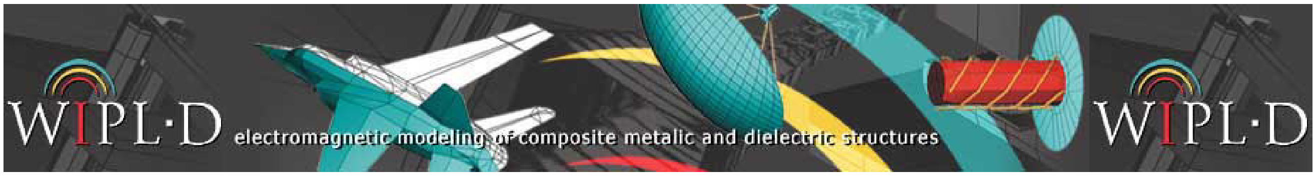

Dielectrically Loaded Circular Horn Antenna

Horn antennas are among the simplest and most widely used antennas. Horns have been used for more than a hundred years, and today they used in radio astronomy, satellite communications, in communication dishes as feeders, in measurements, etc. There are two basic categories of horn antennas:

- Rectangular horns
- Circular horns

Main characteristics of a horn antenna filled with dielectric is side lobe suppression, decreasing beamwidth and thus increasing gain in relation to antenna without dielectric. The most important parameters for operation of this antenna are shown in Fig. 1 and Fig. 2. These parameters are:

- Length of the antenna (designated as *Lhorn*)
- Width of the aperture (designated as radius *R*)
- Characteristics of both, coaxially placed dielectrics are $\varepsilon_{r1} = 2.5 - \mathrm{j}0.00175$ and $\varepsilon_{r2} = 1.58$.

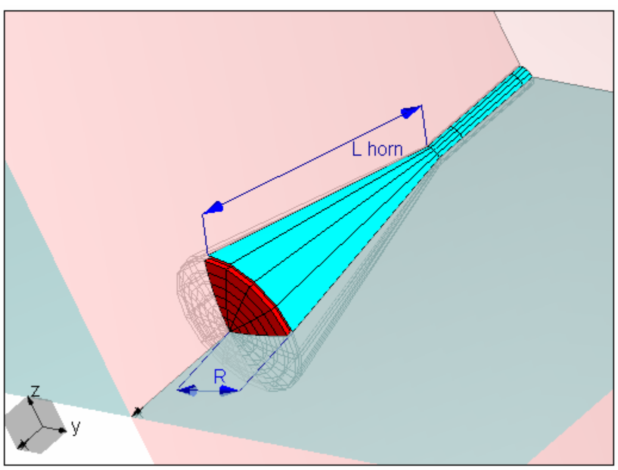

Figure 1. Circular horn

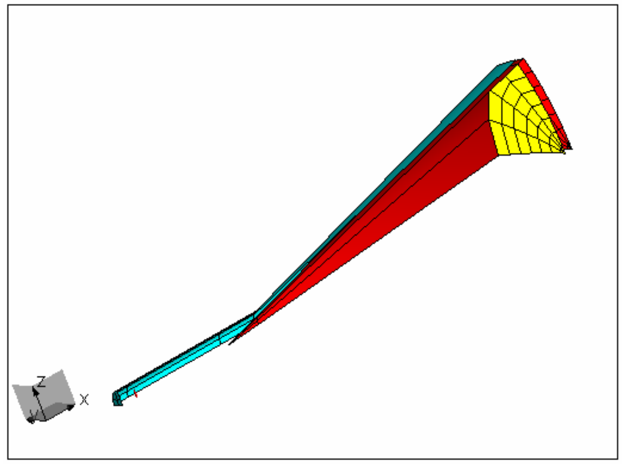

Figure 2. Quarter of a circular horn, interior is filled with dielectric

WIPL-D Simulation

In WIPL-D Pro, horn antenna given in Fig. 1, can be modeled in a very simple way, by using several parameterized geometrical objects as building blocks. One can use the *Symmetry* feature in both electric and magnetic plane, so only half or quarter of given antenna can be modeled (Fig. 2). Antenna is considered to be surrounded by vacuum, i.e. it is located in free-space. Antenna is filled with two dielectrics, one in a conical shape along the entire length of the horn and the other in a disk shape at the aperture.

Dimensions of the rectangular horn model are given in Tab. 1. Operating frequency is 10 GHz.

For parameters given in Tab. 1, we will calculate gain and near field. Computer used for these calculations is Pentium Dual-Core CPU E5200, 2.5 GHz clock, with 2 GB RAM.

Table 1. Parameters of analysis

Parameter	Value [mm]
R	61.14
Lhorn	211.846

Radiation pattern in 3D is shown in Fig. 3 and its phi-cut, where *phi*=0 (antenna is placed along x axis) is shown in Fig. 4. Please note that the theta angle is measured with respect to the xOy plane.

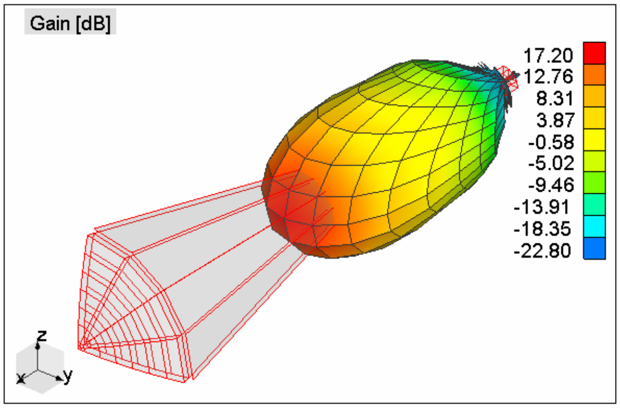

Figure 3. Radiation pattern

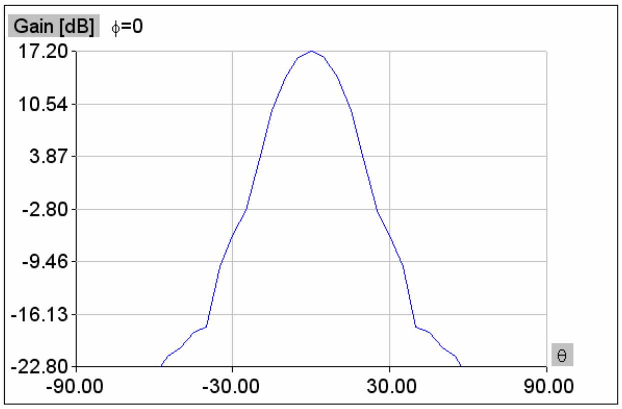

Figure 4. Radiation pattern, phi-cut

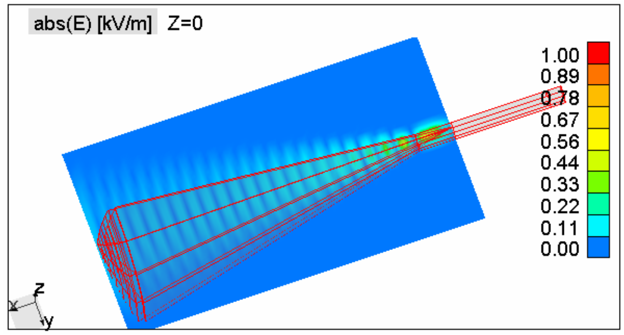

Figure 5. Near field

Calculated near field is shown in Fig. 5. It illustrates the radiation mechanism of the horn.

Number of unknowns, memory required, and simulation time are given in Tab. 2.

Table 2. Analysis characteristics

Model	No. of unknowns (memory [MB])	Time @ 10 GHz [sec]
quarter model	3801 (115.6)	499

Conclusion

The presented antenna is not one of the simplest antennas for EM modeling and simulation but also not one of the most complex. WIPL-D Pro provides simulation results in a matter of minutes, demonstrating efficiency of higher order MoM for models of mid-range complexity. The difference in performance comparing to the rectangular horn model is mainly due to the introduction of dielectrics which require twice the number of unknowns (and 4 times more memory) per surface unit than metals.