Spherical Radome over Circular Horn

Radome represents enclosure protecting, usually, a radar antenna. The radomes are designed in such manner that they minimally influence operating characteristics of the protected antenna. Ideally, radome should be transparent for the EM ways penetrating it. However, in real life scenarios, the radome influences operating characteristic of the protected antenna. Thus, a radome and an antenna are usually simulated as the inseparable components of an antenna system.

In this application note, a demonstrational model of the radome and the horn antenna will be simulated. Software tool used for simulations will be WIPL-D Pro, a full 3D EM Method-of-Moments based solver. The demonstrational model of the radome represents model of monolithic radome used as a cover for simple circular horn antenna. The main focus of this application note is to show how fast and accurate the horn antenna covered by radome can be simulated using WIPL-D software. In order to present WIPL-D capabilities, two models will be simulated. The first model represents circular horn antenna with the waveguide and the radome supporter. The second model represents the first model with the monolithic, electrically thin radome coverage.

WIPL-D Models

Simulated circular horn antenna with the supporter is shown in Fig. 1. The whole simulate model consists of the horn, the waveguide (with the feeding area) and the metallic reflector surface which is also used as a supporter for the radome. Also, Fig. 1 displays usage of two symmetry planes. That way, simulation time and number of unknowns are decreased (only quarter of the model was simulated), while the accuracy of output results is preserved.

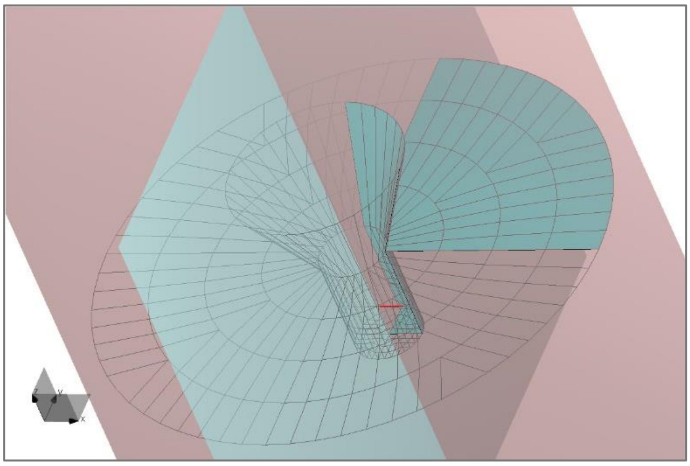

Figure 1. Simulated circular horn antenna

Horn antenna with the radome is shown in the Fig. 2. Despite almost the entire model is presented in Fig. 2, only quarter of the structure was simulated (two symmetry planes were used; similar as it is shown in Fig. 1). Actually, the model with radome is presented as it was done in Fig. 2, in order to clearly show position of the horn antenna which is covered by the radome.

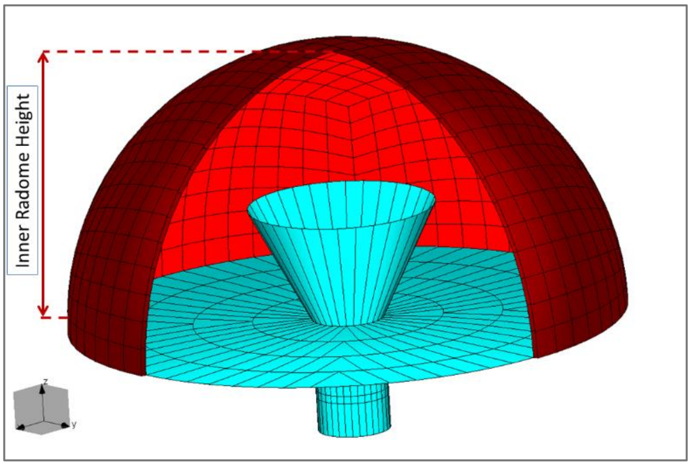

Figure 2. Simulated circular horn antenna with the radome

The dimensions of the antenna, radome and dielectric parameters are presented in Fig. 2, Fig. 3 and Table 1. Inner radome height is explained in Fig. 2. Diameter of the horn aperture, the length of the horn and inner radome diameter (which is equal to double inner radome radii) are shown in Fig. 3.

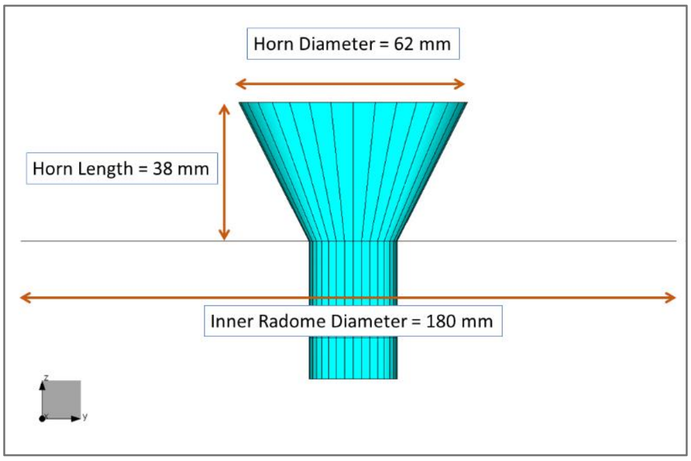

Figure 3. Dimensions of the antenna

Table 1 contains information about dielectric parameters, inner radome height, inner radome radius, radome thickness and the radius of the waveguide feeding the horn antenna.

Table 1. Dielectric parameters and dimensions

Parameter	Value[Units]	Parameter	Value [Units]
Relative Dielectric Permittivity	3.1	Radome Radius	90 mm
Loss Tangent	0.008	Radome Thickness	2 mm
Inner Radome Height	90 mm	Waveguide Radius	~11.91 mm

All dimensions and dielectric parameters are randomly selected for the demonstrational purposes. The radome and the circular horn antenna were easily created using WIPL-D Pro built-in objects and manipulations.

Results and Simulations

Two models were simulated at 9.5 GHz. The first model represents circular horn antenna with the waveguide and the metallic reflector surface. The second model represents the first model covered by the radome. The radiation pattern results obtained after simulating these two models in two cuts (ϕ=0 Degrees and ϕ=90 Degrees) are compared and presented.

Radiation patterns in ϕ=0 cut are presented in Fig. 4.

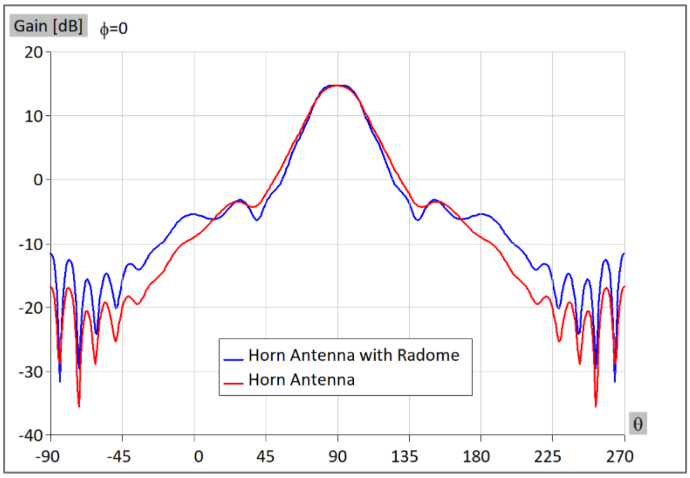

Figure 4. Radiation patterns in ϕ=0 cut

Radiation patterns in ϕ=90 cut is presented in Fig. 5.

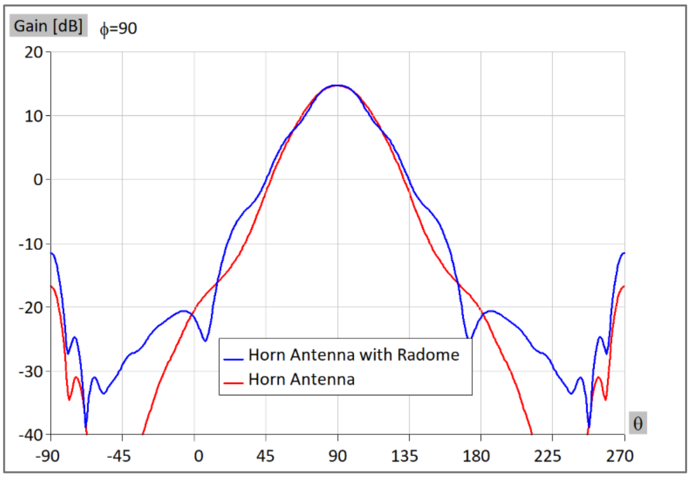

Figure 5. Radiation patterns in ϕ=90 cut

Computer used for these simulations is standard desktop Intel® Core(TM) i7-7700 CPU @3.60 GHz.

Number of unknowns, computer memory requirement and the simulation times for these two models are presented in Table 2. Total simulation time mainly consists of time spent in matrix fill, matrix solution and time spent in calculation of output results.

Table 2. Number of unknowns, computer memory requirement and total simulation times

Model	Number of unknowns	Memory [MB]	Total simulation time[sec]
Horn Antenna	810	5	0.9
Horn Antenna with the Radome	7,082	383	18.1

Conclusion

Two models were simulated using WIPL-D software. The first model represents circular horn antenna, while the second represents circular horn antenna with the radome. Both models were simulated using CPU platform. Simulations of both models were performed very fast. In addition, two symmetry planes were utilized in order to reduce number of unknowns and simulation time. Presented results (Figures 4-5) clearly show influence of dielectric applied within the electrically thin radome – only lower levels of the radiation pattern are significantly disturbed.