EDGES MEMO #190

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To: EDGES Group

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Subject: Physical functions vs polynomial

The low band data is fairly well fit with only 4 terms in the frequency range 61 to 97 MHz but whether a 4-term physical model or a 4-tem polynomial fits best depends on beam effects. Simulations show that for the beam effects from the 9.8 × 9.8 m ground plane a 4-term model of scale, spectral index, spectral curvature and ionospheric absorption fits the beam chromaticity better than a 4-term polynomial. With a larger ground plane a 4-term polynomial fits better.

Table 1 shows simulations of the presence an absorption signature at 85 MHz in the absence of any systematic effects. It shows that a 100 mK absorption can be detected with SNR of about 6 for a FWHM width of 10 MHz using 4 or 5 term physical or polynomial model. When the width is increased to 20 MHz a 3 sigma detection is possible using a 4 term physical model with 25 mK of noise is added. The rms values labeled “rms 2” are the values in the presence of an EoR signature before solving for the signature.

Number of terms	Type	EoR width MHz	SNR	rms 1	rms 2
4	Phy	10	7.7	25	32
4	Poly	10	6.8	25	31
5	Phy	10	5.1	25	29
5	Poly	10	5.6	25	29
4	Phy	20	2.8	25	26
4	Poly	20	2.1	25	26
5	Phy	20	1.2	25	25
5	Poly	20	1.4	25	25

Table 1. Simulations EoR absorption signature of 100 mK without beam effects. 25 mK of noise is added in each case.

Number of Terms	Type	rms	EoR-width MHz	EoR_bias mK	rms 2	Ground
4	Phy	31	10	-26	30	GF
4	Poly	111	10	-479	80	GF
5	Phy	31	10	-90	29	GF
5	Poly	49	10	-205	40	GF
4	Phy	31	20	-70	30	GF
4	Poly	111	20	-2294	57	GF
5	Phy	31	20	-99	19	GF
5	Poly	49	20	-1326	22	GF
4	Phy	140	10	500	91	Infinite
4	Poly	34	10	100	29	Infinite
5	Phy	18	10	-46	17	Infinite
5	Poly	1	10	4	1	Infinite
4	Phy	140	20	1720	58	Infinite
4	Poly	34	20	500	27	Infinite
5	Phy	18	20	-500	13	Infinite
5	Poly	1	20	12	1	Infinite

Table 2. Simulations of beam effects and EoR bias.

Table 2 shows simulations of the systematic signature due to the beam effects averaged from 1.75 to 5.75 hours LST. Two cases look viable for a potential EoR signature detections. In the first case with the current ground plane the beam effects are “fortuitously” low using a physical model of 4 or 5 terms. In the second case with a large ground plane using a polynomial model is clearly superior reducing the systematic to 1 mK. The column labeled “rms” is the rms level of the beam effects while “rms 2” are the rms values after solving for an EoR signature. Viable cases for EoR signature detection are those for which the magnitude of the EoR bias is well under 100 mK. The results with GF ground are for current 9.8 × 9.8 m ground plane with soil dielectric 3.5.

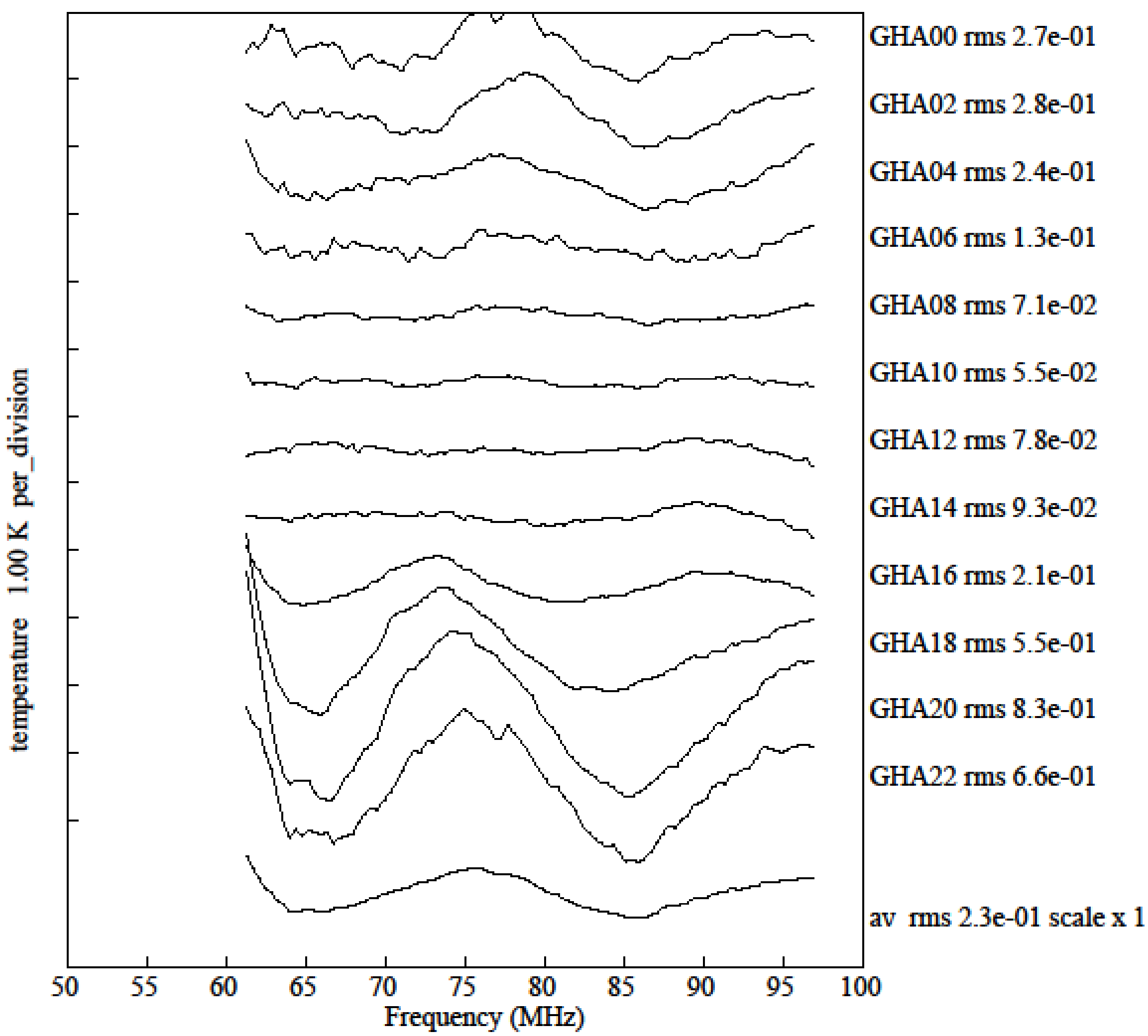

Figure 1. Low band data 4 physical terms removed without beam correction from 2015_286-2016_044 averaged over 4 hours at each GHA

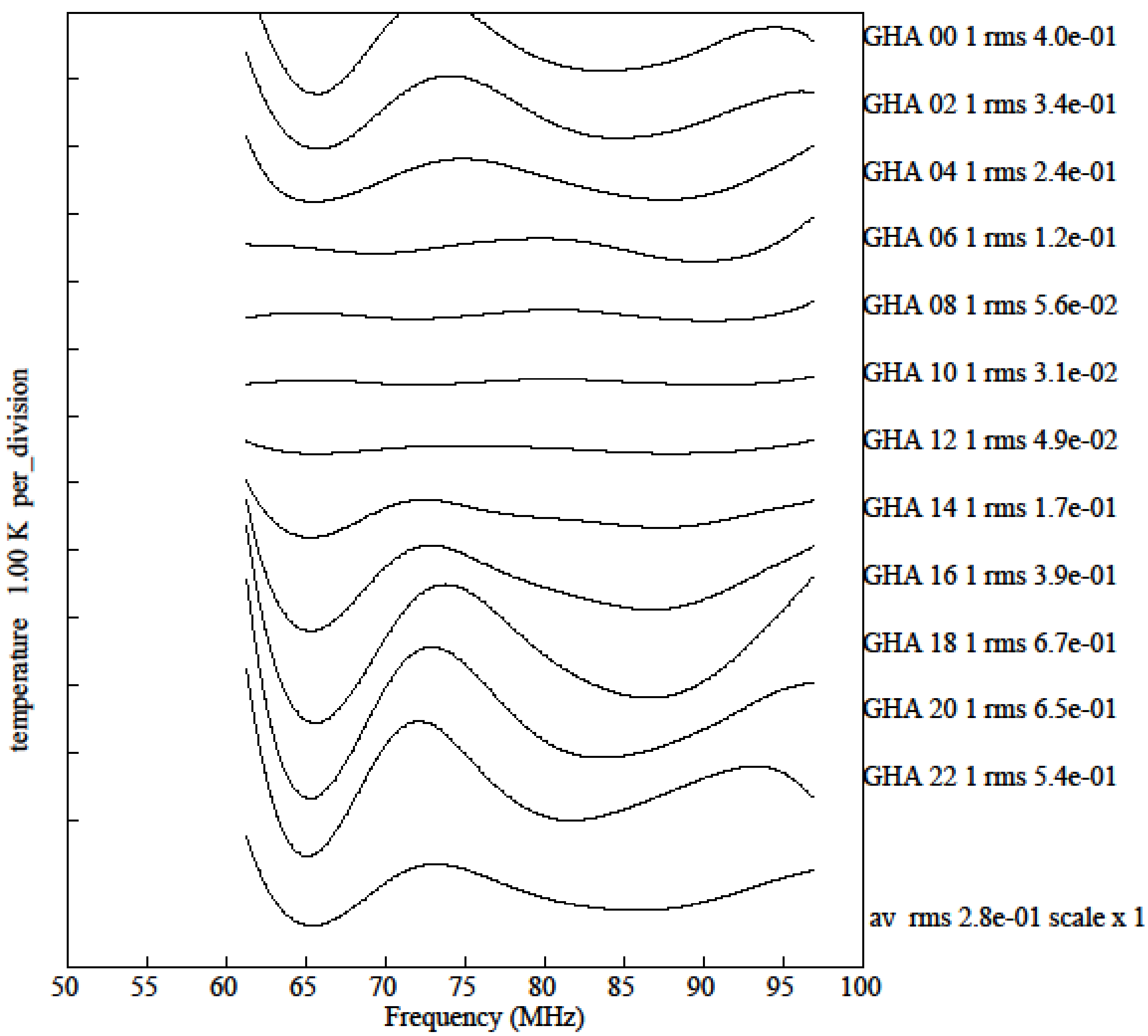

Figure 2. Simulation of beam effects for ground plane 9.8 × 9.8 m. Beam data smoothed with 22 term Fourier series. 4 physical terms removed.