Open-End Waveguide Array Antenna

Introduction

WIPL-D Pro 3D EM solver is state of the art Method of Moments based full wave solver. It is well known for its ability to quickly solve EM structures of electrically moderate or large size.

One of the most important advantages of WIPL-D kernel is the fact it uses quadrilateral mesh, unlike majority of other EM software which uses triangular meshing elements. Using an all-quad mesh instead of a triangular one brings the benefit of halving the number of unknowns for the problem of the same size. This means decreasing the memory requirements 4 times, and speeding-up simulation 8 times (in case of a direct, LU-decomposition type linear system solver).

In addition to quad mesh elements, WIPL-D uses higher order basis functions (HOBFs), up to 8th order. This enables usage of very large mesh elements of size up to 2 wavelengths by 2 wavelengths. Accordingly, WIPL-D can use very large mesh elements over flat or smooth model parts and small mesh elements over the tiny and/or curved model parts. Besides, the program allows many additional features to further decrease number of unknowns keeping the high accuracy unaffected, which leads to even less demanding EM simulation. One of the typical features is application of symmetry planes. Typically, when compared with other EM software packages, WIPL-D number of unknowns is 3-10 smaller. Finally, WIPL-D offers very efficient CPU and GPU simulation on inexpensive hardware platforms.

EM Model Description

The device under simulation is a waveguide antenna comprising from larger number of waveguides with elliptic cross section and varying length.
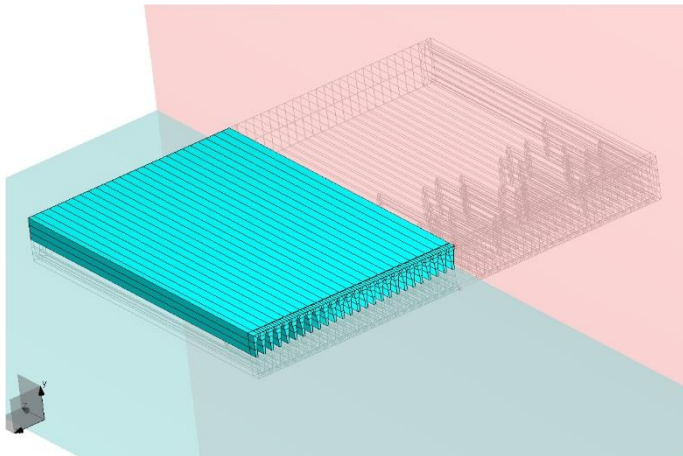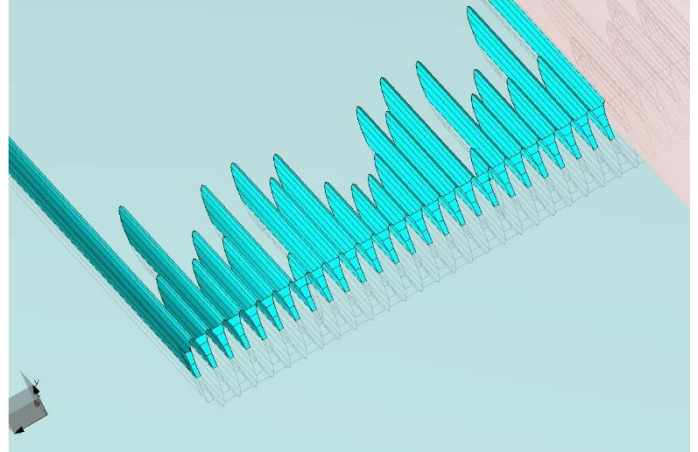

Figure 1 Exterior of the device

Figure 2 Interior of the device

The structure can be created simply (because of its regular geometry) by using built-in objects and defined parametrically so that it can be later tuned or optimized. Due to the obvious symmetry of the geometry, two symmetry planes can be applied which reduces requirements and simulation time.

The first simulation is carried away as RCS simulation. The structure is illuminated by a plain wave coming directly (under 90 degrees angle) into the apertures of elliptic waveguides. The response is shown in Figure 3.
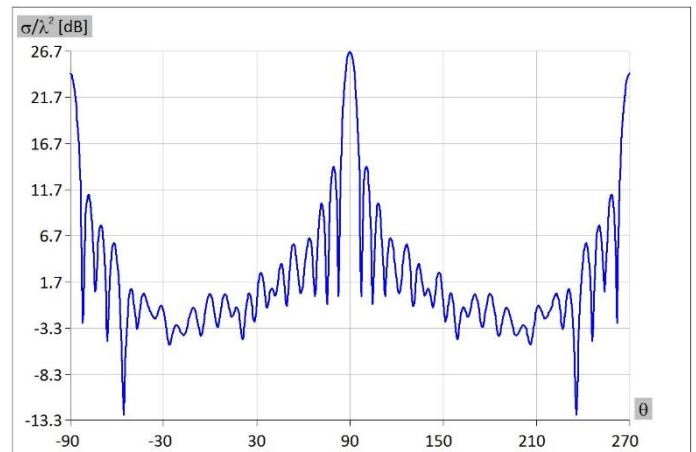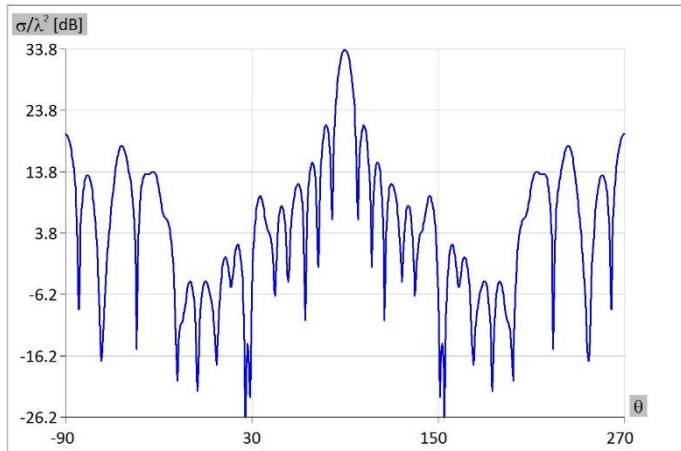
Figure 3 RCS of the waveguide antenna

The simulation is carried out fast and easy, since it has very low requirements. The EM model requires **5,946 unknowns** and it can be simulated at any desktop PC or laptop. The simulation is carried out on a quad core CPU:

Intel i7-7700K@3.60 GHz

The simulation lasts around 17 sec.

Next simulation is carried out in antenna mode. The central waveguide is excited while the last two waveguides are matched. The radiation pattern in two principle planes is shown in Figure 4.
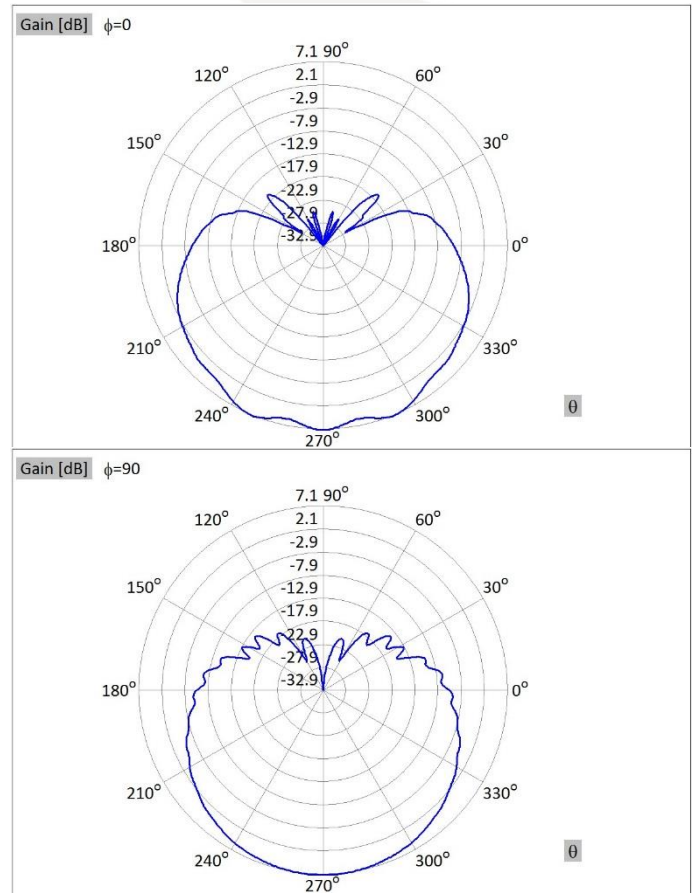

Figure 4 Radiation from the central waveguide element

Conclusion

WIPL-D Pro offers easy parametric modelling and fast simulation of waveguide structures in general. The abilities of the tool are demonstrated for simulation of the waveguide antenna with large number of waveguide elements. Simulations are carried out on every day work PC, without the need for using any expensive hardware. Simulations typically last around 15 seconds per frequency point.

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