EDGES MEMO #037

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To: EDGES Group
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Subject: Arrays with MWA and modified MWA Antennas

The MWA antenna element is a simpler mechanical design than the EDGES "Fourpoint" but it has an excessively high response at the horizon at 200 MHz due to the vertical currents in the "batwing" elements. The response at the horizon is undesirable for 2 reasons:

A] It increases the susceptibility to RFI which mainly comes from the horizon.
B] When the array factor function produces a side lobe near the horizon the side lobe in the beam can be more significant because the solid angle of side lobes near the horizon is larger owing to the reduced projected baseline normal to the horizon.

The horizon response can be reduced by changing the shape of the "batwing" to a "two-point." Ideally the "two-point" would be in the horizontal plane as in the EDGES "Fourpoint" but this design cannot be supported without adding long dielectric rods or pipes. The single element shapes are shown in Figure 1 and their characteristics are summarized as follows:

	"Batwing"	"Two-point"	Units
VSWR at 100 MHz	11	10	Referred to 50 ohms
VSWR at 200 MHz	6	7	Referred to 50 ohms
VSWR at 300 MHz	5	2	Referred to 50 ohms
Zenith gain 100 MHz	9.22	9.62	dBi
Zenith gain 200 MHz	7.53	9.20	dBi
Zenith gain 300 MHz	3.42	7.36	dBi
Horizon gain 100 MHz	-19.21	-26.87	dBi
Horizon gain 200 MHz	-0.33	-10.86	dBi
Horizon gain 300 MHz	-7.66	-8.78	dBi

Table 1. Single element characteristics

The element impedances are compared in Table 2

Freq (MHz)	"Bowtie"	"Twopoint"
100	6.2 – 31.8 j	5.5-19.5 j
150	44 + 85j	52 +109j
200	204 + 135 j	318 + 81 j
250	303 – 23 j	177 – 108 j
300	190 – 121 j	108 – 41 j

Table 2. Comparison of single element impedance.

In forming an array there is a slight advantage in orienting the elements in the form of "crosses" (see D array memo #28) rather than "pulses."
I have evaluated the arrays using the batwing and twopoint in a 4×4 tile with 1.1 m spacing between elements using EZNEC (EZNEC_M v. 3.0) with 20 mm diameter wires and in phase current sources at each element. I obtained the following results:

	"Batwing"	"twopoint"	Units
Zenith gain 100 MHz	16.16	16.35	dBi
Zenith gain 200 MHz	18.36	21.24	dBi
Zenith gain 210 MHz	20.98	20.88	dBi
Zenith gain 225 MHz	21.58	22.19	dBi
Zenith gain 290 MHz	15.44	22.17	dBi
Max side lobe 200 MHz	13.89	8.96	dBi
Max side lobe 210 MHz	8.65	8.40	dBi
Max side lobe 225 MHz	9.42	8.49	dBi
Max side lobe 290 MHz	18.47	11.38	dBi

Table 3 – Array Characteristics.

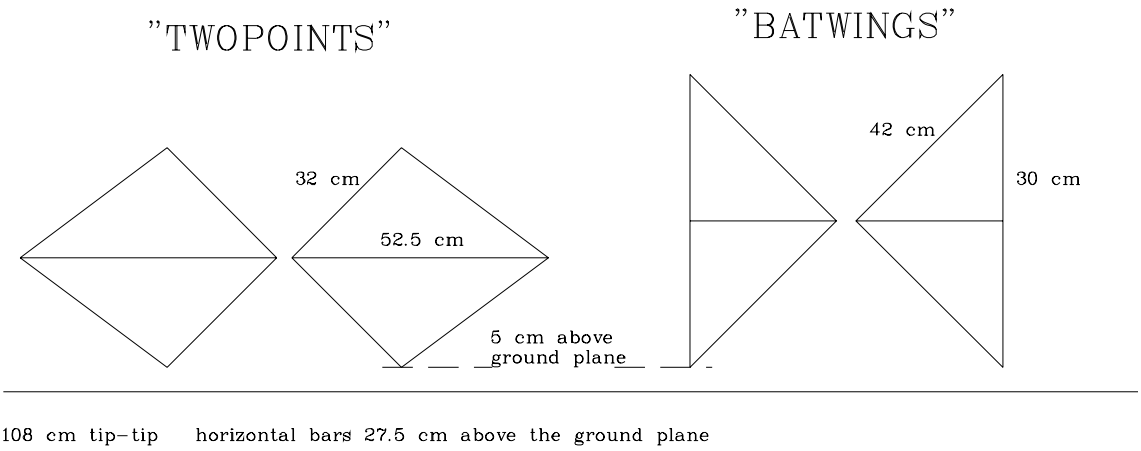

Figure 1. Antenna Elements

Simple mods which improve the batwing

1. Increase the height of the "tips" from the ground plane to 10 cm. this increases the zenith gain of the array by 1.53 dB and reduces the horizon side lobe from 13.89 dBi to 11.00 dBi. The single element horizon side lobe is reduced from -0.33 to -3.82 dBi. While the "resonance" as 200 MHz is reduced the performance at 290 MHz is degraded.
2. Change the orientation of the elements to the "crosses" configuration. This increases the array gain at 200 MHz by 1.34 dB and reduces the horizon side lobe from 13.89 to 7.17 and improves the performance at 290 MHz.