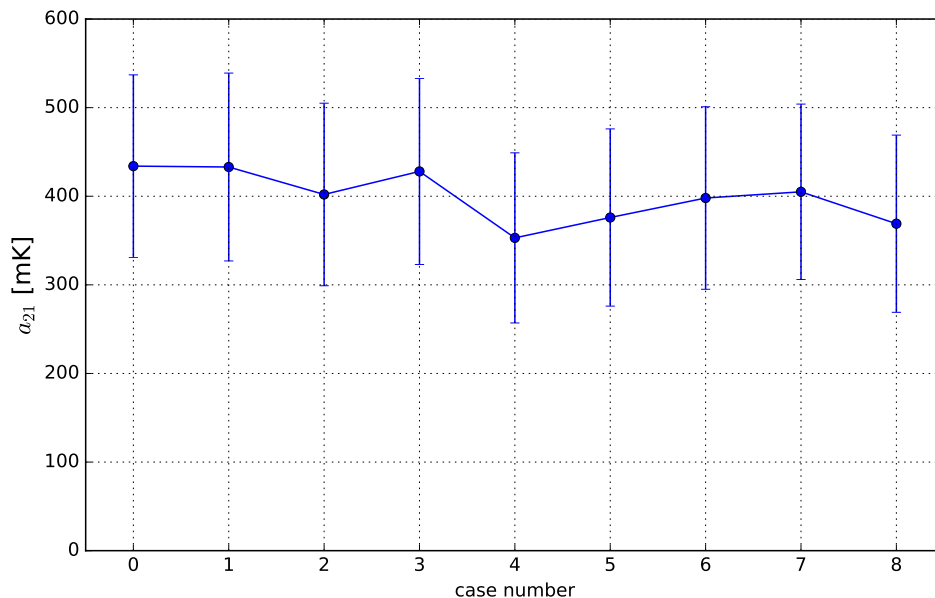


Figure 1: Signature amplitude for the cases of Table 1.

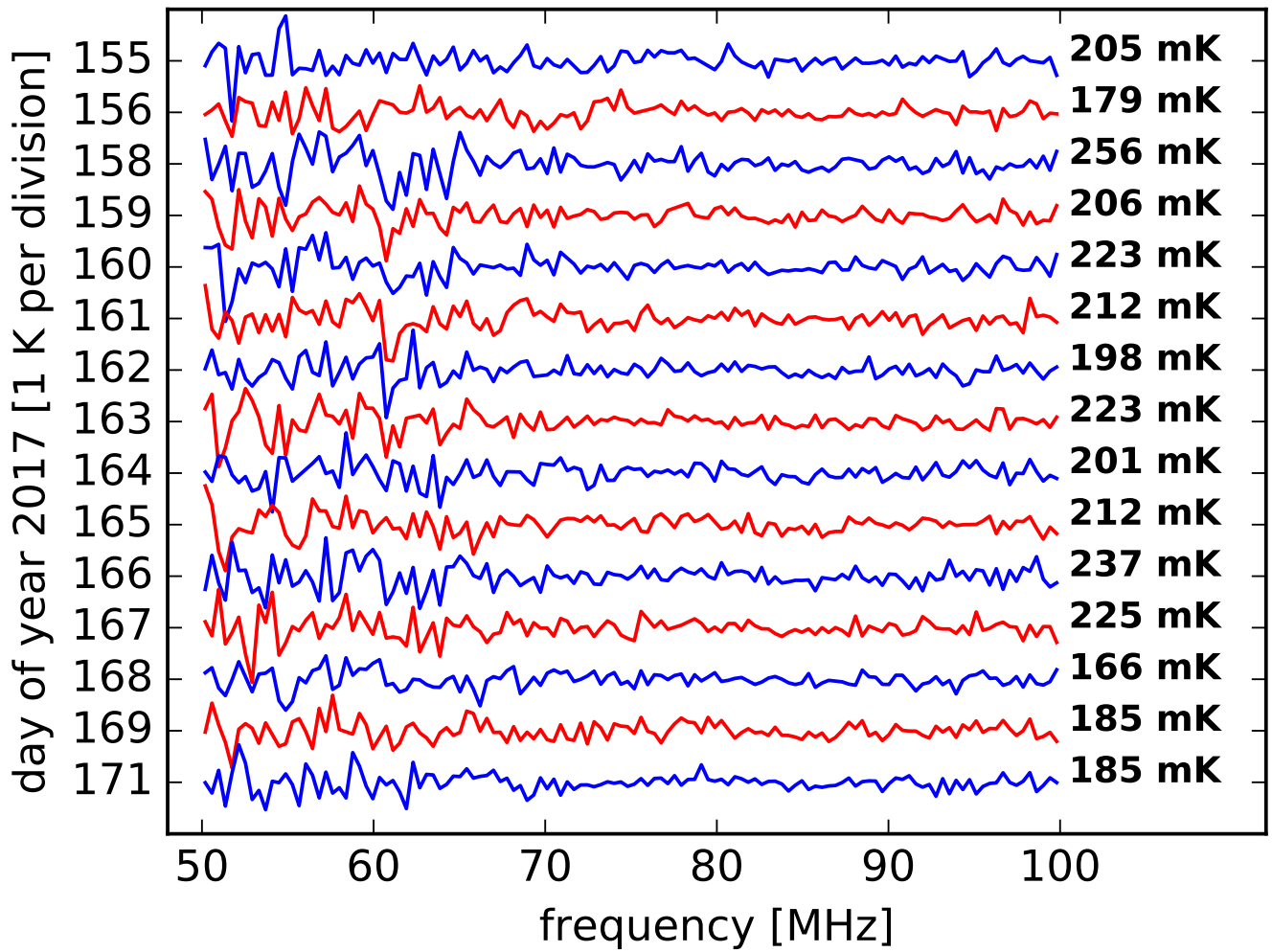


Figure 2: Daily residuals to 7-term polynomial over 50-100 MHz, for all days considered. The GHA range is 0-24 hr.

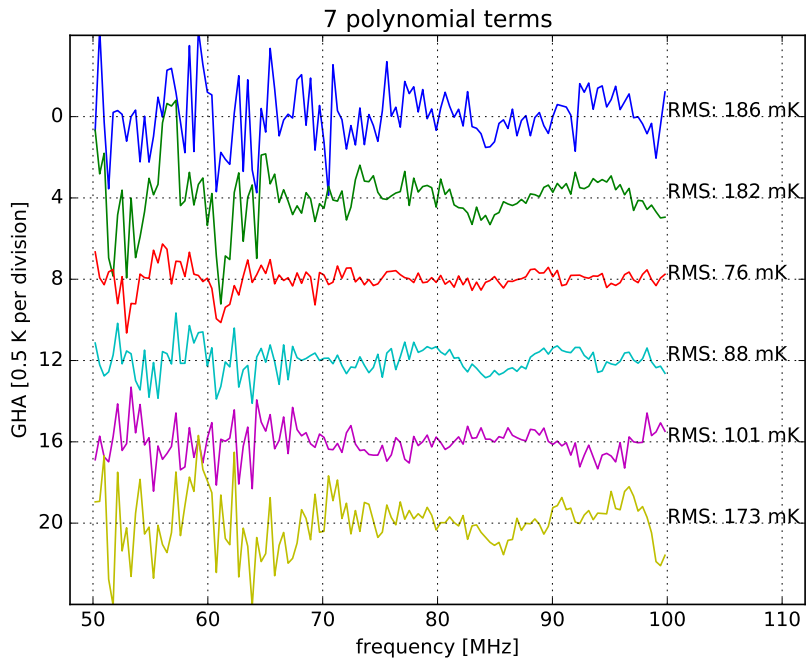


Figure 3: Residuals for 4-hr GHA averages, to 7-term polynomial over 50-100 MHz.

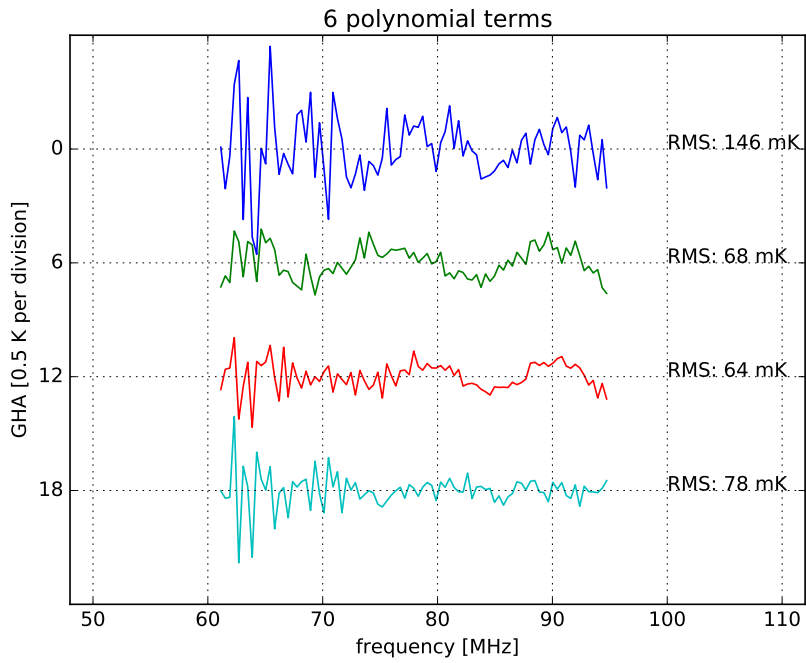


Figure 4: Residuals for 6-hr GHA averages, to 6-term polynomial over 61-95 MHz.

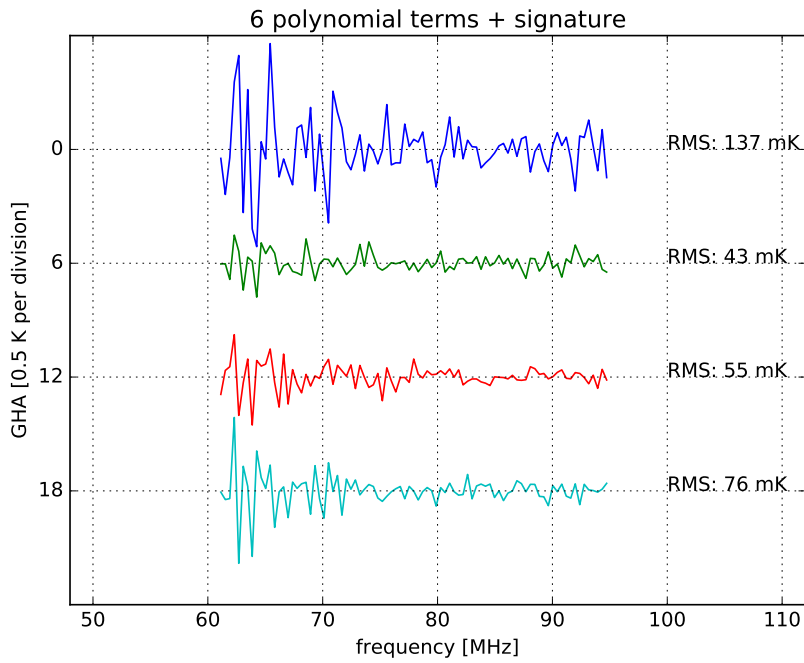


Figure 5: Residuals for 6-hr GHA averages, to 6-term polynomial plus 21-cm signature, over 61-95 MHz. The signature center and duration are not fixed, but found by maximizing the SNR.

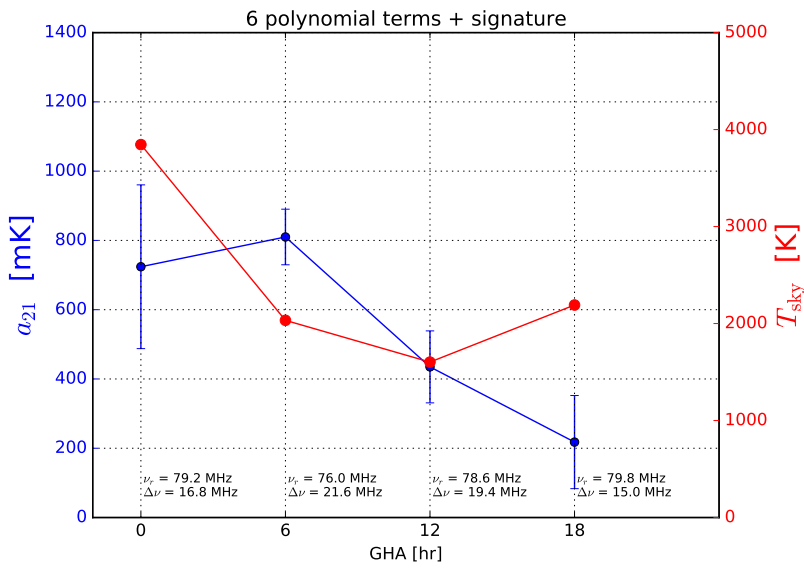


Figure 6: Amplitude of 21-cm signature as a function of GHA for 6-hour averages, in parallel to the total sky temperature at the frequency of the signature center. The signature center and duration are shown at the bottom.

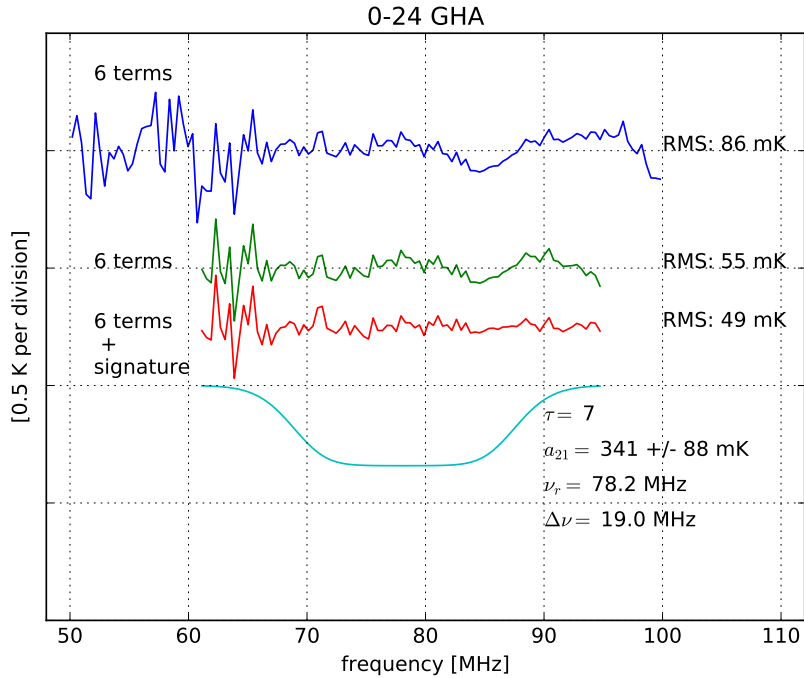


Figure 7: Residuals for average over 0-24 GHA, to 1) 6-term polynomial over 50-100 MHz (blue); 2) 6-term polynomial over 61-95 MHz (green); 3) 6-term polynomial plus 21-cm signature over 61-95 MHz (red). Also shown (cyan) is the best fit 21-cm signature over 61-95 MHz.

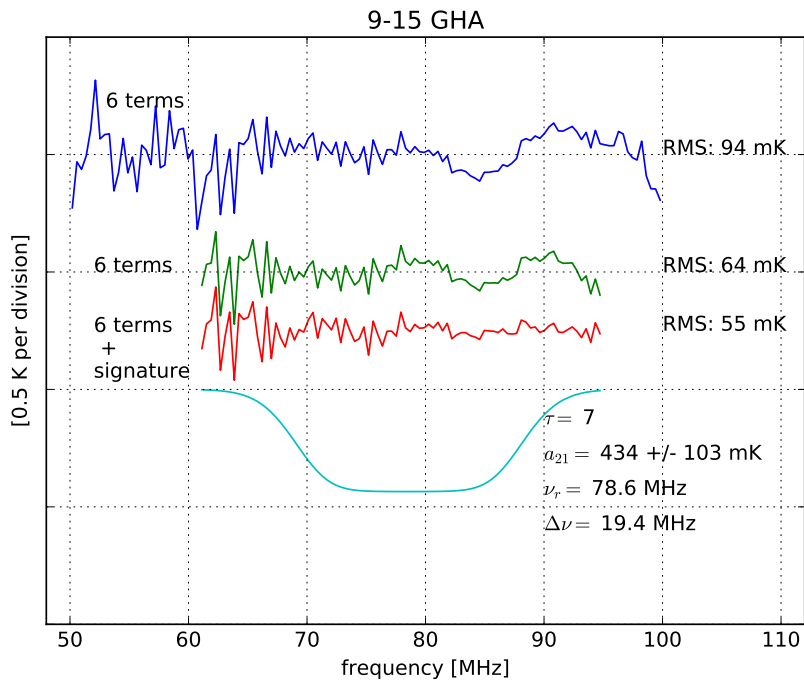


Figure 8: Residuals for average over 9-15 GHA, to 1) 6-term polynomial over 50-100 MHz (blue); 2) 6-term polynomial over 61-95 MHz (green); 3) 6-term polynomial plus 21-cm signature over 61-95 MHz (red). Also shown (cyan) is the best fit 21-cm signature over 61-95 MHz.

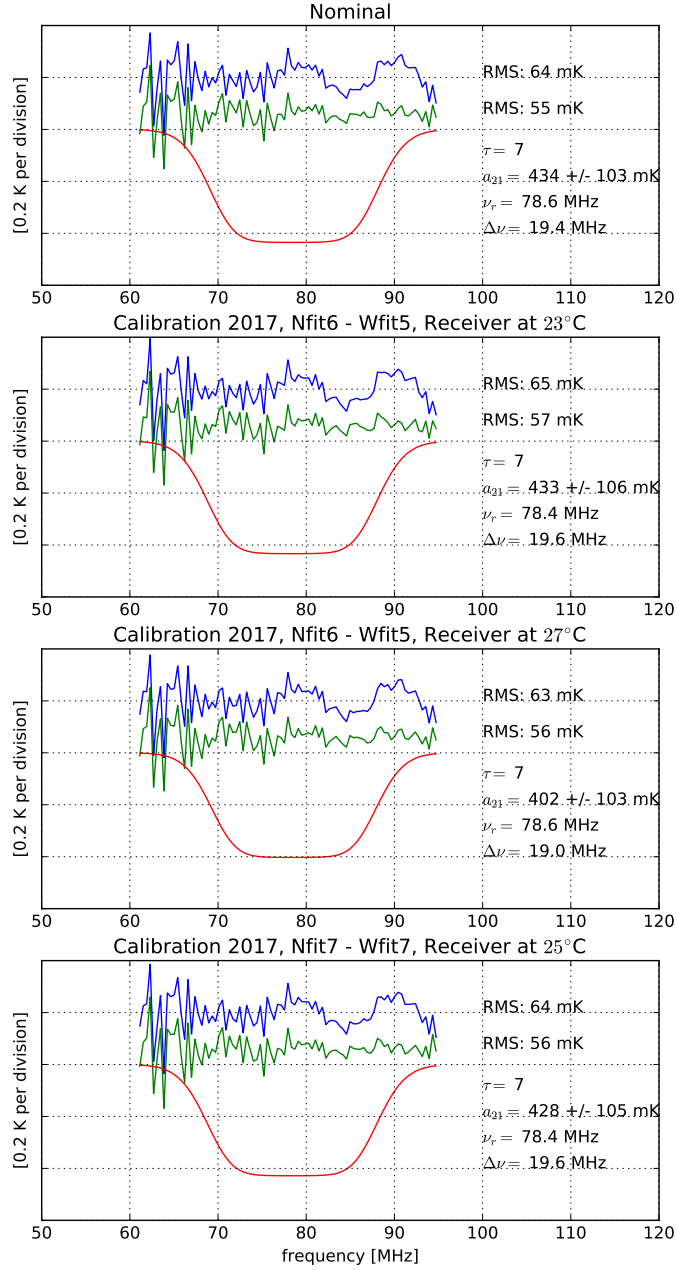


Figure 9: Residuals and 21-cm signature for three alternative receiver calibrations: 1) Nfit=6, Wfit=5, 23°C, 2) Nfit=6, Wfit=5, 27°C, and 3) Nfit=7, Wfit=7, 25°C. Top panel is the nominal case.

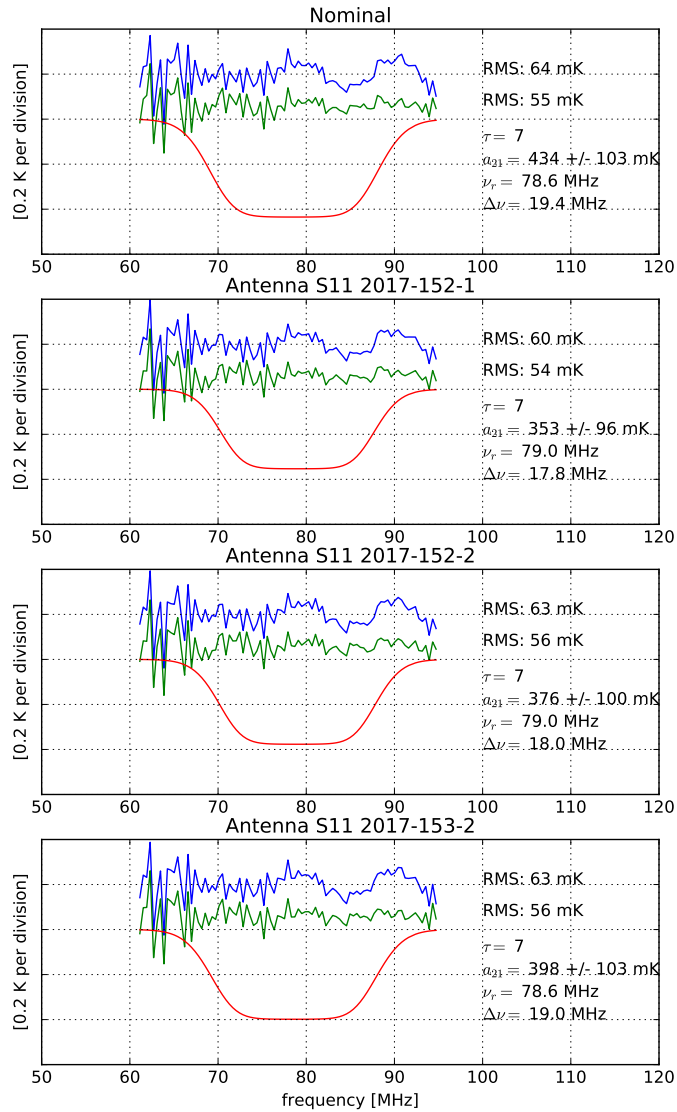


Figure 10: Residuals and 21-cm signature for three alternative antenna S11: 1) 2017-152-1 (before balun measurement), 2) 2017-152-2 (after balun measurement), 3) 2017-153-2 (VNA in hut, not inside pit). Top panel is the nominal case.

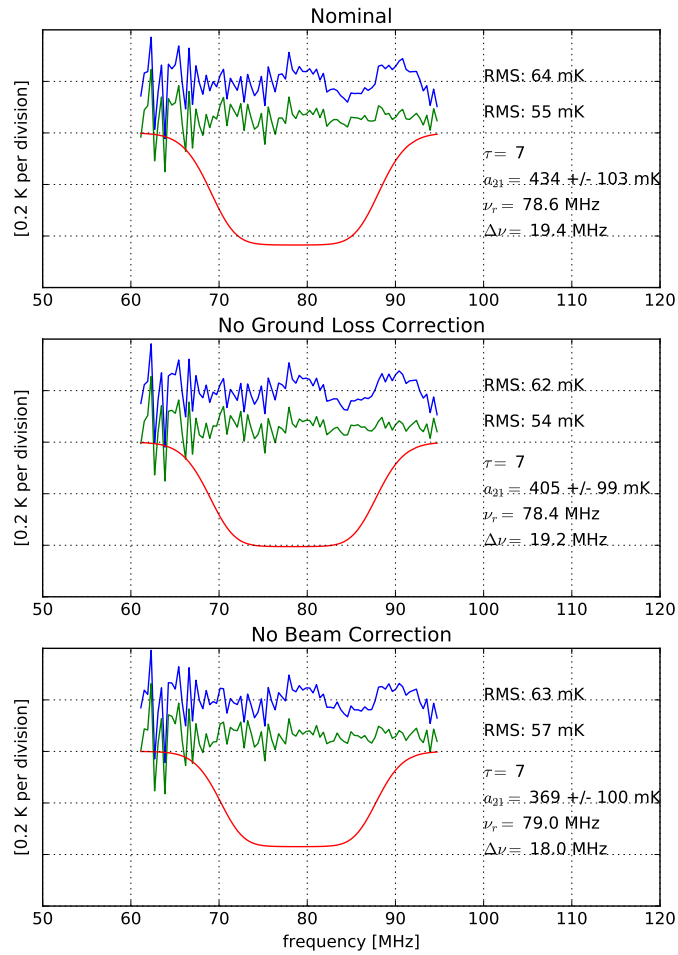


Figure 11: Residuals and 21-cm signature for two alternative corrections: 1) applying no ground loss correction, and 2) applying no beam correction. Top panel is the nominal case.