EDGES MEMO #462

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November 14, 2024

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To: EDGES group

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Subject: Filtering needed for DC connections to EDGES-3 via the cable box

A study of the wire grid ground plane for the EDGES-3 deployment on Adak Island in memo 457 shows that the DC power cable needs to come perpendicular to the wire grid. This choice was made because the FEKO models were made with a electrical connection to the cable box which provides the entry point for the DC power and fiber optics as shown in figure 1 of memo 459. Figure 1 of memo 310 shows the small box used in the EDGES-3 deployment in Oregon and Figure 1 of memo 399 shows the filtering circuitry that is needed to isolate the positive and negative wires from the antenna using clamp-on ferrite filters to isolate the copper wires in order to eliminate effects on the antenna beam and coupling of RFI into the spectra. While the effects in the study in memo 399 were relatively small a very large effect was noted in memo 457 when the power cable was run parallel to the wire grid.

A more complete FEKO modeling has been made and the results are in Table 1 below.

	case	center MHz	SNR	amp K	width MHz	rmsin mK	rms mK	average rms
1	no added wires above grid	77.7	78	0.51	20	40	6	76
2	wire to box without filters	77.0	7	1.32	17	288	246	1080
3	wire to box with filters	77.0	13	0.75	20	67	43	270
4	with filters plus ferittes	78.1	17	0.51	20	51	28	90
5	no added wires grid 2.54 mm	77.7	92	0.51	20	42	5	69
6	wire to box without filters	64.0	1	0.19	10	210	209	670
7	50m 8 awg parallel 6 mm	78.1	63	0.51	20	57	10	73

Table 1. Effect of cable wires parallel to wire grid raised 2.54 cm cases1-4 raised 2.54 mm cases 5-7

The first four entries in Table 1 are for the wire grid raised by 2.54 cm above a ground with dielectric 6.5 and conductivity 1e-1 S/m. With this separation and power cable above the wire grid there is a high sensitivity to the power cable at any locations where the cable is not perpendicular to the wire grid. It was pointed out in memo 384 that raising the wires by more than 1 cm degrades the performance. In this case the high conductivity of the moist ground in Adak increases the coupling with the ground which results in the reduced chromaticity and emphasizes the importance of ensuring that the wires lay on the ground along the full length of the wire grid. The effects of a 1 inch raised wire grid in table 4 of memo 459 are minimal because in this case the FEKO model did not include the effects of added metal structure that is not perpendicular to the wire grid.

Cases 5 and 6 which were run with a reduced height of 2.54 mm have a slightly reduced effect. Case 7 is a test of the effect of a 8 awg radial which might be present at the Adak site, coming up 6 mm above ground which is 4 mm above the wire grid wires. In this case the residuals are only slightly higher than the residuals in case 5 for which the radial wire is not present.

The results in table 1 have the 2018 absorption added to the sky and 5 polynomial terms are removed for residuals, no beam correction is made and frequency range is 55 -102 MHz. A GHA range of 06 to 18 in one hour steps for the residuals labeled rms and rmsin and over all GHA in one hour steps for the average rms.

Reducing the height of the wire grid to 2.54 mm provides stronger coupling to the damp soil which helps reduce the effects added wires and cable and results in a lower beam chromaticity.

In order to avoid a direct connection of the power wires to the antenna the red positive wire should pass through clamp-on ferrite filter before connection to the feed-thru filter and the black negative wire, and plain copper wire should pass through a clamp-on before connection to the metal of the cable box. This study shows that large effects on the beam chromaticity can result from a direct connection to the antenna even if the cables run perpendicular to the wire grid wires. Since the fiber optic cable outer material is conductive it should also pass through a ferrite clamp-on filter in the cable box, or not enter the cable box or connect to the cable box or not connect either end.

FEKO simulations show that in general wires need to be filtered and may even require clamp-on ferrite filters at ground plane level. In addition these simulations increase the concern expressed in memo 457 that there could be ripples in the spectra which result from the buried radials at the Adak site. If ripples are a problem then a clamp-on filter over the power cable could be added where the cable leaves the ground plane and goes up into the filter box shown in figure 1 of memo 459. Adding clamp_on filters on the cable might be needed as a potential fix for any remaining ripples or resonances.

A test of the internal signals in the power box connected to the generator, which will be located in the building show the presence of signals at 50.0,53.6,56.5,66.3,68.5,71.4,73.2,75.0,77.2, and 108.1 MHz which are being generated by the “management” electronics . The strongest of these signals is the 75.0 MHz signal which is about -30 dBm in the box. Adding a low pass DC feed-through filters to the DC output from the box should provide sufficient attenuation of this signal. It also possible that the 75 MHz and other signals might be removed when EDGES-3 sky data is being taken by turning off the electronics which is generating these signals.

In summary ferrite filters in the antenna box are needed to reduce the “ripple” in the beam chomaticity with 5-polynomial terms removed without an added 21-cm absorption are shown in Figure 1. Figure 2 shows the FEKO model and in this model the cables come into the cable box and go inside without connecting to the box and then the wires pass through clamp_on ferrite filters in the box before they connect to the box and to the added filter on the positive DC wire which goes up the pipe to the EDGES electronics.

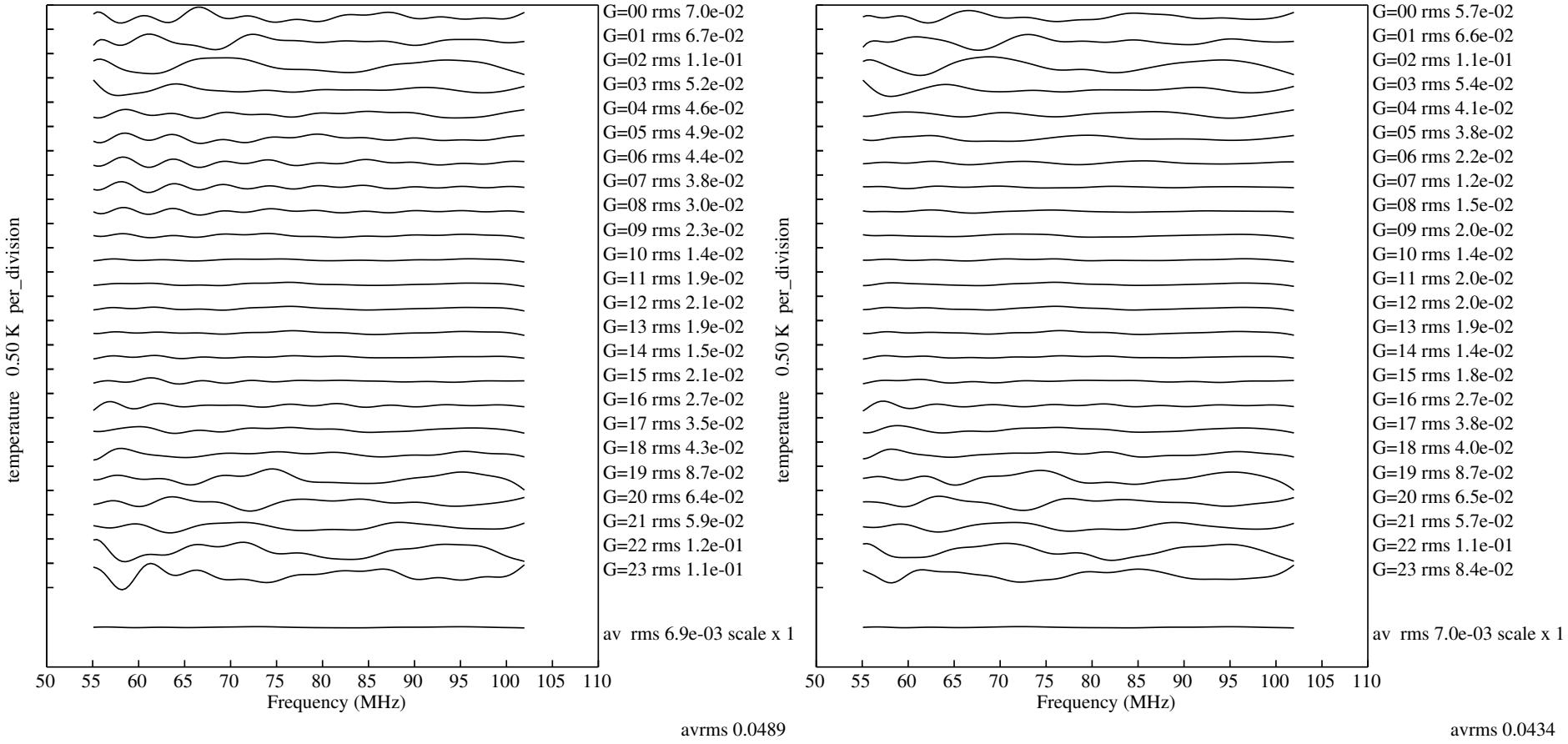

Figure 1. Beam chromaticity without ferrite and with ferrite filters on left and right respectively

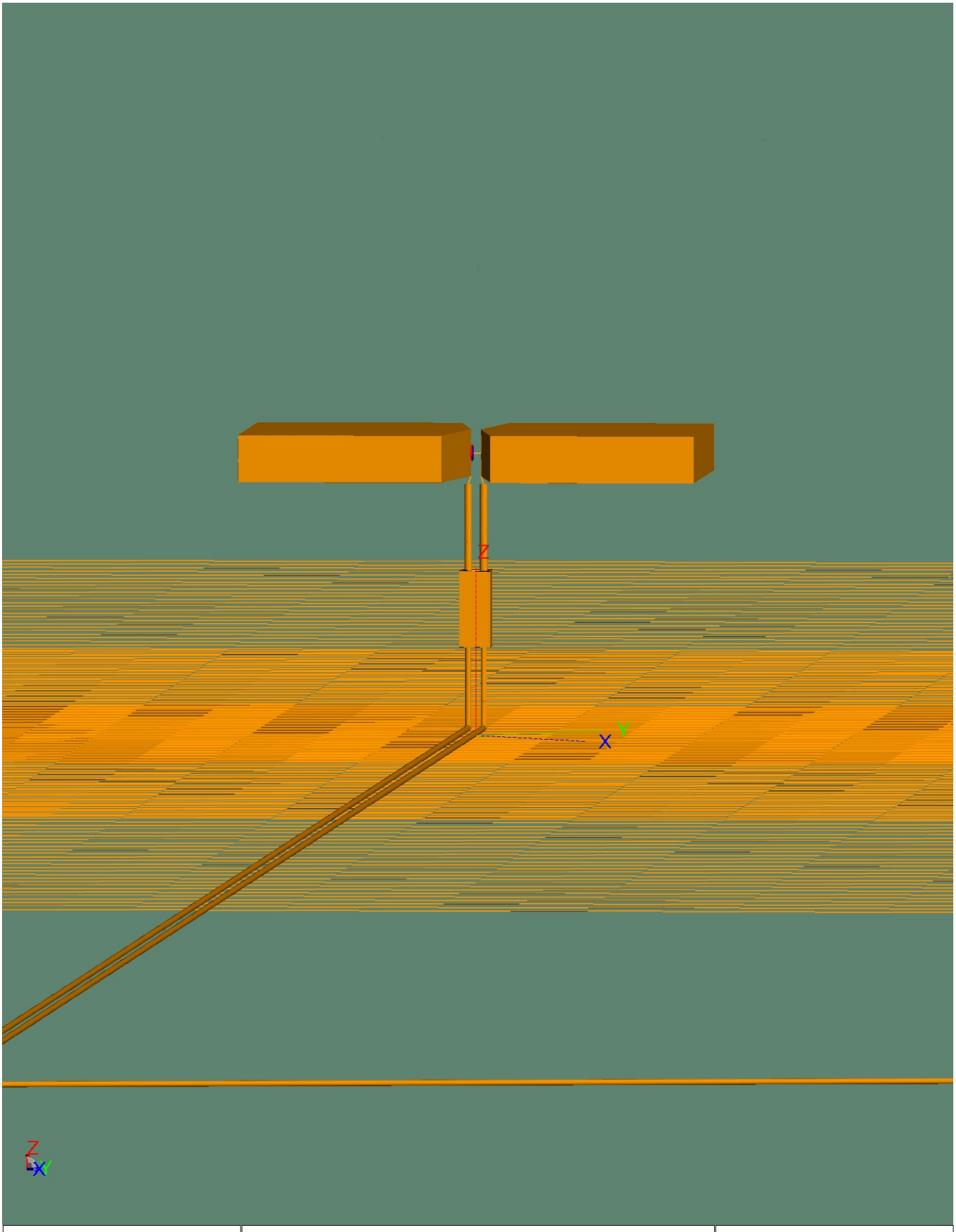

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Figure 2. FEKO model with wire grid and cable box with cables coming from building