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To: EDGES Group

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Subject: Proposed low band ground plane design

The proposed improved ground plane for low band is based on the perforated edge of the Open Area Test Sites (OATS) of the National facilities described in a report by Meng (see memo 203). The proposed design consists of a 20×20m square with 4 isosceles triangular panels with 5m base and 5m height on each side. The overall shape is shown in Figure 1 from the FEKO simulation. The ground plane is made from 48 5×2.5m panels of welded wire mesh. 32 panels form the center 20×20m square. 16 panels are each cut in half and welded back to form the triangles. The design has a total area of 600m^2 and is symmetric in the X and Y directions so the antenna orientation can be changed by 90° without change of the edge diffraction effects.

Figure 2 shows the simulated residuals to a 4-term polynomial fit from 72 to 97 MHz using FEKO's "GF" mode with soil dielectric 3.5 and conductivity 2×10^{-2} S/m. The top left plot is for the current 9.9×9.8m ground plane. The top right is for an infinite ground plane and the bottom plots are for the proposed ground plane oriented NS and at azimuth 45°. Figure 3 shows the simulated residuals to a 5-term fit from 52 to 97 MHz.

The beam chromaticity which results from the proposed finite ground plane is improved when compared with the current ground plane but is still the major limiting factor when the Galaxy is "up" so that an even larger ground plane would be needed to make use of the method of Galaxy calibration (see memo #202).

			52-97 5T			72-97 4T		
Square size	# triangles	Area m^2	Max	GHA10	AV	Max.	GHA10	AV
10×10	8	200	340	75	29	65	26	5
15×15	12	375	110	60	21	55	12	8
20×20	16	600	100	13	11	30	8	2
25×25	20	875	61	14	5	26	3	3
30×30	24	1200	65	15	6	17	4	2
INF	INF	INF	33	8	7	23	6	1
10×10	0	100	800	120	130	140	6	44

Table 1. Performance vs size. rms residuals in mK.

The table shows the maximum, value at GHA=10, average over all values of rms for 5-polynomial terms removed from 52 to 97 MHz and for 4-polynomial terms removed from 72 to 97 MHz. Above an area of 875 m^2 there is little improvement. Except for the maximum over the full band, the rms at GHA=10^h and the rms of the average approach the values of an infinite ground plane. However there is some question of the accuracy of the modeling for the large ground planes although the results are quite stable under changes in mesh size. The current ground plane performs well at GHA=10^h over the limited band. This appears to be fortuitous. While the larger ground planes have lower levels of reflections this structure has more rapid variations with frequency, owing to the larger delay from the edges, which is not removed by a low order polynomial. The perforated edges work by smearing the phases of the reflections and need to be at least half a wavelength deep to be effective.

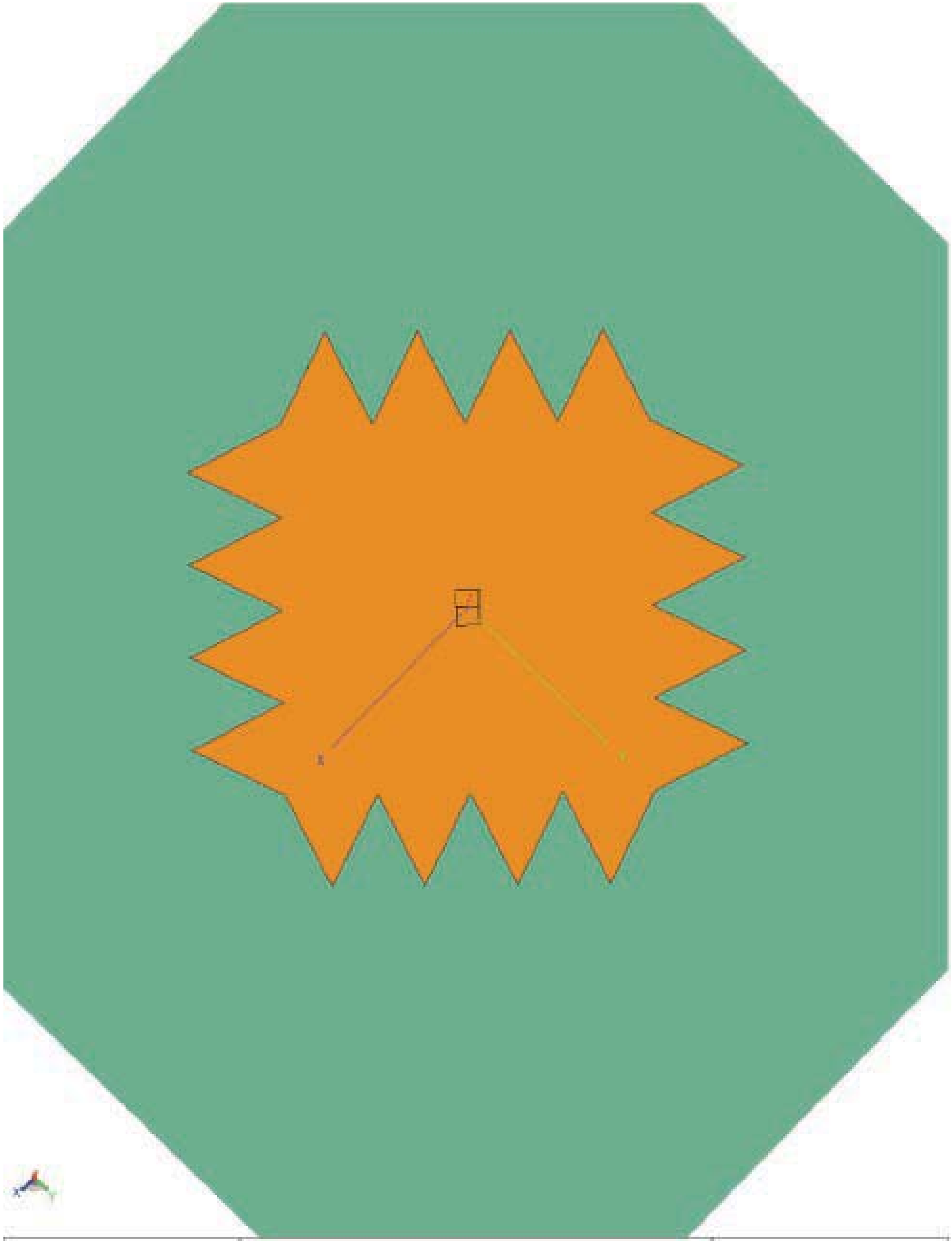
Figure 1. Proposed low band ground plane.

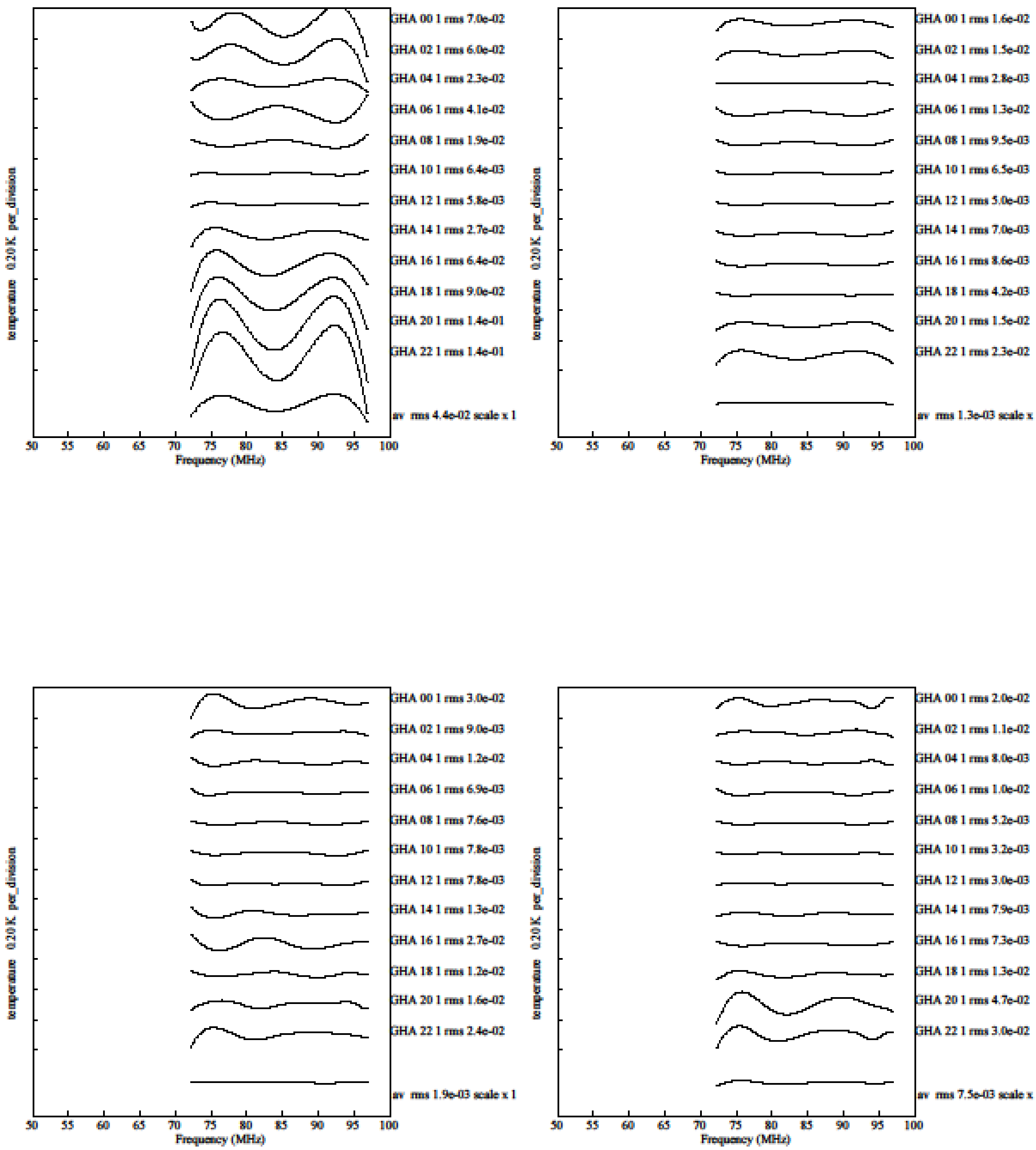

Figure 2. Simulation of beam effects – see text.

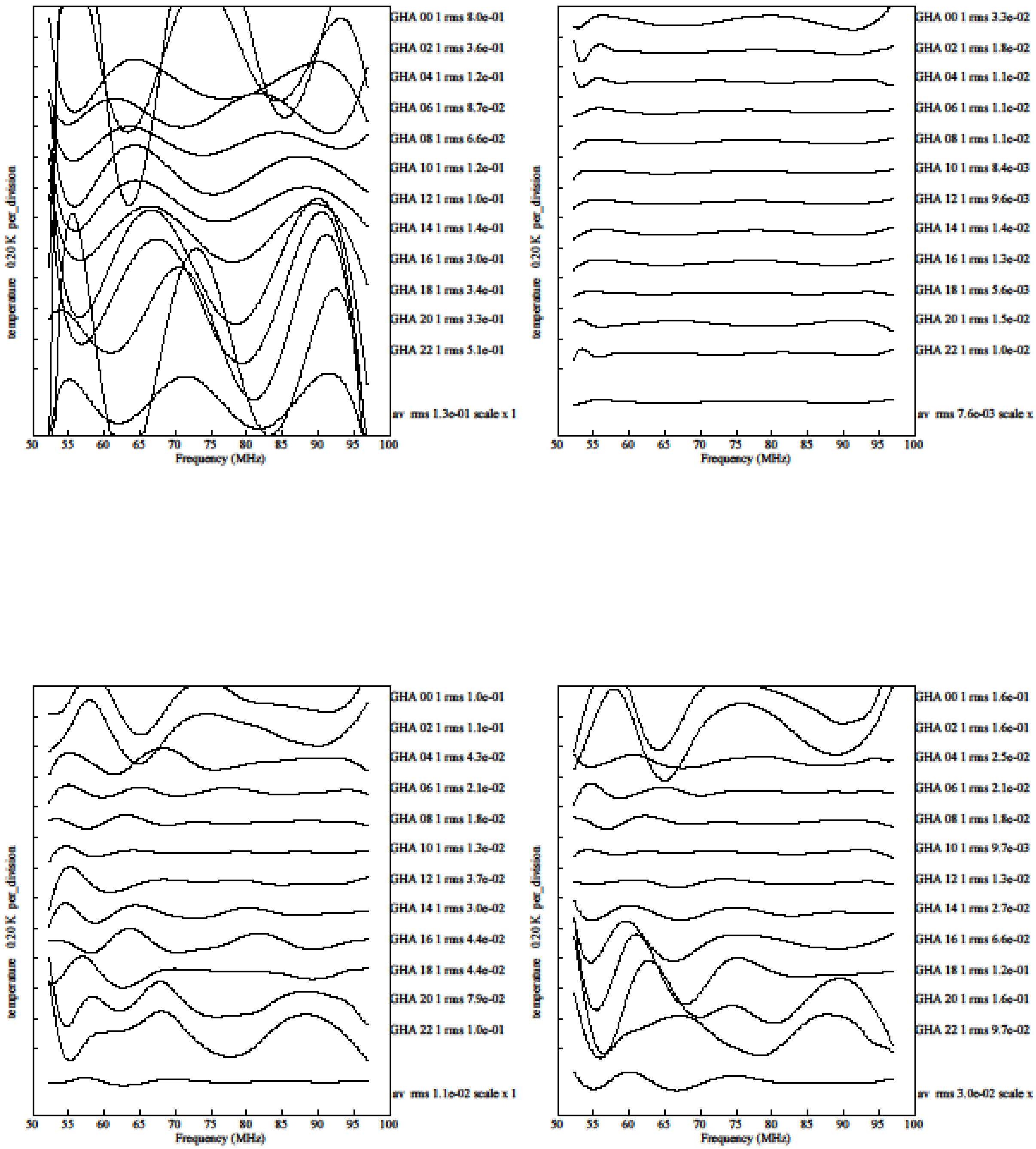

Figure 3. Simulation of beam effects over 52-97 MHz.