Using Near Field Equivalent Sources in Combination with Large Element Physical Optics to Model a Slant 45 Degree Omni Directional Antenna over Ground

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***Abstract*—This paper compares the theoretical and measured antenna patterns of a slant 45-degree antenna on a rolled edge ground plane. Advantages of using sampled nearfield currents in combination with large element physical optics in determining the reflected far fields will be described.**

***Keywords*—Antenna, equivalent sources, Feko, MoM, multipath, PO, Slant 45.**

I. INTRODUCTION

The purpose of this report is to demonstrate the behavior of a commercial slant 45 degree omni-directional when the antenna is mounted on a ground plane and show how one can predict the patterns using near field current distributions in conjunction with regular and large element physical optics approximations in Altair Feko [1].

There is a need in the antenna community for antennas that pick up both vertical and horizontal antenna patterns (as well as RCP and LCP) with the required field of view being 360 degrees in azimuth. In addition, the frequency band required may be over a broad range of frequencies. The antenna type that is often recommend for this application is a bi-conical antenna with a multi-layer polarizer composed of wire grids that are designed to tilt the polarization from pure vertical pole to slant 45 degree polarization. See Fig. 1.

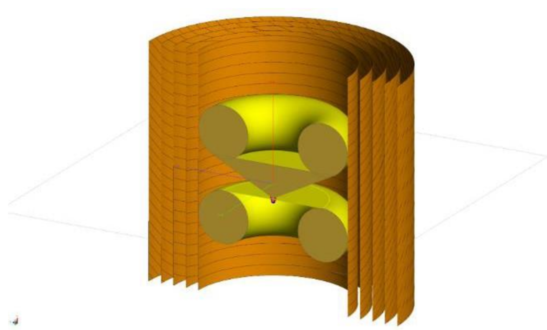

Fig. 1. Broadband discone inside slant 45 polarizer.

II. SAMPLE ANTENNA PATTERN NO GROUND PLANE

A sample of the predicted antenna pattern for 8 GHz is shown in Fig. 2. The plot shows both vertical and horizontal response and is a figure of revolution about the vertical axis.

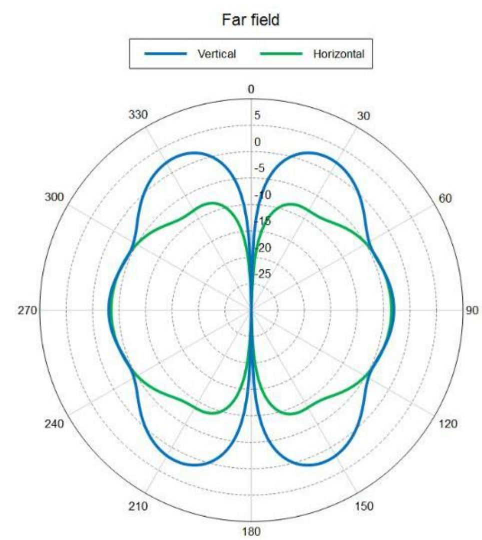

Fig. 2. MoM calculated antenna pattern at 8 GHz.

III. MODELING THE GROUND PLANE

The ground plane that will be used for antenna measurements on this antenna is a rolled edge circular ground plane. In order to calculate the antenna patterns at higher frequencies there are two steps. First calculate the Near Fields and Sample Currents on a volume that fully encloses the antenna using an infinite ground plane. This is a quick calculation. An example for the model at 6 GHz is shown in Fig. 3.

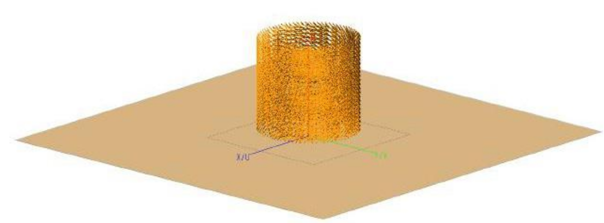

Fig. 3. Method of moments model at 6 GHz over infinite ground.

Both the Electric and Magnetic Near Fields are stored in separate files and then can be imported into Feko to simulate the actual rolled edge ground plane using physical optics. Fig. 4 shows the intensity of the sampled near fields for 6 GHz.

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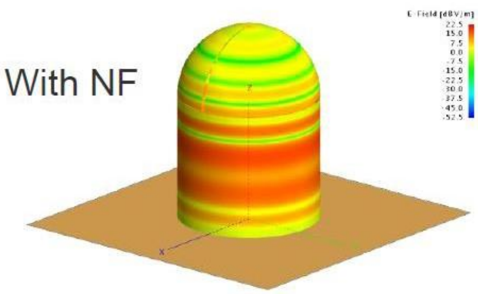

Fig. 4. Electric near field.

At this point the sample currents are placed slightly above the ground plane that the antenna will be mounted on. The ground plane is a 5 ft diameter rolled edge circular surface of revolution as shown in Fig. 5.

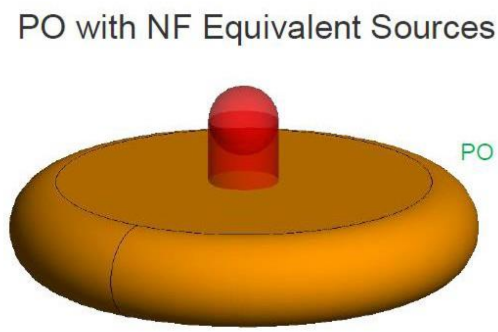

Fig. 5. Near field equivalent sources combined with physical optics.

There is a great time savings by using PO with the Near Field Equivalent Surfaces to calculate the antenna patterns. The Antenna patterns calculated at 6 GHz for vertical polarization are shown in Fig. 6 for several calculation options. Equivalent NF sources combine with Large Element PO [2] gives accurate results in a very short amount of time.

Note that because of reflections on the flat surface the vertical polarized signal now has nulls at elevation angles of 7.5, 18 and 34 degrees.

An off the shelf model of the antenna was measured on the same shape ground plane and the vertical antenna patterns are shown in Fig. 7. Note that the measured antenna patterns agree with the calculated results with nulls at 7.5, 18 and 34 degrees elevation.

IV. Conclusion

Feko has been used combining NF Equivalent Sources and Physical Optics to predict antenna patterns on a rolled edge ground plane. Measured results confirm that there will be reflections in the resultant vertically polarized antenna patterns. This also occurs for horizontal polarization.

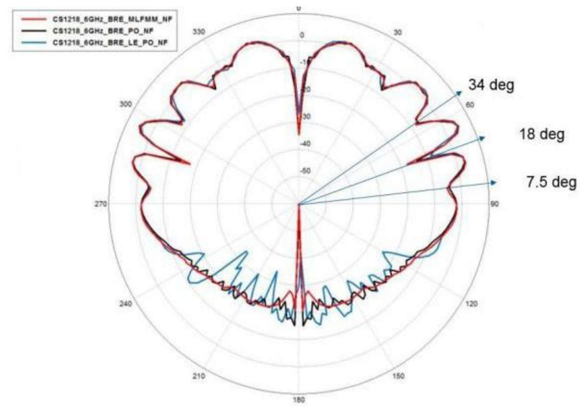

Fig. 6. Calculated vertical pol at 6 GHz on rolled edge ground plane.

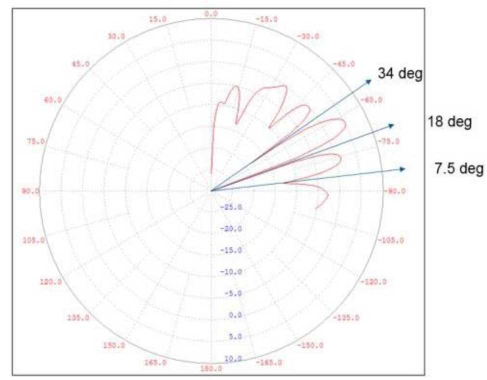

Fig. 7. Measured antenna pattern of slant 45 degree antenna on rolled edge ground plane at 6 GHz.

Acknowledgment

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References

[1] Altair Feko, https://altairhyperworks.com/product/FEKO

[2] U. Jakobus, M. Schoeman, J. van Tonder, D. Ludick, and W. Burger, “Selection of New Features in the Electromagnetic Solution Kernel of FEKO Suite 6.0,” 27th Annual Review of Progress in Applied Computational Electromagnetics, Williamsburg, Virginia, Mar. 27-31, 2011.