EDGES MEMO #233

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886

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Telephone: 781-981-5414
Fax: 781-981-0590

To: EDGES Group

From: Alan E.E. Rogers

Subject: Simulations of the effects of systematics on a specific absorption signature

Memo #222 looks at the effects of systematics on a search for an absorption. This study looks at the effect of systematics for a specific absorption signature of 20 MHz FWHM centered at 78 MHz width flattening parameter of 7 (see memo 226). Data is simulated with the receiver parameters of the low band receiver deployed on the extended ground plane from 2016_258 to 2017_017, blade antenna S11 from 2015_342 and FEKO beam correction with soil dielectric 3.5 and conductivity 2e-2 S/m. The data is then processed with changes listed in Table 1. A 4-term polynomial plus the signature is fit using least squares and the average amplitude of the signature and rms variation for 5 values of GHA at 10, 11, 12, 13, 14 hours. The frequency range was 60 to 99 MHz

	az = 354		az=264		both		
change	av	rms	av	rms	av	rms	
Reference ε =3.5 σ = 2e-2	0	0	0	0	0	0	0
-50 ps added to ant S11	-0.10	0.00	-0.11	0.01	-0.01	0.01	-0.28
-50 ps added to LNA S11	-0.07	0.00	-0.07	0.00	-0.07	0.00	-0.20
0.1 dB added to ant S11	-0.07	0.00	-0.08	0.01	-0.07	0.01	-0.33
0.1 dB added to LNA S11	-0.02	0.00	-0.03	0.00	-0.03	0.00	-0.07
No balun loss	-0.00	0.00	0.01	0.01	0.01	0.01	0.31
Soil ε = 13 σ = 1e-1	0.03	0.09	-0.11	0.11	-0.04	0.12	0.54
Soil ε = 3.5 σ = 1e-1	0.02	0.09	-0.10	0.12	-0.04	0.12	0.32
Soil ε = 3.5 σ = 5e-1	0.02	0.06	-0.06	0.07	-0.02	0.08	0.15
Soil ε = 4.5 σ = 2e-2	0.01	0.03	-0.02	0.02	-0.01	0.03	0.11
Azimuth – 2 degrees	-0.06	0.09	-0.05	0.07	-0.06	0.08	0.00
Azimuth + 2 degrees	0.05	0.06	0.07	0.07	0.06	0.07	-0.07
Infinite ground plane	-0.02	0.16	-0.20	0.16	-0.11	0.18	1.61
No beam correction	-0.19	0.12	0.07	0.20	-0.06	0.21	-0.40
CMB change to Haslam map	0.01	0.02	-0.02	0.01	-0.01	0.02	0.00

Table 1. Simulation of signature amplitudes which result from systematic errors in receiver, antenn loss and imperfect beam correction. The amplitudes are the average and rms variation for GHA=10, 11, 12, 13 and 14 hours at antenna azimuth 354, 264 degrees and for the average of both. The last column is for the average for GHA=0 at both azimuths. The units for all columns are degrees K.

As a check, it was verified that adding 1K signature to the simulation results in a 1 K addition to the amplitudes. The simulations were run for an antenna azimuth of 354 and 264 degrees, an average of both and for both at GHA=0.

The results show the following:

1] The largest effects on the signature come from systematic errors in beam correction and these systematics come from uncertainties in the soil dielectric and conductivity.
2] The beam correction effects depend on the GHA and result in a significant variation in addition to the average bias in signature amplitude.
3] Except in the case of no beam correction averaging the results from the 2 orthogonal antenna orientations does not reduce the average bias in signature amplitude.
4] The signature bias due to a delay error in antenna and LNA S11 are comparable while an error in LNA S11 magnitude, measured in dB is less significant.
5] The average signature bias is much larger for Galaxy up (GHA=0) but when "Galaxy calibration" is used the Galaxy up bias is reduced by a factor of about 4.
6] The balun loss correction is not correlated with the absorption signature and has a small effect on signature bias.