Rectangular Horn Antenna

Rectangular horn antenna is one of 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.

The main characteristic of the rectangular horn antenna presented here is its approximately 20 dB gain. Horn antenna can be considered as an especially designed waveguide extension. The most important parameters for operation of this antenna are shown in Fig. 1. These parameters are:

- Length of antenna (determined by *Lhorn*)
- Width of aperture (determined by *a2* and *b2*)

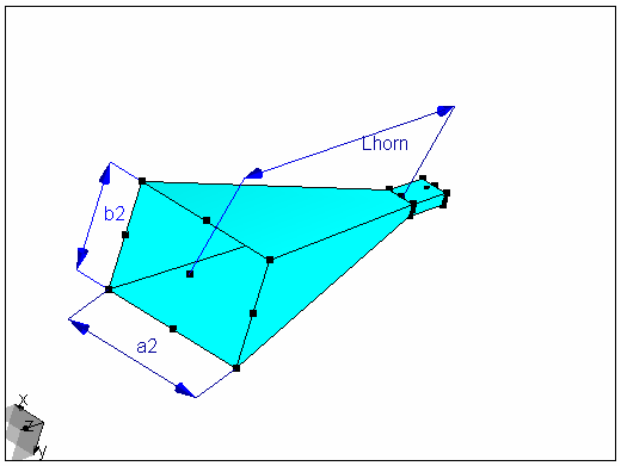

Figure 1. Rectangular horn

WIPL-D Simulation

In WIPL-D Pro, horn antenna given in Fig. 1, can be modeled in a very simple way, by using several basic 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), depending on the type of feeding. Antenna is considered to be surrounded by vacuum, i.e. it is located in free-space.

For parameters given in Tab. 1, we will calculate gain, near field and we will compare analysis characteristics for different models of antenna (with and without *Symmetry* feature). Computer used for these calculations is Intel(R) Core(TM) i7 CPU 950@3.07 GHz.

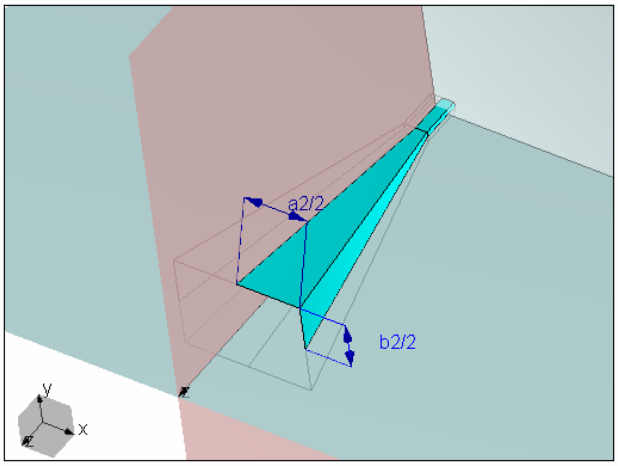

Figure 2. Quarter of a rectangular horn

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

Table 1. Parameters of analysis

Parameter	Value [m]
a2	0.1237
b2	0.09195
Lhorn	0.2555

Radiation pattern 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.

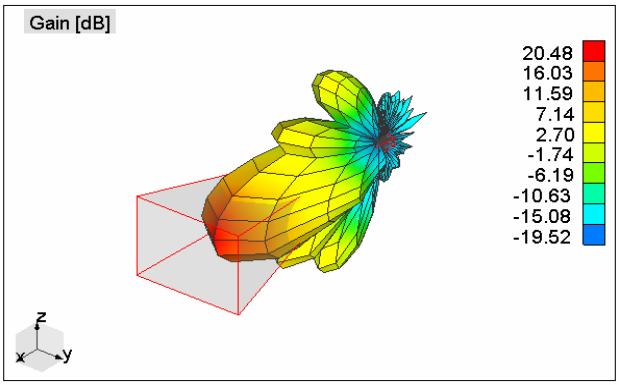

Figure 3. Radiation pattern

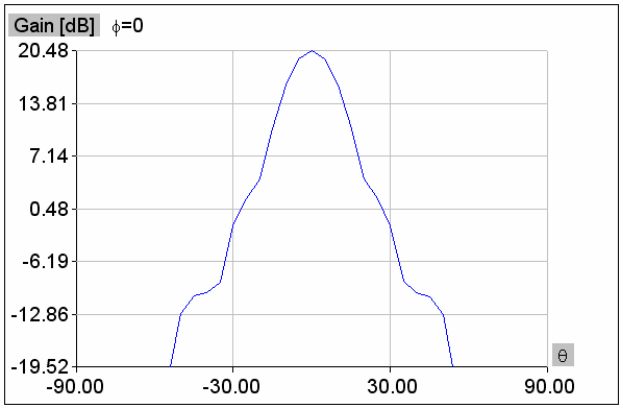

Figure 4. Radiation pattern, phi-cut

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

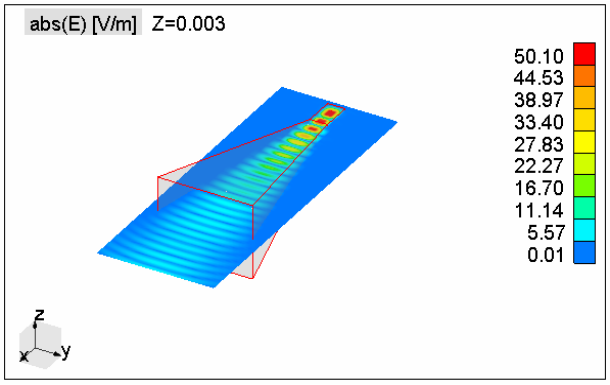

Figure 5. Near field

Numbers of unknowns, memory requirements, and simulation time are given in Tab. 2.

Table 2. Simulation data

Model	No. of unknowns (memory [MB])	Time @ 10 GHz [sec]
quarter	658 (3.5)	1
half	1351 (14.6)	1
full	2625 (55.1)	2

Conclusion

The rectangular horn antenna is one of the simplest antennas for EM modeling and simulation. However, some simulation tools use computational methods that require relatively long time (several minutes) to produce results even for the simplest horn models. WIPL-D Pro provides simulation results swiftly in a matter of seconds rather than minutes, demonstrating that higher order MoM makes a difference comparing to other methods even on the simplest examples, not just the electrically large structures.