EDGES MEMO #309

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To: EDGES Group

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Subject: Shielding factor from non-uniform ground

Memo 295 discusses the effect of non-uniform ground on the beam chromaticity. Memo 292 discusses how the beam chromaticity on uniform ground initially increases with ground plane size reaching a peak at about 5×5m and then decreases for larger ground planes. If a location with uniform ground could be found good performance might be achieved using a small ground plane.

In a temporary deployment an initial test without a ground plane might be useful since an underlying rock layer can be clearly detected in both the antenna S11 and the large beam chromaticity. Figures 1 and 2 show the FEKO simulated antenna chromaticity and antenna S11 for a layered ground with dielectric 3.5 conductivity 2e-3 S/m down to rock with dielectric 8.5 and conductivity 3e-2 at 5m below.

In this case the beam chromaticity is about 100 times larger than for uniform ground and the antenna S11 shows the expected ripples with 16 MHz period at a level of about 100 above the S11 noise. Using simulations it can be show that the chromaticity increase over that on a uniform ground and S11 ripples decrease approximately by the same factor as the ground loss factor.

The ground is shielded from the antenna by the ground plane and the degree of shielding determined by the ground plane loss so that for example a ground plane with 1% loss is 99% shielded from the ground and the effect of the ground on the beam is the non-uniformity of the ground is reduced to 1% of what it would be without any ground plane.

Higher conductivity of the top layer of soil reduces the effects of the underlying layers. The simulations in memo 295 assumed 2e-3 S/m which is typical of very dry soil. FEKO simulations show that when the conductivity increases to about 3e-2 the rock below 50 cm has no effect on the beam and rock layer less than 50 cm below the ground also has little effect on the beam chromaticity. If this layer is uniform. The soil conductivity of 3e-2 S/m is the critical conductivity above which there is less concern about having uniform solid down to more than 50 cm.

The simulations do not account for frequency structure or chromaticity in the loss which is discussed in memo 295. The loss chromaticity for case in Figure 1 is about 7 K with 5-terms removed.

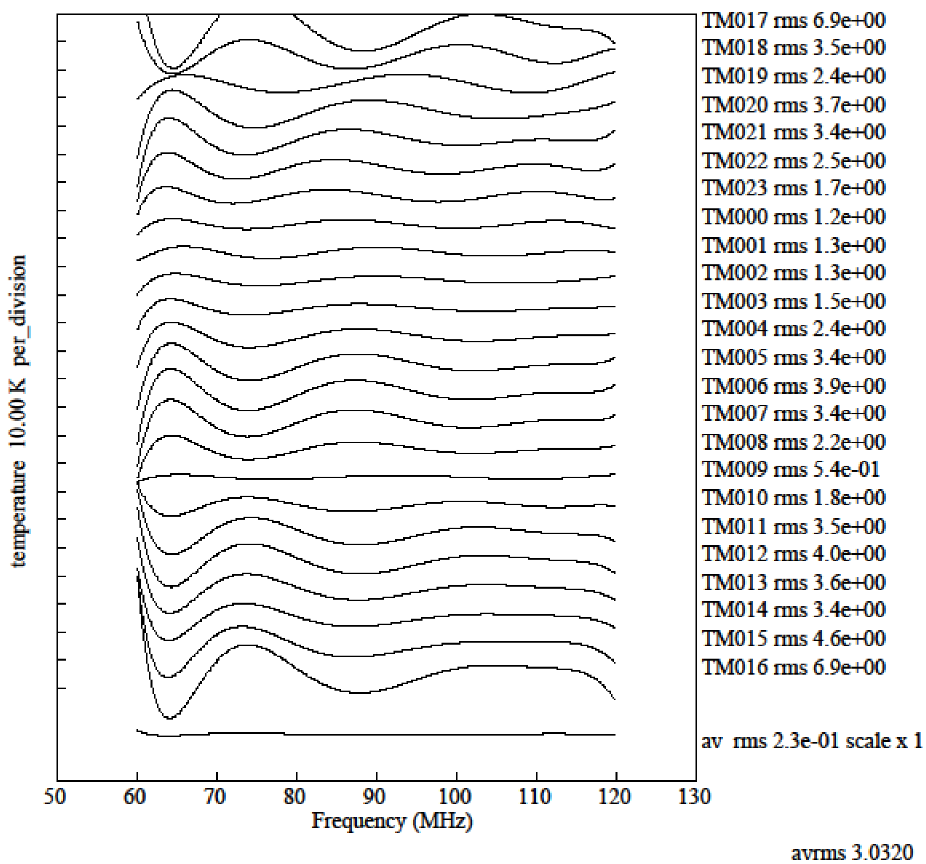

Figure 1. Beam chromaticity with 5-terms removed for antenna on soil with rock at 5m depth. TM is the local time in Oregon in mid September.

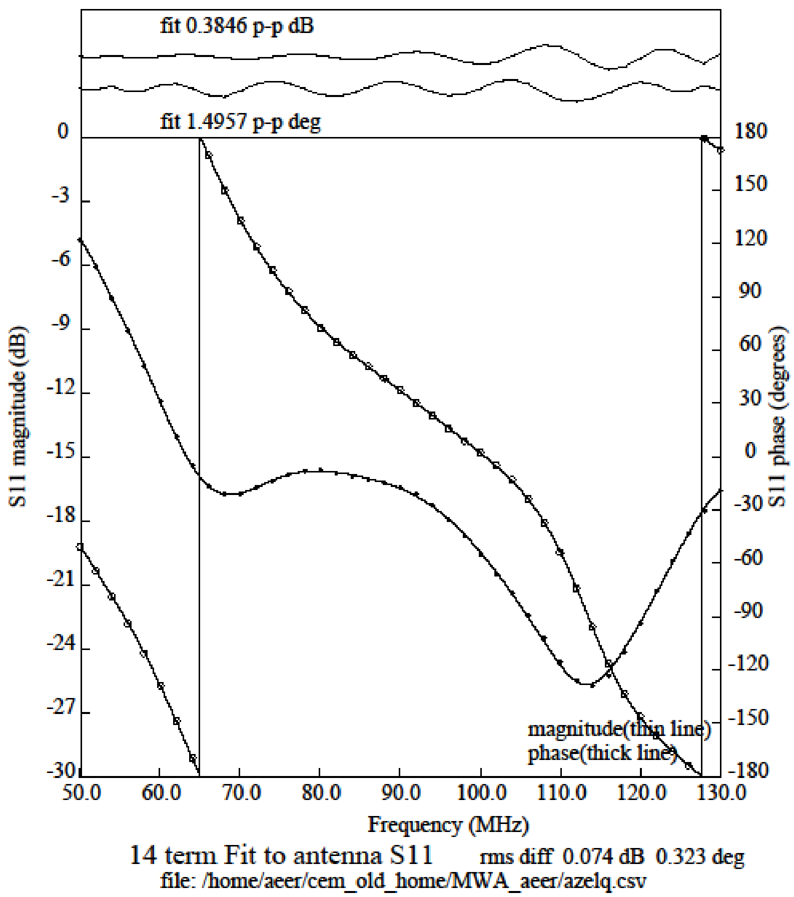

Figure 2. S11 from FEKO simulation clearly shows effect of reflection from rock below.