EDGES MEMO #195

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To: EDGES Group

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Subject: Comparison of fine structure in the high and low band spectra

Figures 1 and 3 show the low and high band spectra averaged over 4 hours for Galactic center hour angle (GHA) 0 to 22 hrs. In each case 4 terms have been removed. The 4 terms are scale, spectral index, spectral curvature and ionospheric absorption. The spectra have been calibrated and corrected for balun and ground plane losses. The beam effects are shown in Figures 2 and 4 but beam corrections have not been applied. The beam effects are derived from FEKO simulations of the antenna pattern convolved with the Haslam map extrapolated to the low and high frequencies with a constant spectra index of -2.5. Soil conditions of dielectric constant of 3.5 and conductivity of 10^{-2} S/m are assumed.

The purpose of removing only 4 terms is to preserve as much sensitivity to systematics as possible while reducing the rms derivations in the range of GHA from 6 to 14 hours to a level where the fine structure in the spectra can be seen. Some residual digital TV can be seen in the high band spectra but otherwise the spectra at GHA 10 and 12 hours are smoother than those of the lowband in the range of 65 to 80 MHz.

The following tests were done:

Test	GHA 10	Average	Note
Reference	54	210	
nfit4 10-8	59	210	1
S11 from day 289	57	210	2
No balun loss	65	100	
No ground loss	51	200	
EoR minus	37	170	3
EoR plus	87	245	
Effect of hut	-	-	4

Table 1 Effect of changes to rms at GHA 10 hr and average over all LST.

Notes:

1] Smoothing of antenna S11 smoothing increased by decreasing the number of polynomial terms from 10 to 8.
2] Change antenna S11 data used from day 342 to 289.
3] Subtracting an EoR absorption signal of 200 mK at 85 MHz with 10 MHz full width at half power.

4] Simulations of the presence of the electronics hut studied in memo 194 show significant structure that is not seen in the data. The explanation is that the ground plane effects are sensitive a shallow region of soil under the ground plane with reflection from the hut depends on the solid down to a greater depth there is rock or red-brown hardpan with higher dielectric and conductivity. The reason is that the hut is several wavelengths away from the antenna and the coupling involves horizontal polarized ground wave propagation which is highly attenuated by the ground conductivity. The MWA conductivity (Sutinjo[1] et al. 2015) can be as high as 0.1 S/m for solid with 10% moisture which presumably is typical at depth. Tests using FEKO show that it takes a conductivity of about 0.1 S/m to eliminate the beam effects due to the hut.

In summary the frequency structure seen in the low band for GHA at 10 and 12 hours is not yet understood. It could be from the ground plane or reflections from the hut. However simulations of the ground plane as well as those including the hut fail to show any significant structure in the GHA range 8 to 12 hours. It is quite possible that it is, at least in part, from a 21-cm absorption signature.

[1] Sutinjo et al. "Characterization of a low Frequency Radio Astronomy Prototype Array in Western Australia." Arxiv.org/pdf/1510.01515.pdf

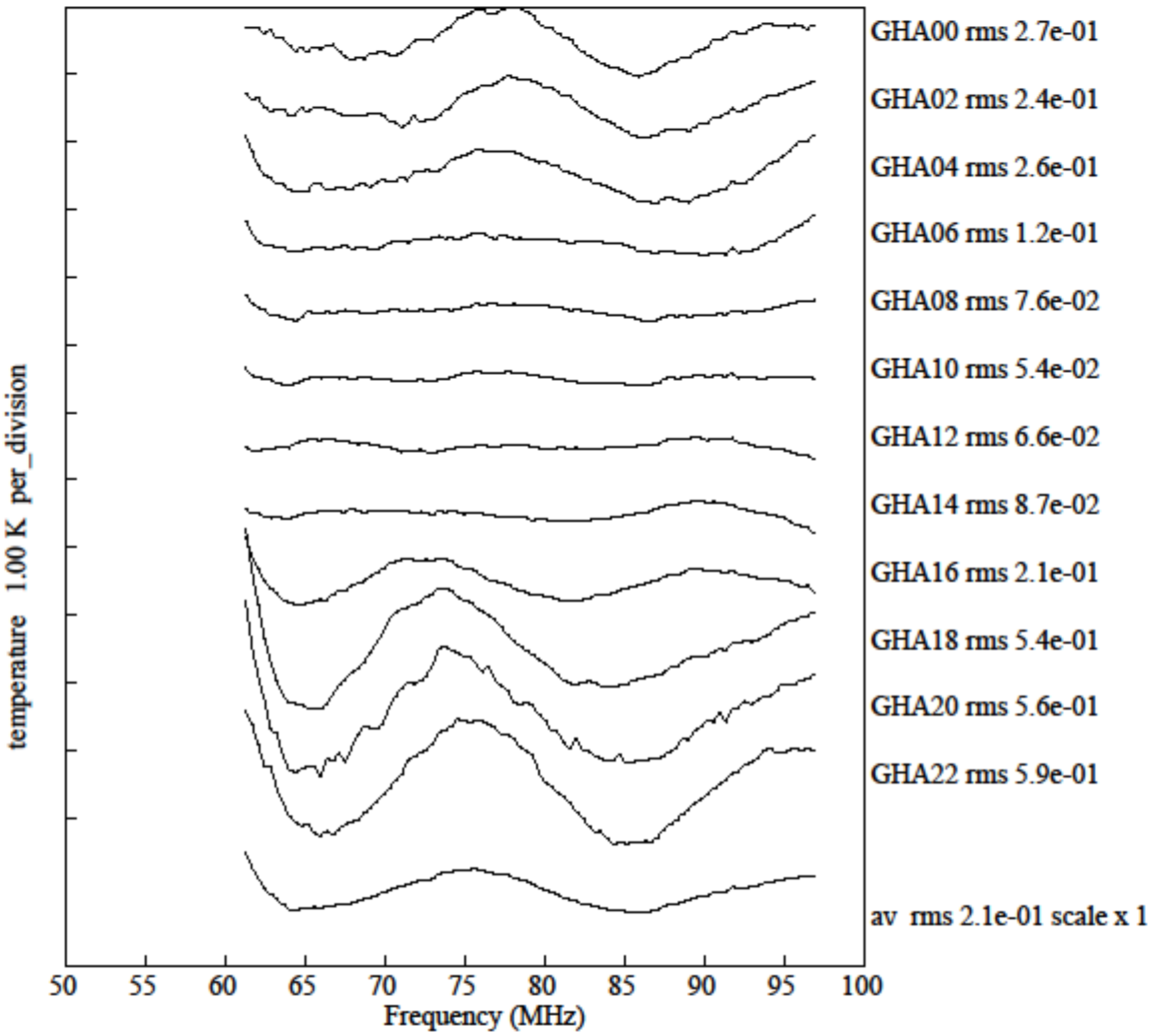

Figure 1. Low band spectra from 2015_286 to 2016_95 with 4 physical terms removed.

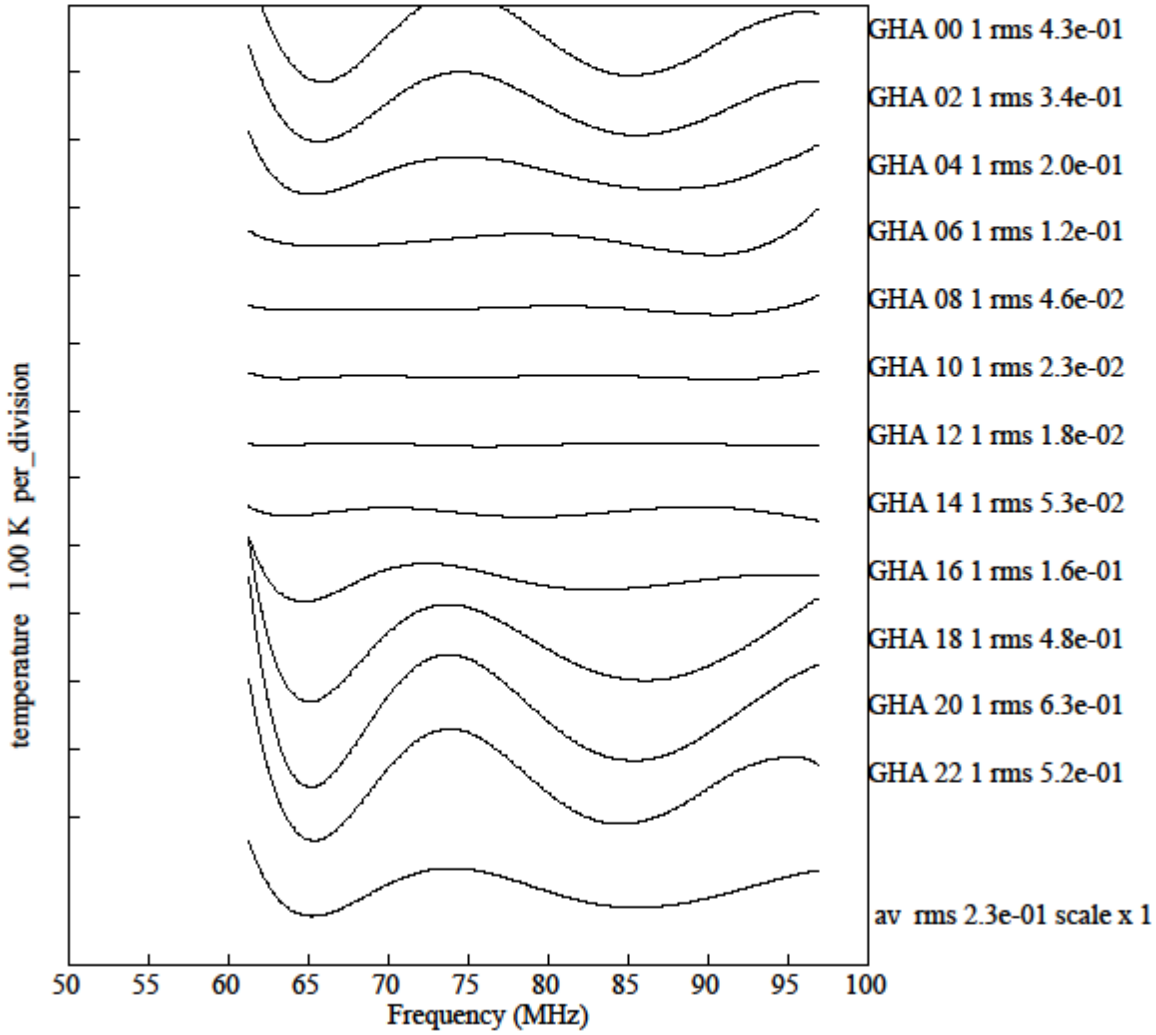

Figure 2. Simulated beam effects.

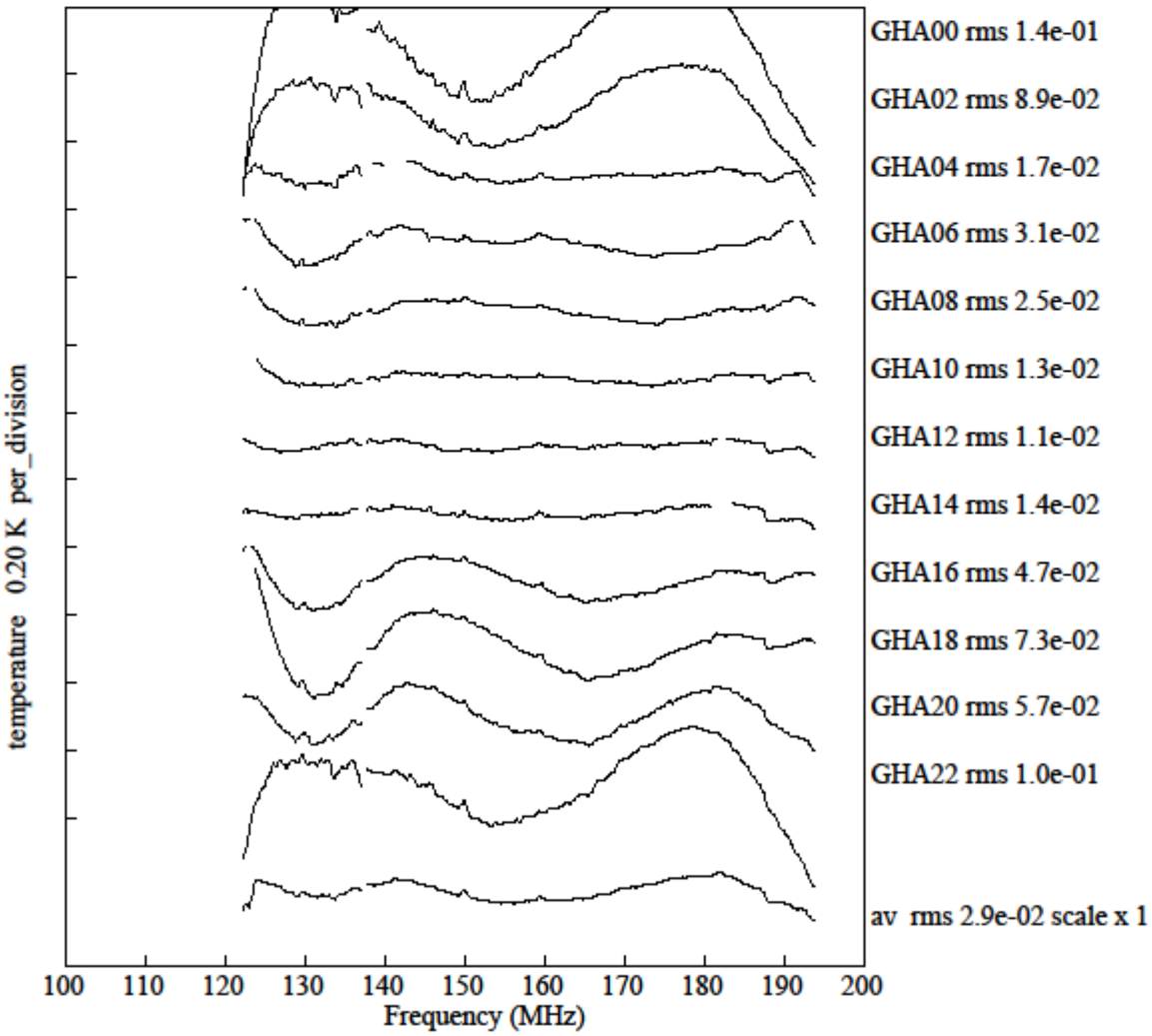

Figure 3. High band spectra from 2016_204 to 2016_95 with 4 physical terms removed.

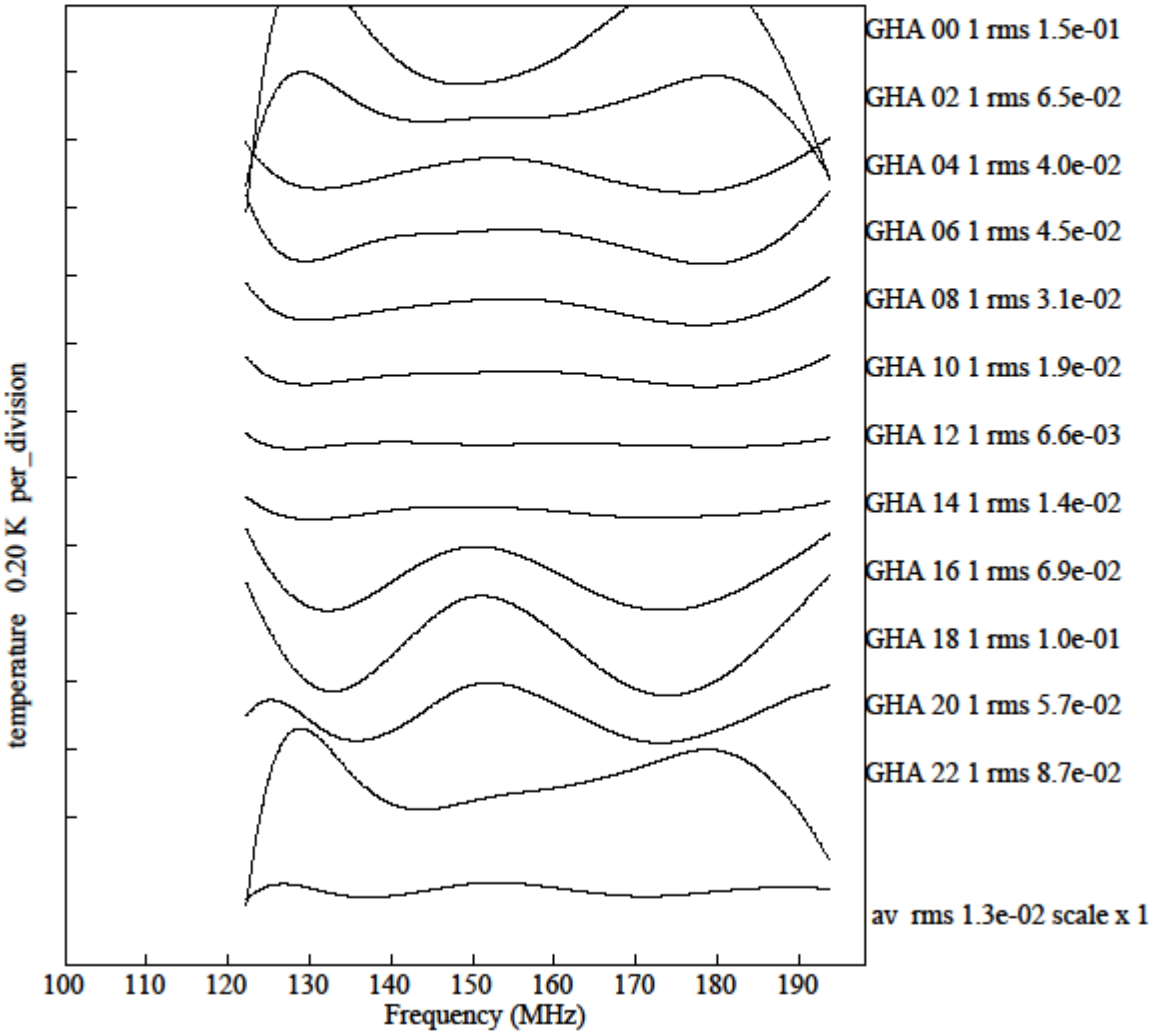

Figure 4. Simulated beam effects.