Dielectrically Loaded Circular Horn Antenna

The aim of this application note is presenting models and results which are obtained after simulation of dielectrically loaded circular horn antenna. In addition, radiation pattern results in H-plane for dielectrically loaded circular horn antenna and pure metallic circular horn antenna are compared.

WIPL-D Models

Both models of circular horn antennas were created and simulated using WIPL-D Pro - a full 3D EM Method-of-Moments based solver. In all simulated models, two symmetry planes are utilized. This means that only quarter of the structure is modeled (simulated). The models are created easily - mainly it was done by using *Body-of-Revolution*, a WIPL-D Pro built-in object.

Pure metallic circular horn is presented in Figure 1.

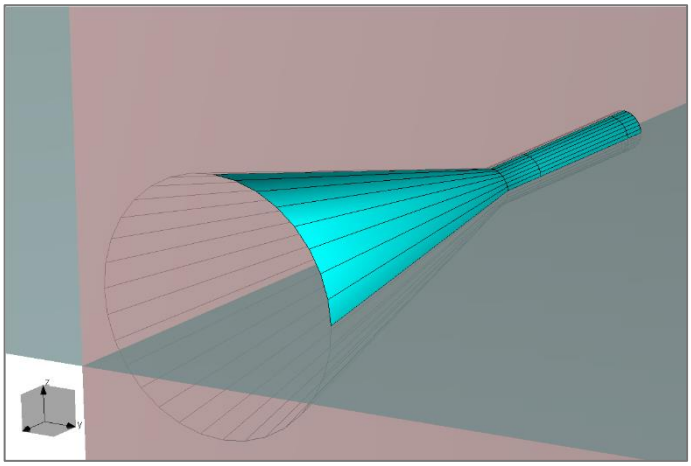

Figure 1. Circular horn

Dielectrically loaded circular horn is presented in Figure 2.

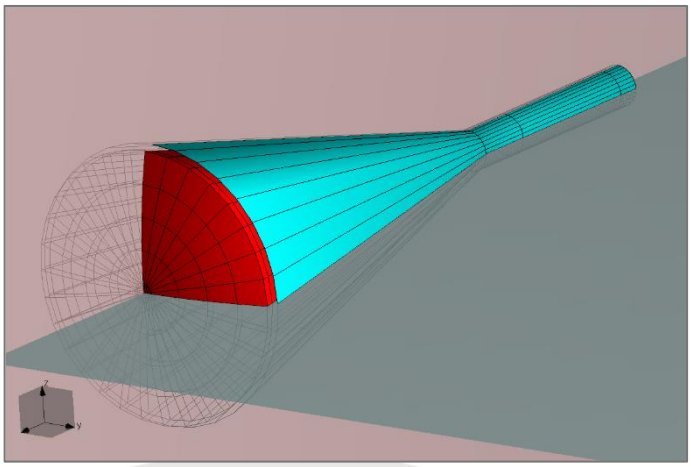

Figure 2. Dielectrically loaded circular horn

Dielectrically loaded horn is filled with two different dielectrics. In order to clearly present how the dielectric materials are added, a demonstrational model shown in Figure 3 is created. The model presented in Figure 3 was not simulated - it was created for the demonstrational purposes, only. It can be seen that there is a space between the metallic walls of the horn and the inner dielectric. The dielectrics are specially designed and chosen, in such manner that their presence suppresses backward radiation.

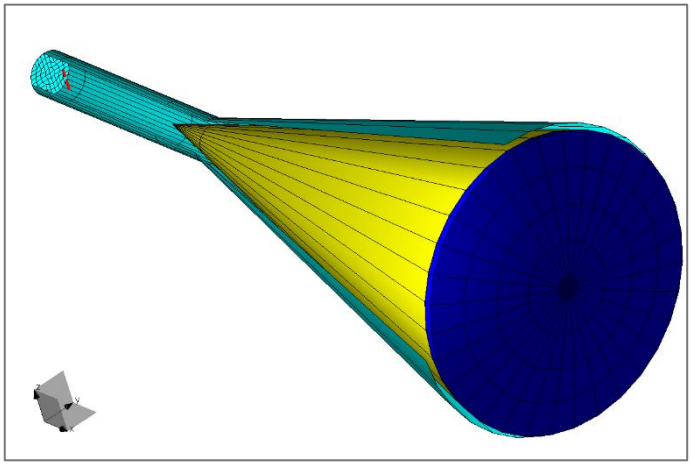

Figure 3. Two different dielectrics within the horn antenna – the model used for demonstration

Results and Simulations

Antennas were simulated at 10 GHz. After completing process of checking convergence of the results, output results presented below are obtained. Compared radiation patterns (dielectrically loaded circular horn antenna and pure metallic circular horn antenna) in H-plane are presented in Figure 4.

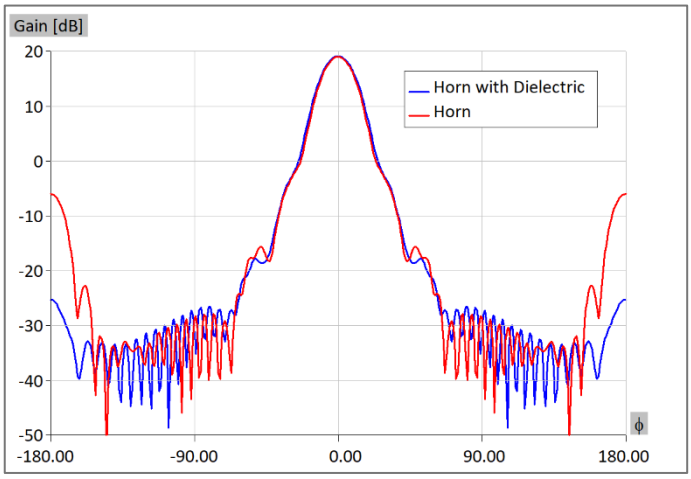

Figure 4. Radiation patterns in H-plane

Radiation pattern of dielectrically loaded circular horn in 3D is shown in Figure 5.

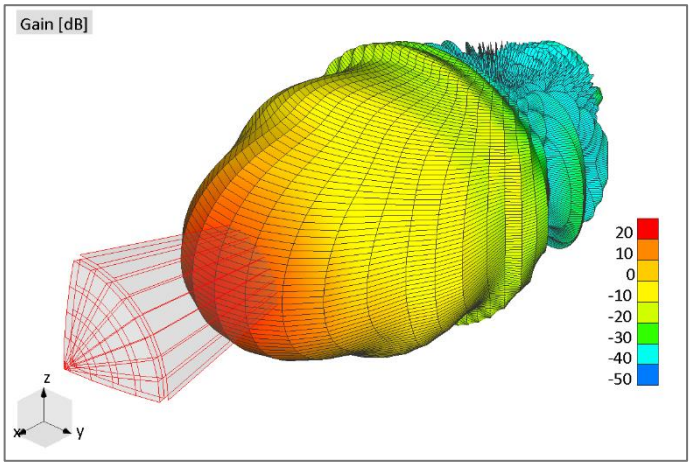

Figure 5. 3D radiation pattern – dielectrically loaded horn.

Calculated near field of dielectrically loaded circular horn is shown in Figure 6.

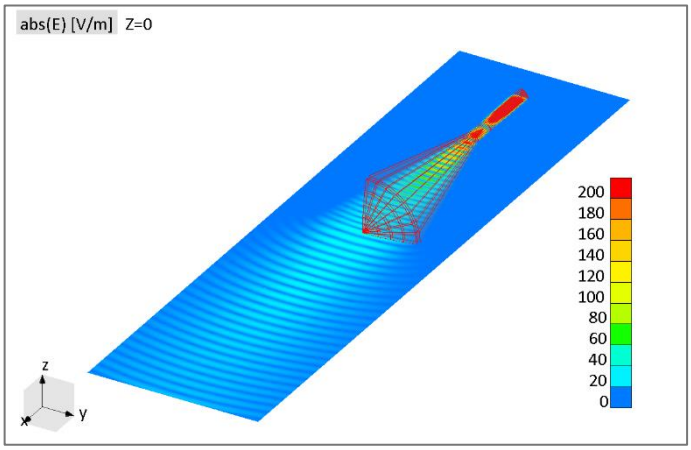

Figure 6. Near field – dielectrically loaded horn

Computer used for these simulations is Intel® Core™ i7-7700 CPU @ 3.60 GHz. Number of unknowns, computer memory required and simulation time are presented in in Table 1. Simulation time mainly consists of computer time necessary for matrix fill-in, as well as for the matrix solution and calculation of output results (here, radiation pattern in H-plane).

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

Model	Number of unknowns	Memory [MB]	Simulation time [sec]
Dielectrically loaded horn	9,446	680.75	24.27
Metallic horn	2,014	30.95	2.34

Conclusion

Two models of circular horn antenna were simulated using the WIPL-D software. Special attention is devoted to the dielectrically loaded horn antenna. The influence of the dielectric loading is highlighted and it is the most noticeable in Figure 4. In Figure 4, it is clearly seen that radiation back lobe is significantly suppressed if dielectric load is used.

In order to reduce number of unknowns and simulation time, two symmetry planes were successfully used in each model. Both models were simulated very fast with minimum computational requirements, while simulation time is couple of seconds.