Luneburg Lens Illuminated by Corrugated Horn

The lenses are used to collimate incident energy and to prevent it from spreading in undesired directions. In this application note, we will show Luneburg lens illuminated by corrugated horn antenna. Luneburg lens is represented as spherically symmetric structure with variable index of refraction. In the other words, this application presents Luneburg lens as a model consisting of 5 spheres with coinciding centers.

WIPL-D Models

Model of Luneburg's lens illuminated by corrugated horn is created and simulated using WIPL-D Pro, a 3D EM Method-of-Moments based solver. The model with two symmetry planes applied is shown in Figure 1. The same model, rotated in such manner that dielectric layers defining Luneburg lens can be clearly seen is shown in Figure 2. Corrugated horn illuminating the lens is shown in Figure 3.

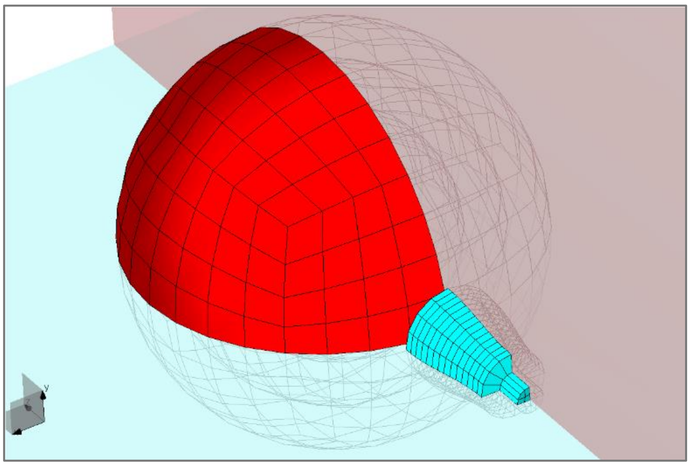

Figure 1. Luneburg lens and corrugated horn

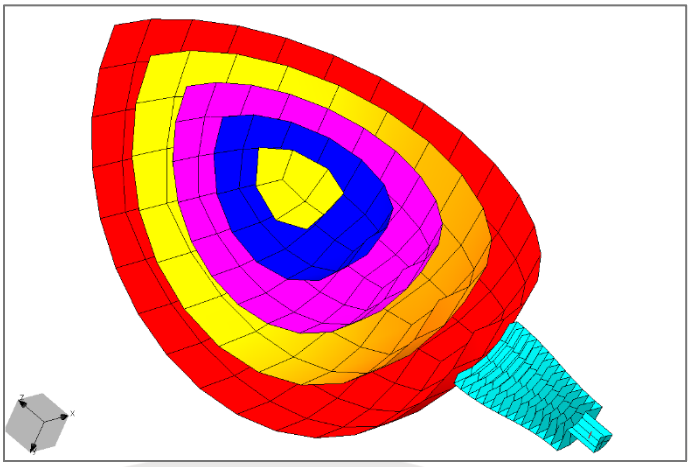

Figure 2. Dielectric layers within the Luneburg lens and the corrugated horn

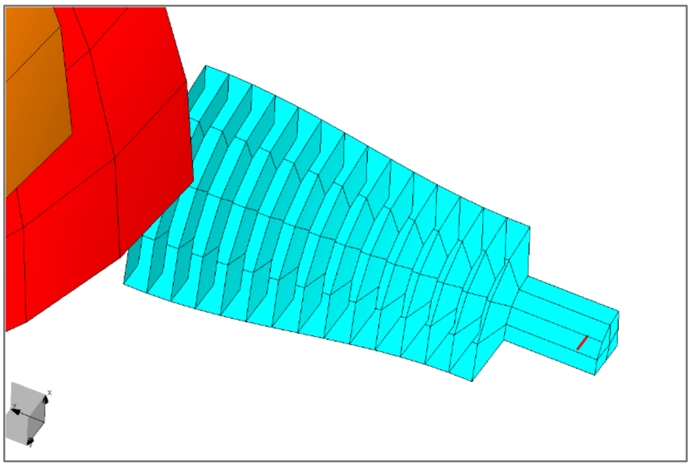

Figure 3. Corrugated horn antenna

Results and Simulations

Although the application note is focused on the Luneburg lens, two models were simulated at 1.414 GHz. The first model is corrugated horn only. The second model is Luneburg lens illuminated by corrugated horn.

After completing process of convergence check, relevant output results are presented. Radiation pattern of corrugated horn and radiation pattern of Luneburg lens illuminated by corrugated horn and compared in the Figure 4.

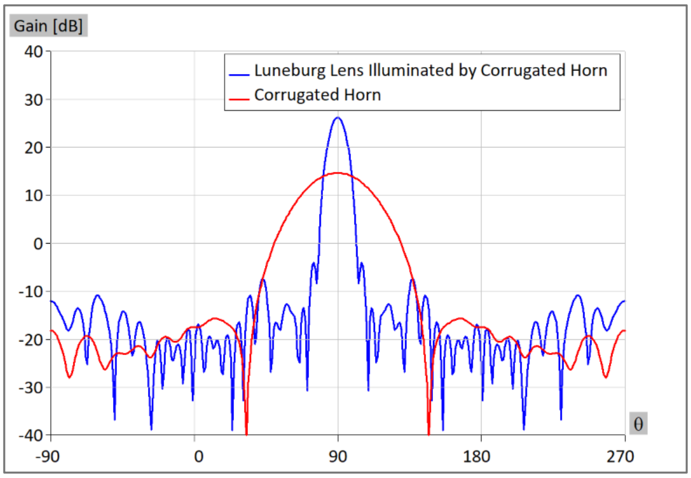

Figure 4. Radiation patterns

Furthermore, 3D radiation pattern and near field distribution obtained after simulation of Luneburg lens illuminated by horn antenna are shown in Figure 5 and Figure 6, respectively.

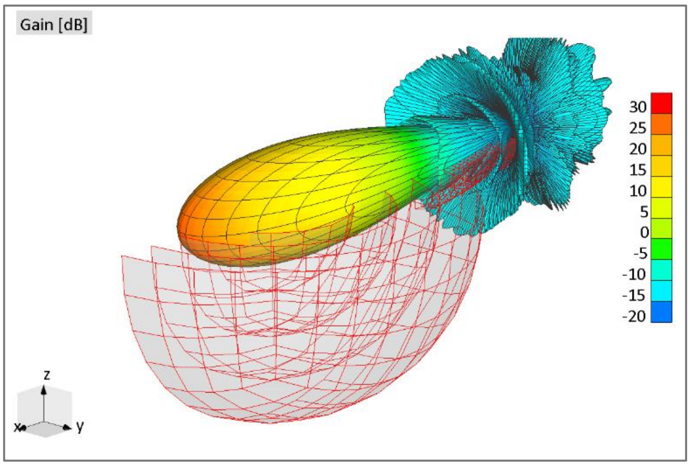

Figure 5. 3D radiation pattern

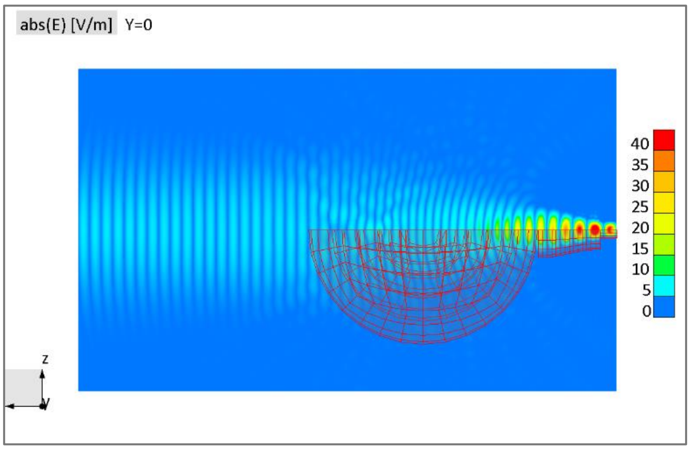

Figure 6. Near field distribution

Computer used for these simulations is inexpensive desktop PC based on Intel® Core(TM) i7-7700 CPU @3.60 GHz, with single low-end GPU card NVIDIA GeForce GTX 1080.

Number of unknowns, computer memory required for simulation of Luneburg lens with the horn antenna and the simulation times are presented in Table 1.

Simulation time mainly consists of computer time necessary for matrix fill-in, computer time necessary for matrix solution and computer time spent in calculating output results (here, 2D radiation pattern).

Luneburg lens illuminated by corrugated horn was simulated using two computational scenarios. In the first one, all operations are performed on CPU (e.g. matrix fill, matrix inversion…). Total simulation time for this scenario is presented in Table 1, in the third column (under the name *CPU matrix inversion.*). In the second scenario, all operations except matrix inversion are performed on CPU. Matrix inversion was performed by using GPU card and WIPL-D add-on tool named GPU Solver. Total simulation time required when using GPU Solver is presented in the fourth column under the name *GPU matrix inversion*.

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

Number of unknowns	Memory [GB]	CPU matrix inversion. Total Simulation time[sec]	GPU matrix inversion. Total Simulation time [sec]
17,174	2.20	55.75	26.08

Conclusion

The model of Luneburg lens illuminated by corrugated horn antenna was created and simulated using WIPL-D Pro. The simulation comprised two computational scenarios. In the first scenario CPU was used for matrix inversion. In the second scenario GPU card and WIPL-D add-on tool named GPU solver were used for matrix inversion. In both scenarios, the rest of operations were performed on CPU. The simulations in both scenarios were performed very fast. Especially, with this number of unknowns required and this GPU card, simulation with matrix inversion at GPU card was finished significantly faster. In addition, all models were simulated after applying two symmetry planes which initially reduced number of unknowns.

Presented results (Figures 4-6) indicate that the output results were calculated accurately and that they coincide with theory – the focusing effect of lens usage is clearly seen in these figures.