EDGES MEMO #170

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To: EDGES Group

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Subject: Limits set by the foreground due to frequency dependence of the beam.

To evaluate the effects of the foreground the antenna beam is assumed to be known perfectly so that for a known sky map the effects of the frequency dependence of the beam can be perfectly corrected. The following table gives the rms residuals after removal of 2 to 6 terms.

		rms residual mK						20 MHz	40 MHz
Antenna	GHA (hr)	2	3	4	5	6	Case	SNR	SNR
Fourpoint	-1	4171	1600	236	10.6	4.5	A		
Blade	-1	2949	754	111	4.2	2.4	A		
Fourpoint	-9	309	45	16	5.5	3.3	A	6	
Blade	-9	71	64	11	3.7	0.6	A	14	
Fourpoint	-1	1010	116	73	9.4	1.0	B		
Blade	-1	871	199	64	7.4	1.0	B		
Fourpoint	-9	278	31	6	2.0	0.7	B	10	
Blade	-9	386	9	3.5	0.5	0	B	13	10
Fourpoint	-9, -1	1522	894	276	48	3	C		
Blade	-9, -1	1585	714	197	39	5	C		
Fourpoint	-9, -1	697	110	12	1	1	D	7	
Blade	-9, -1	784	134	20	4	1	D	11	
Dipole	-9, -1	892	113	4.8	1	0	D	10	7

For Case A the Haslam map at 408 MHz with constant spectral index of -2.5 is used to generate the sky model for the frequency range 100 to 190 MHz. For case B the sky model is modified to incorporate a different spectral index for the Galactic plane along with other changes described in memo 160. The Haslam map used in case A is used to correct the data so that the rms residuals are the result of the difference in beam corrections for what might be closer to the real sky and sky model of case A. In case C the effects of the frequency dependence of the beam are simulated for

the Galaxy up/down method using the model of case A. In case D the up/down method is simulated with the sky model of case B and beam corrections made using the sky model of Case A.

The signal to noise ratio (SNR) is shown in promising cases for a 30 mK Gaussian signature of 20 MHz full width at 150 MHz with 5 mK rms noise at 400 kHz resolution. In all cases the removal of 6 term polynomial is needed to reduce the systematics to a level where they no longer dominate an EoR signature detection. All antenna patterns were generated using FEKO.

Comments

1] Increasing the EoR signature to 40 MHz requires dropping to the removal of no more than 5 terms. This may be possible in the cases with SNR value in the last column.

2] There appears to be little difference between the fourpoint, blade and dipole using the up/down method with beam corrections based on the Haslam model. In this case the limit is set by the uncertainty in the sky map which in turn limits the beam correction.

3] These results should scale to low band by increasing the EoR signature to 170 mK reducing widths to 10 and 20 MHz and increasing noise to 28 mK. This noise level should be reached in about 2 weeks of 8 hours per day.