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To: EDGES Group

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Subject: Improvement in bandwidth of EDGES-3 chromaticity using a cone under the antenna.

In 2002 Suh described the Fourpoint dipole on which the EDGES-1 antenna was based in his thesis. Suh also suggested that a layered structure under the antenna could be used to increase the bandwidth. This suggestion was pursued with EDGES-3 in memo 317. This has now been pursued further with the constraint of an optimization of the size and height without change of the EDGES-3 dimensions so that after acquiring enough EDGES-3 data at the MRO a cone could be added in order to extend the frequency range from 120 MHz up to 180 MHz. Table 1 compares the beam chromaticity on a PEC ground plane pointed North at the MRO with and without a cone with dimensions of 2.4 meters in diameter and 23 cm in height as shown in Figure 1.

| EDGES-3 without cone | | EDGES-3 cone | | 5-term |
|----------------------|------------|--------------|------------|----------|
| 60-120 MHz | 60-180 MHz | 60-120 MHz | 60-180 MHz | function |
| 74 mK | 2585 mK | 47 mK | 673 mK | linlog |
| 42 | 918 | 17 | 288 | linpoly |
| 88 | 2772 | 54 | 786 | physical |

Table 1. beam chromaticity comparison.

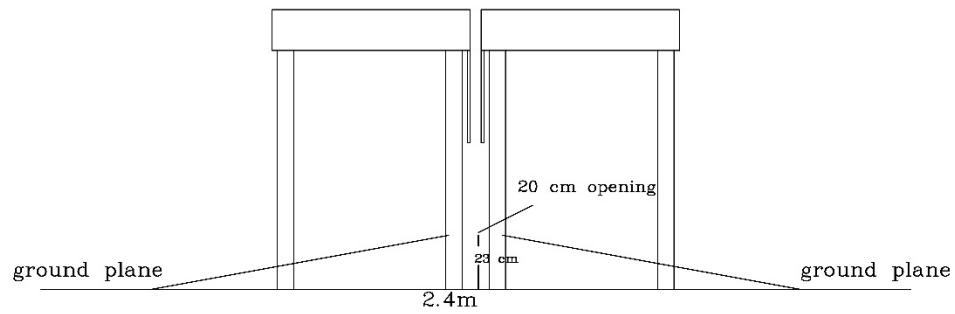
Figure of merit is average of rms values for 24 1 hr blocks centered at GHH=0 to 23 hrs. Following the optimization using a cone I found that a pyramid is a slightly better choice found optimum dimensions of a square base 3.2×3.2 m with 26 cm in height giving 280 mK rms using 5-term linpoly from 60–180 MHz on PEC ground plane.

The layer under the antenna effectively lowers the antenna at the high frequency end of the band. This results in a reduction in beam chromaticity by about a factor of 3 allowing a frequency overage ratio of a factor of 3 with S11 under -8 dB as shown in Figure 2.

The optimization was done on a PEC ground plane to allow fairly rapid turn around using FEKO. It was expected that a factor of 2-3 in chromaticity would be obtained using the 48.8×48.8 m 3 triangles/side perforated ground plane (in memo 317) but it was found that with a finite ground plane the addition of the cone increases the beam chromaticity. Upon examination was found that the cone creates vertically polarized at the horizon at a level of -10 dBi compared with levels of -25 dBi from the currents in the pipes.

As discussed in memo 317 vertically polarized radiation is more strongly scattered from the edges of the ground plane than the horizontally polarized radiation. This means that a finite ground plane has to be much larger for an antenna which is vertically polarized than for a horizontally polarized antenna.

In order to avoid generating some vertical polarization all the currents in the antenna have to be horizontal and this can normally only be achieved using a planar structure. Some tests were made using flat disks under the antenna but these disks have resonances and while using multiple disks helps. So far I have been unable to achieve a significant improvement in beam chromaticity compared with the factor of 2-3 achieved with a cone on the infinite ground plane.



Notes: cone or pyramid is connected to ground plane
 dimensions shown for cone 3.2x3.2m 26cm high for pyramid with 20cm opening
 10cm diam holes also need in cone or pyramid for antenna fiberglass supports

Cone or pyramid layered ground
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Figure 1. Cone or pyramid shaped layer under antenna.

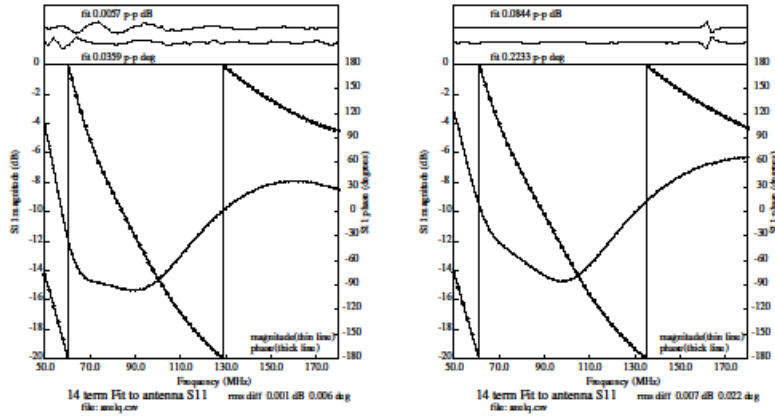
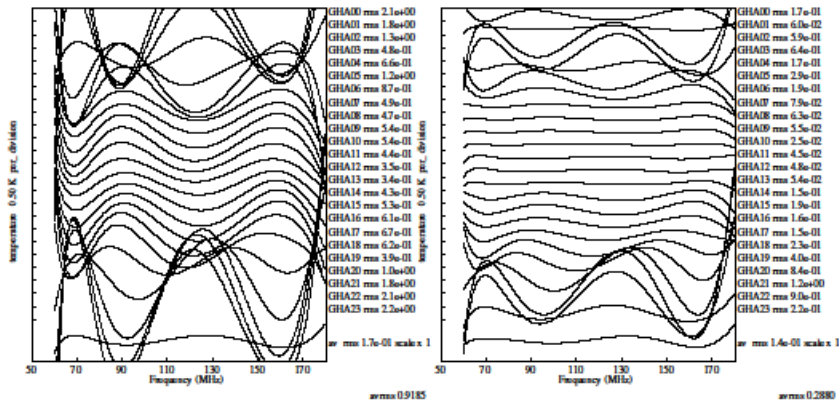


Figure 2. Comparison of EDGES-3 S11 and beam chromaticity on PEC ground plane without cone (on the left) and with cone (on the right).