Corrugated Horn in WIPL-D Pro Software

The motivation behind this work is to showcase a **user-friendly and effective modelling** of corrugated horn antennas with radial corrugation implemented in WIPL-D Pro software. The modeling and performance of corrugated horn antenna will be introduced using a model of a circular horn antenna. Radiation pattern results will be presented and antenna parameters required for efficient modeling explained. All simulations and the modelling will be carried out using **WIPL-D Software**, **a full wave 3D electromagnetic Method-of-Moments based software which applies Surface Integral Equations.**

WIPL-D Models

The circular horn antenna model is shown in Figure 1. Corresponding corrugated horn antenna with cross-section arranged to expose the interior of the antenna where the corrugation details are easily identified is shown in Figure 2.
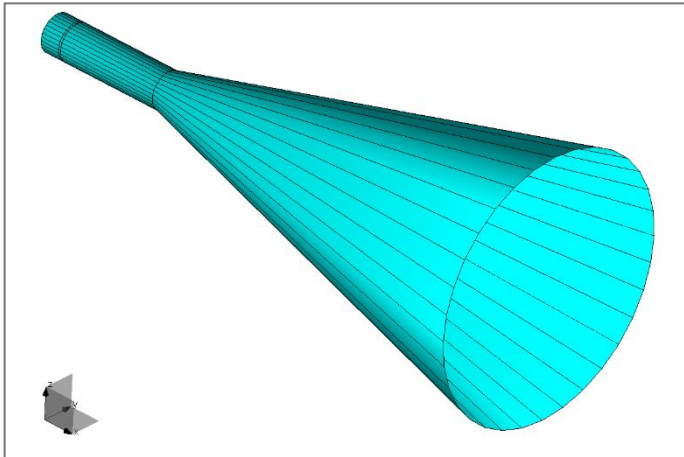

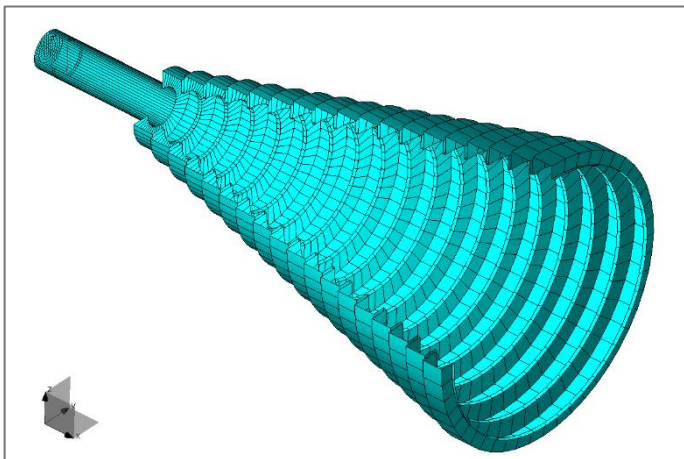**Figure 1. Circular horn antenna**

Figure 2. Cross section of the corrugated horn antenna

Both of the models from Figures 1-2 were simulated using two-fold symmetry to reduce the problem size, i.e. only the quarter of the structure is simulated to reduce the number of unknowns and speed up the simulations.

In WIPL-D Pro the quarter of the corrugated horn can be easily created using a built-in object named *Body of Connected Generatrices*. The parameters required should be entered in a dialog window, as shown in upper part of Figure 3. The model of the corrugation resulting from the particular choice appearing within the WIPL-D Pro Preview window is shown in lower part of Figure 3.
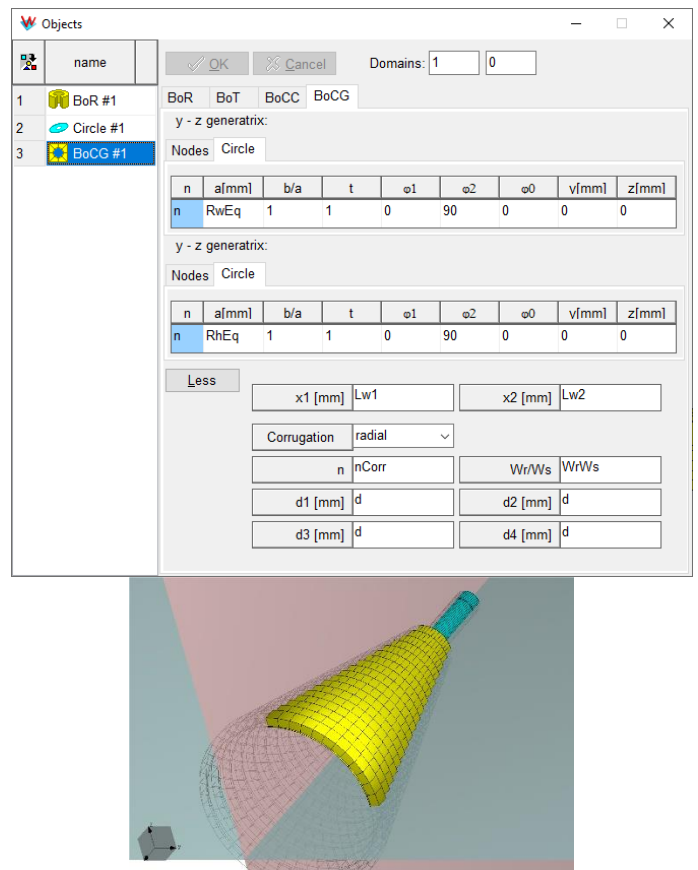

Figure 3. *Body of Connected Generatrices* **WIPL-D Pro built in object defining antenna corrugations and its representation within WIPL-D Pro Preview window**

The parameters user should enter to define the corrugated horn when using WIPL-D Pro built-in object are two generatrices and parameters of corrugation. For the particular example presented in Figure 3, majority of the **parameters are defined using symbols**.

The relation between dimensions of the corrugations and symbols entered in a dialog window presented in Figure 3 are illustrated using Figures 4-5. Letter 'k' in Figure 5 denotes constant which depends on the dimensions of the horn, while "nCorr" represents number of corrugations.
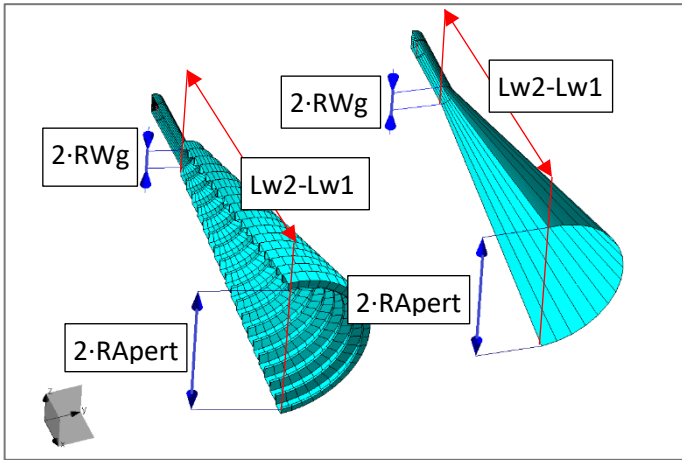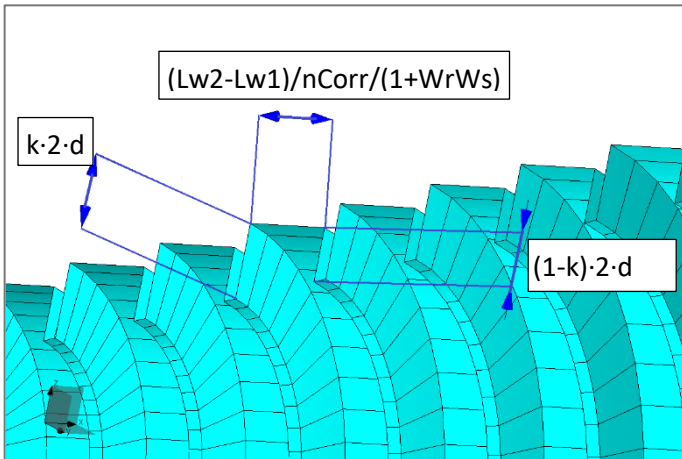
Figure 4. Dimensions of the antennas

Figure 5. Dimensions of the corrugations

Simulations and Results

Both antennas were simulated at 10 GHz. The radiation pattern results were calculated in 361 directions in xOy plane. The results of the simulations of circular horn antenna and appropriate corrugated circular horn antenna are compared in Figure 6. Computer hardware used for simulations is presented in Table 1.

Table 1. Computer used for the simulations.

Hardware	Description
CPU	Intel® Core™ i7-7700 CPU @ 3.60GHz 3.60 GHz
RAM	64 GB

Number of elements, number of unknowns, and total simulation time required for simulation of the models are presented in Table 2.
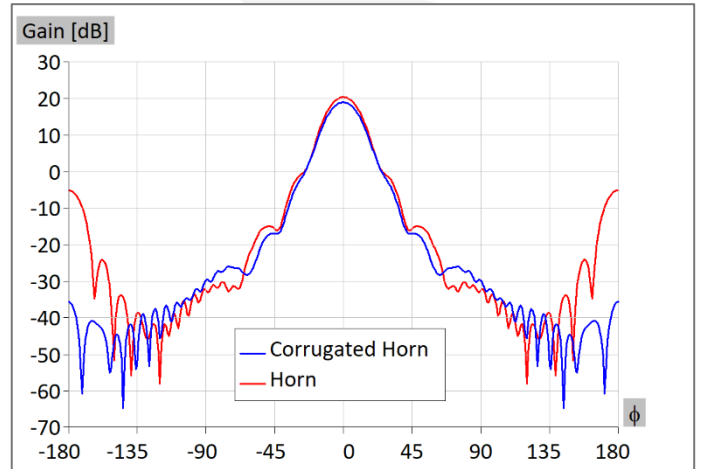

Figure 6. Comparison of antenna radiation patterns

Table 2. Number of elements, number of unknowns, and total simulation times for simulated antennas

Models	Number of elements	Number of unknowns	Total simulation time [sec]
Horn	594	3,267	6.01
Corrugated Horn	12,665	23,522	323.21

Conclusion

In this application note we compared simulated radiation pattern results for circular horn antenna and corresponding **corrugated horn antenna**. Also, we shortly outlined basic modelling of corrugated horn antenna with radial corrugations using **WIPL-D Pro built-in object** *Body of Connected Generatrices*.

All the simulations with the modelling were carried out using **WIPL-D Software**, **a full wave 3D electromagnetic Method-of-Moments based software** which applies Surface Integral Equations.

It was highlighted that **corrugated horn antenna can be created efficiently** combining WIPL-D Pro **built-in object** *Body of Connected Generatrices* and **WIPL-D symbolic mechanism**. The **results clearly show** that with corrugated horn antenna the level of back lobes is significantly lower. All of the simulations were carried out with **high numerical efficiency resulting in short simulation times** even when a standard workstation is used for simulation.