EDGES MEMO #152

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Subject: Comparison of Blade antenna for EDGES

The EDGES antenna is based on the "Fourpoint" design by Suh, IEEE VTC 2004. This design was chosen for having the following characteristics

1] Low reflection, S11 below -15 dB from 110 to 190 MHz at 50Ω input.
2] Horizon response below – 20 dBi
3] Minimal frequency dependence of the beam.

Some alternate designs are a fat dipole, biconical antenna, bowtie and blade. In order to obtain a low horizon response vertical currents need to be avoided which leads to a planar design. Next to the Fourpoint a planar bowtie or variations of a planar dipole have the potential to perform as well or better than the Fourpoint.

Table 1 compares the rms residuals to a polynomial fit of the sky noise spectrum derived from the convolution of the beam with the sky brightness.

Type	Number of terms in polynomial							
Antenna	1	2	3	4	5	6	7	7
Fourpoint	30	12	1.6	0.45	0.048	0.011	0.005	0.0015
Fourpoint*	30	12	1.6	0.45	0.037	0.007	0.0017	0.0003
Blade	32	11	1.0	0.30	0.028	0.004	0.0011	0.0001
Dipole ½ λ	42	11	0.7	0.14	0.015	0.002	0.0007	0.0001

Table 1. Residuals to $f^{-2.5+i}$ i=0 to N-1 from 100 to 190 MHz in units of Kelvin. The rms is the maximum for the range -6 to + 6 hours GHA. The last column is for Galaxy below the horizon.

The best Fourpoint has the dimensions.

Panel side	0.375 m
Panel diagonal	0.685 m
Panel lip	0.0016 m
Gap between panels	0.01778 m
Tip capacitance	1.4 *pf*
Panel height	0.52 m
Balun	0.5" diam 2.2" separation
Top capacitance	6.8 *pf*
Tuner capacitance	2 *pf*

The blade antenna which is shown in Figure 1 has dimensions

Panel width	0.625 m
Panel length	0.495 m
Gap between panels	0.0127 m
Panel height	0.52 m
Tip capacitance	0.5 *pf*
Balun (same as used with Fourpoint (without tuner).	
Top capacitance	5 *pf*

The blade antenna beam has less frequency dependence than the Fourpoint but the best S11 found so far is better than -12 dB from 110 to 200 MHz or on the average about 2 dB worse than the Fourpoint.

A 6" high balun shield was used for each antenna except the dipole. The row marked Fourpoint* in Table 1 is for a symmetrical balun showing that some of the frequency dependence is from the asymmetry in the "topcap" connection to the balun.

A test was also made for a blade antenna with a 0.0016 m lip. When the gap was increased to 0.0283m the beam results were almost the same as the blade without a lip and the S11 was better. With further optimization it is expected that the overall performance could be better than the Fourpoint for EDGES. Furthermore this antenna is more compact than the Fourpoint which is an important consideration for the low band.

The sky noise brightness used for Table 1 included spectral index variation with Galactic latitude, gamma and nominal values for the ionosphere. In Table 2 the 408 MHz sky noise was only corrected by a fixed value of spectral index of 2.5. Table 2 also shows the results for various values of tip capacitance and shows the effect of a 10% increase in capacitance in only one of the antenna tips. The effects of small asymmetry are linear so that a 1% increase in capacitance in only one of the tips reduces the effect by a factor of 10.

Type	Tip (*pf*)	Asy	Number of terms rms (K)							
			1	2	3	4	5	6	7	7
Fourpoint	3.0	0	17	6	2.4	0.37	0.05	0.03	0.01	0.0036
Fourpoint	2.4	0	17	6	2.1	0.32	0.04	0.02	0.007	0.0024
Fourpoint	1.4	0	17	5	1.9	0.27	0.03	0.009	0.004	0.0014
Fourpoint	3.0	0.1	17	8	6.0	3.7	3.5	2.9	1.4	0.14
Fourpoint	2.4	0.1	17	6	4.4	3.1	1.7	1.6	1.4	0.14
Fourpoint	1.4	0.1	17	5	1.9	0.57	0.50	0.33	0.17	0.015
Blade	0.5	0	22	4	0.88	0.12	0.008	0.003	0.0006	0.0001
Blade	0.5	0.1	22	4	0.88	0.13	0.08	0.06	0.03	0.016
Blade	0.5	0.01	22	4	0.88	0.13	0.01	0.007	0.003	0.0017
Dipole			32	4	0.26	0.02	0.0016	0.0003	0.0002	0.0001

Table 2. Residuals from 100 to 190 MHz. Sky noise brightness from 408 MHz scaled using spectral index of 2.5.

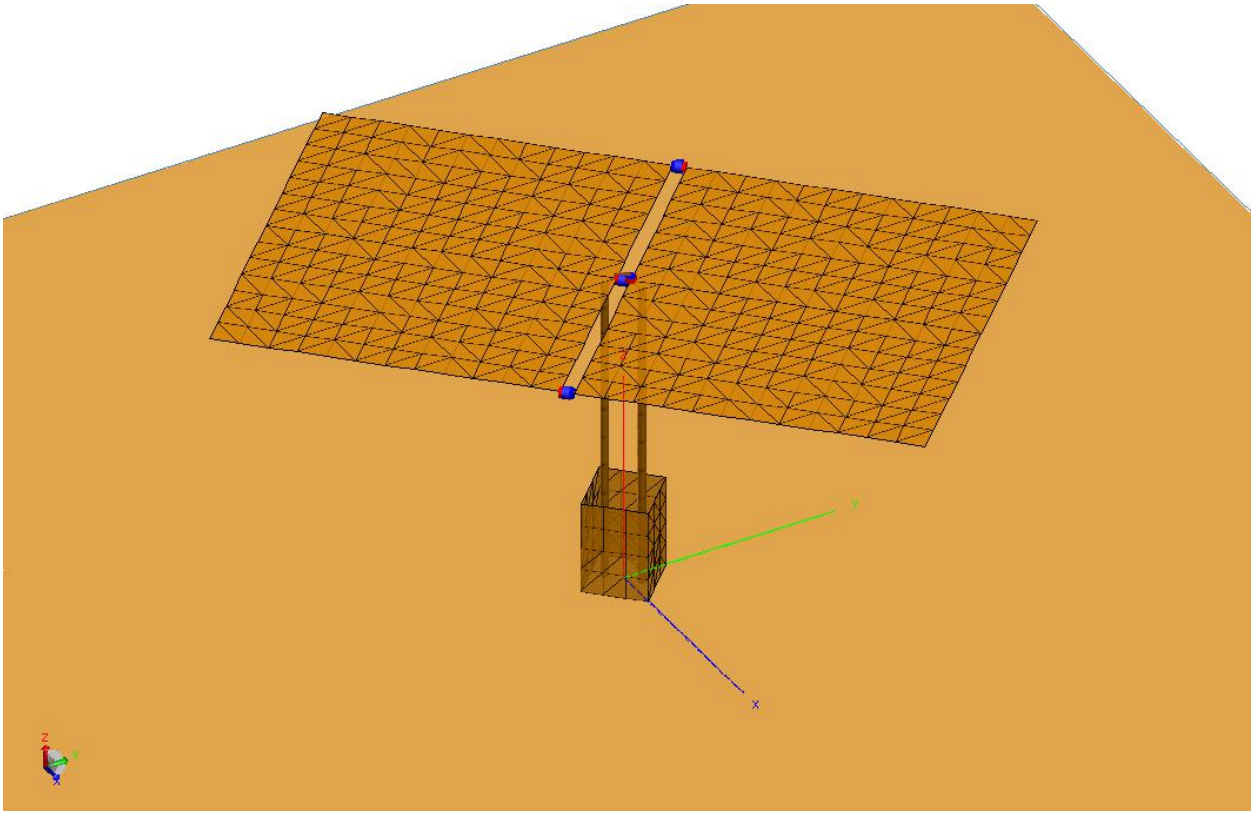

Figure 1. Simulations of “Blade antenna” using FEKO