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To: EDGES Group  
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Subject: Comparison of frequency structure in beam and loss from simulations and EDGES data

### 1] Simulations

Tables 1 and 2 give the 5-term residuals from simulations. The “beam” is obtained using FEKO with the blade antenna on an infinite ground plane. “GF beam” is obtained for the blade on the finite ground plane over ground with dielectric constant 3.5. The “balun” is estimated loss of the balun using physical models of the transmission line parts. The “antenna” loss is obtained from FEKO. The “GF ground” is the loss estimated from one minus the fraction of the beam above the horizon. “GFM” ground is the loss calculated with less smoothing of the FEKO results.

### 2] Tests using high and low band data

Tables 3 and 4 give the residuals to high and low band data. In this case we start with data processed with beam and ground plane loss selections that minimize the residuals. Then the effect of adding or removing selected corrections are listed.

	100-195 up	115-192 up	100-195 dn	115-192 dn
Beam	85	24	18	6
GF beam	280	63	16	5
Balun	43	24	46	17
Antenna	0.7	0.3	0.2	0
GF ground	15	6	19	6
GFM ground	13	6	15	6
GFM plus	23	8	16	5

Table 1. Residuals to 5-physical terms for high band frequency ranges 100-195 and 115-192 MHz for Galaxy up (GHA=0) and Galaxy down (GHA=10). The units are in mK.

	51-95 up	61-90 up	51-95 dn	61-90 dn
Beam	339	35	72	8
GF beam	913	127	110	13
Balun	57	14	29	6
Antenna	-	-	-	-
GF ground	69	10	26	3
GFM ground	191	53	64	16

Table 2. Residuals to 5 physical terms for low band simulations. Antenna loss affects rms under 1 mK.

	115-192 up	100-195 up	115-192 dn	100-195 dn
No beam correction	39	153	7.6	15.3
Minus antenna loss	39	154	7.6	15.2
Minus ground loss	36	160	9.5	25.2
Minus balun loss	56	157	17.8	36.3
With beam	58	134	8.5	21.5
With GF beam	53	132	8.9	22.6
No beam 3 term	1027	1313	250	397
With beam 3 term	243	470	128	218
With GF beam 3 term	184	636	128	212

Table 3. Residuals to 5(3) physical terms for high band data from 2015-204 to 2016-015.

	61-90 up	51-95 up	61-90 dn	51-95 dn
No beam correction	216	1089	50.6	157
Minus ground loss	(145)	(168)	48.3	171
Minus balun loss	(163)	(225)	55.0	133
With beam	244	1310	47.7	186
With GF beam	136	216	46.6	147
No beam 3 terms	2365	8090	560	1486
With beam 3 term	745	3110	246	461
With GF beam 3 terms	329	1138	203	503

Table 4. Residuals to 5(3) physical terms for low band data 2015-286 to 2016-015. Numbers in parentheses are with GF beam.

### 3] Conclusions

#### a) High band

It is clear that the correction for balun loss is needed. The corrections for ground loss also improves the 5-term residuals but the need for beam correction is only seen clearly when fewer than 5 terms are removed and it is not clear from the 3-term residuals if the GF beam corrections which includes the effects of a finite ground plane provides any further improvement.

#### b) Low band

The effect of loss and beam correction are not clearly evident in the 5-term residuals with the Galaxy down. However with the Galaxy “up” the effect of beam correction is large and the GF beam correction results in the lowest residuals.

#### c) Overall

The frequency structure in the beam and loss is significant at low band for Galaxy “up” data and it is not yet clear that it can be modeled well enough to allow the use of the Galaxy “up” data to aid in the removal of systematics in the Galaxy “dn” data. In general the 5 physical functions of scale, spectral index, spectral curvature, ionosphere emission and absorption result in lower residuals than a 5-term polynomial.