EDGES MEMO #378

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To: EDGES Group

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Subject: Comparison of welded mesh and meandering wire grid ground planes

The original plan was to install EDGES-3 on a welded mesh ground plane at the MRO but owing to the delay as result of the pandemic the deployment at a new site in the northern hemisphere possibly with the use of a meandering wire ground plane is being considered. The relative simplicity of the installation of the wire grid especially for a temporary deployment is the primary motivation to examine the performance differences.

The meandering wire grid ground plane was studied in memos 298 and the results from REU student Ethan Bair's study are in memo 308. Ethan's meandering wire grid ground plane was used in the short deployment of the EDGES-3 prototype in Oregon in 2019 as described in memo 310.

Ground plane length times width	Beam chromaticity	Loss at 70 MHz	Loss chromaticity	comments
PEC	37	0.01%	1	
30x30m mesh	78	0.3%	15	perforated ground plane at MRO
48x48m mesh	49	0.3%	25	larger ground plane proposed for MRO
30x16m wire	133	1.5%	28	30m long 16m wide used in Oregon
10x10m solid	269	1.1%	30	square with rock diel 10 2m below
10x10m wire	257	2.1%	25	square with rock below 12.5cm spacing
10x10m wire 6.25	258	1.3%	25	square with rock below 6.25cm spacing
20x20m solid	123	0.5%	28	square with rock diel 10 2m below
20x20m wire 12.5	117	1.5%	29	square with rock below 12.5cm spacing
20x20m wire 6.25	119	0.7%	28	square with rock below 6.25cm spacing
30x16m wire 6.25	125	0.7%	30	rect. with rock below 6.25cm spacing
30x30m wire 6.25	62	0.6%	25	square with rock below 6.25cm spacing
10x5m wire 12.5	267	3.6%	21	simple test to show that length > width
5x10m wire 12.5	258	3.5%	34	is about the same as width < length
7x7m wire 12.5	311	3.1%	57	about the same as square of same area
7x7m wire 6.25	487	2.2%	45	square with rock below 6.25cm spacing
10x5m wire 6.25	686	2.5%	35	with rock below 6.25cm spacing
5x5mwire 6.25 1e-2	160	4.0%	33	with rock below 6.25cm spacing

5x10m wire 6.25	298	2.7%	22	with rock below 6.25cm spacing
8x8m wire	150	2.6%	20	antenna perfectly aligned with wires
8x8m wire	406	2.8%	33	5 degree misalignment
8x8m wire	150	2.6%	20	1 degree misalignment

Table 1. FEKO simulations of mesh and wire grid ground planes.

The performance of EDGES-3 ground planes is shown in Table 1 for the MRO site using the Haslam map with the average rms for 24 one hour blocks over all GHA in mK for 5-physical terms removed from 55 to 98 MHz with the antenna pointing N-S. In the cases "with rock" the rock had a dielectric 10 and 1e-2 S/m 2m below soil with dielectric 3.5 2e-2 S/m except for 5x5m wire which had soil dielectric 3.5 and 1e-2 S/m.

The table shows very similar results for solid or welded mesh ground plane or meandering wire grid ground plane of the same size provided the antenna is aligned and the wire spacing is 6.25 cm at least close to the antenna as in the Oregon deployment described in memo 310. Separate tests show that individual wires and a single meandered wire give very close to the same results but a meandering is much easier to install. Since these studies are using the GF method for a layered ground plane the loss chromaticity is limited by glitches to about 20 mK as discussed in memos 258 and 315. See memo 315 for loss and loss chromaticity using the "glitch-free" reflection method.

Ground plane	Soil conductivity S/m	Beam rms mK	loss	Loss rms mK
5x5m wire 6.25	2e-3	647	4.7%	270
5x5m wire 6.25	5e-3	199	4.3%	74
5x5m solid	5e-3	156	4.3%	59
5x5m wire 6.25	1e-2	160	4.0%	33
5x5m solid	1e-2	113	4.0%	28

Table 2. Effects of rock dielectric of 10 and 1e-2 S/m below 2m of soil with different conductivity

Table 2 compares the ability to isolate the effects of an underlying layer of rock using a wire grid with a solid metal ground plane. The FEKO simulation in Table 2 and those discussed in memo 309 show that a high conductivity soil is needed in either case for acceptable performance. It is emphasized that these results are for infinite uniform horizontal layers of soil and rock under the antenna and ground plane.

In summary a wire grid ground plane performs as well as a welded mesh ground plane of the same area as long as the antenna E-field direction is aligned with the wires to within about 1 degree. Similar results are obtained for beam and loss chromaticity as well as similar isolation from the reflections from non uniform soil.