Rectangular Horn Antenna

This application note presents WIPL-D Pro models and the simulation results of one of the simplest and widely used antennas – rectangular horn antenna. Horn antenna was introduced more than hundred years ago. Today, horn antennas are used in radio astronomy, satellite communications, measurements...

WIPL-D Models

WIPL-D Pro models of the horn antenna are shown in Figs 1-3. Full model of the horn antenna is presented in Figure 1. Dimensions of the horn antenna, which are highlighted in the figures, represent: length of the antenna (Lhorn = 0.2555 m), width of the aperture (a2 = 0.1237 m) and height of the aperture (b2 = 0.09195 m).

In WIPL-D software, beside the full model, the rectangular horn antenna can be also modeled by using the Symmetry planes. Usage of symmetry planes enables decreasing simulation time and number of unknowns. Half model of the horn antenna is shown in Figure 2. This is the model with one Symmetry plane (the symmetry is in H-plane). Quarter model of the horn antenna is shown in Figure 3. This is the model with two Symmetry planes (the symmetries are in both E and H planes).

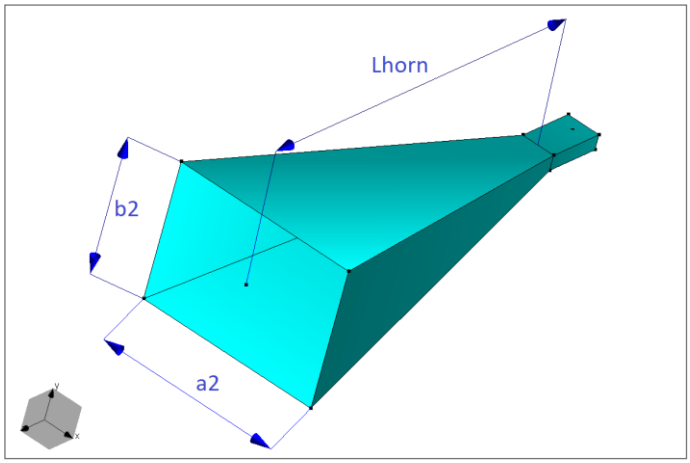

Figure 1. Rectangular horn antenna – full model

Results and Simulations

The antennas were simulated at 10 GHz. Results which will be presented are: compared radiation pattern results in E plane for antennas shown in Figures 1-3, gain in 3D, gain in E plane, gain in H plane and near field in 2D.

In order to show that we can successfully apply the symmetry planes, the radiation pattern results in E plane, obtained in each of the three models (Figures 1-3) are compared and presented in Figure 4.

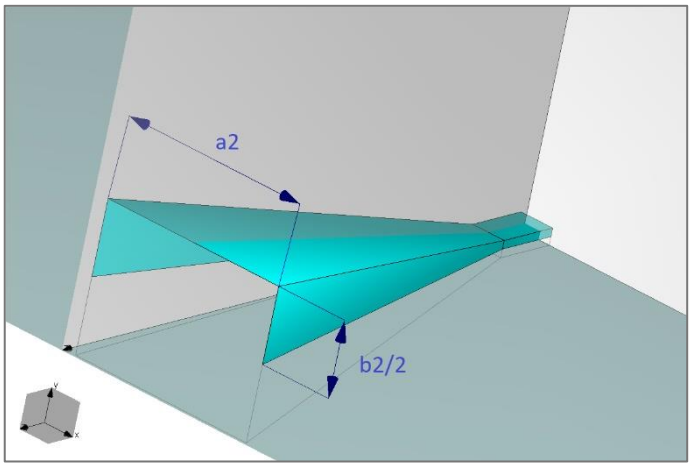

Figure 2. Rectangular horn antenna – half model

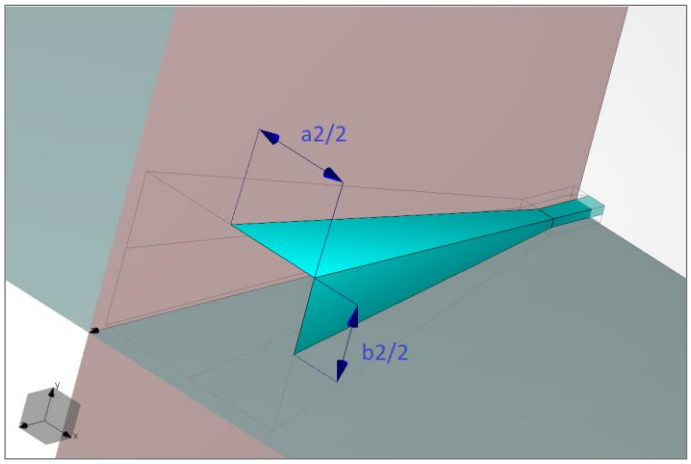

Figure 3. Rectangular horn antenna – quarter model

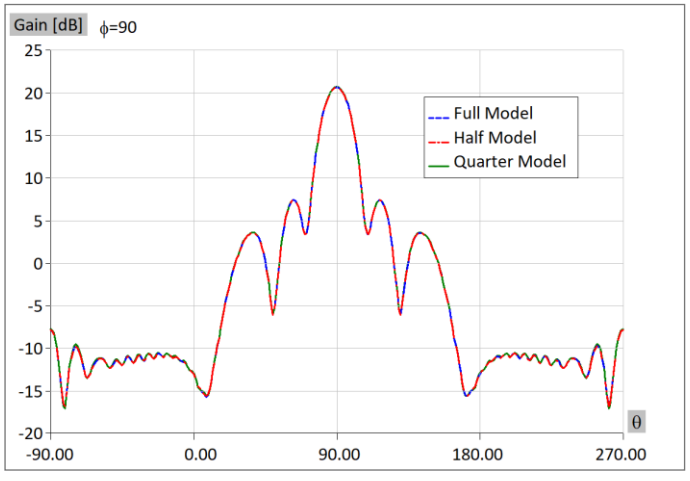

Figure 4. Radiation patterns in E-plane – full, half and quarter model

Radiation pattern in 3D for antenna radiating along x axis is shown in Figure 5. Radiation pattern in H plane and E plane for

the antenna radiating along z axis are shown in Figure 6. Near field in 2D is shown in Figure 7.

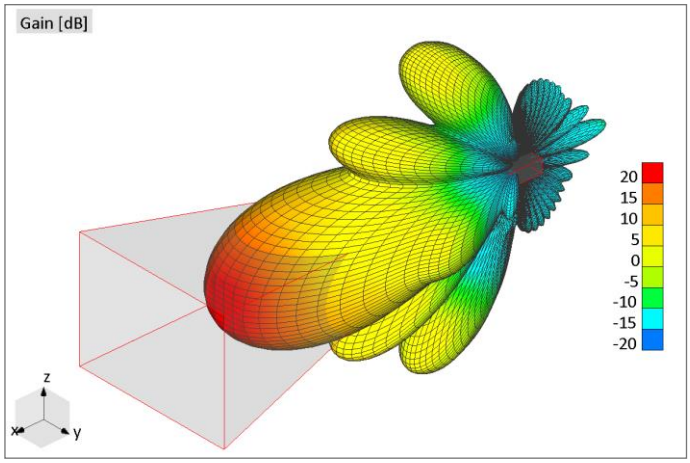

Figure 5. 3D radiation pattern

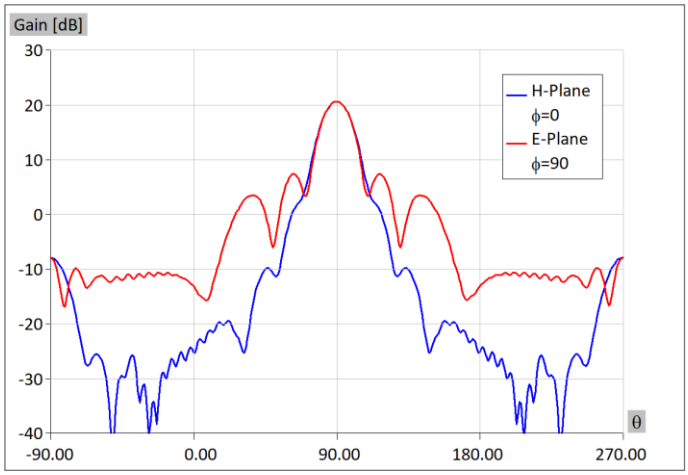

Figure 6. Radiation patterns, E and H plane

Computer used for these simulations is Intel® Core™ i7-7700 CPU @ 3.60 GHz. Number of unknowns, computer memory requirements and simulation time are presented in Table 1 Simulation time mainly consists of computer time necessary for matrix fill-in. Matrix inversion and calculating output results (here, 2D radiation pattern) is negligible.

Table 1. Number of unknowns, computer memory requirement and total simulation time

Model	Number of unknowns	Memory [MB]	Simulation time [sec]
Quarter	1,084	8.96	0.78
Half	2,085	33.17	0.98
Full	4,090	127.62	2.08

Conclusion

Three 3D EM models of rectangular horn antenna were simulated. The first model is full model. In the second and the third model are models with one symmetry plane and two symmetry planes applied, respectively. All antennas were easily modeled and simulated very quickly using the WIPL-D Pro. In addition, 3D radiation pattern and 2D distribution of electric field in the near field region are shown. Usage of Symmetry plane saved memory resources and decreased simulation time, while the difference between results is negligible (consequence of the different mesh and number of unknowns used).

Thanks to efficient implementation of MoM with HOBF, electrically large structures such as the horn antenna, are simulated in a matter of seconds.

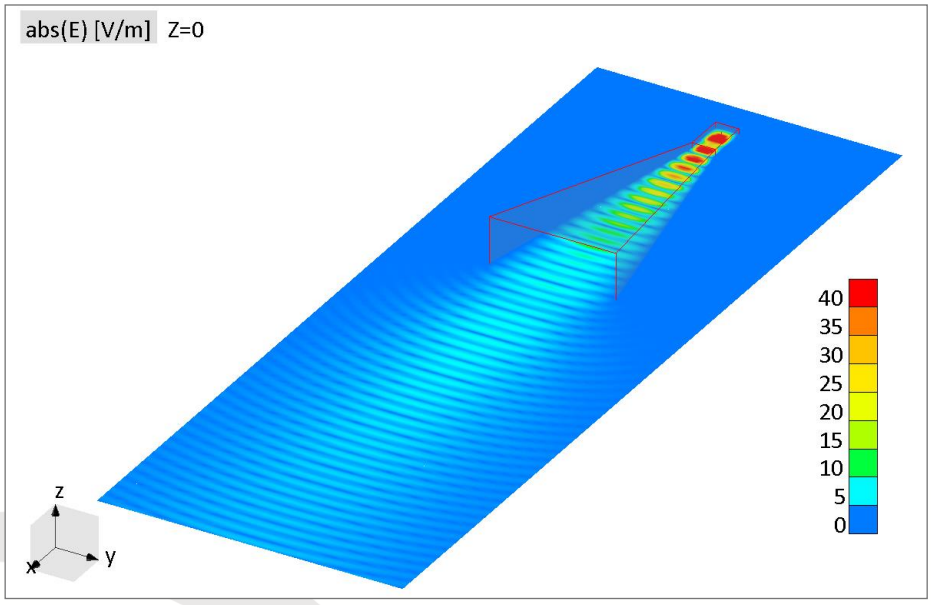

Figure 7. Near field in 2D