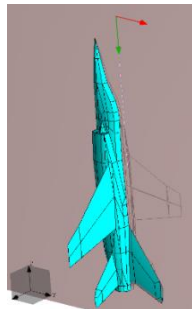


Benchmark Examples (2)

This application note represents an addition to the document *Benchmark Examples (1)*. However, it can be read without previous reading *Benchmark Examples (1)*. Similar as in *Benchmark Examples (1)*, various benchmark examples are created and simulated in order to present WIPL-D Pro capabilities. WIPL-D Pro remains full wave 3D EM solver, based on **Method-of-Moments (MoM)** which is empowered with **quadrilateral mesh** and **higher-order basis functions (HOBFs)**. All the presented models should be considered as demonstrational models. It is expected that the **output results** and **relatively short simulation times** will be in the focus of the reader of this document. Presented simulation times mainly consist of time necessary for matrix fill in, matrix inversion and time necessary for processing output results. Computer used for the simulations is Intel® Core™ i7-7700 CPU@3.60 GHz.

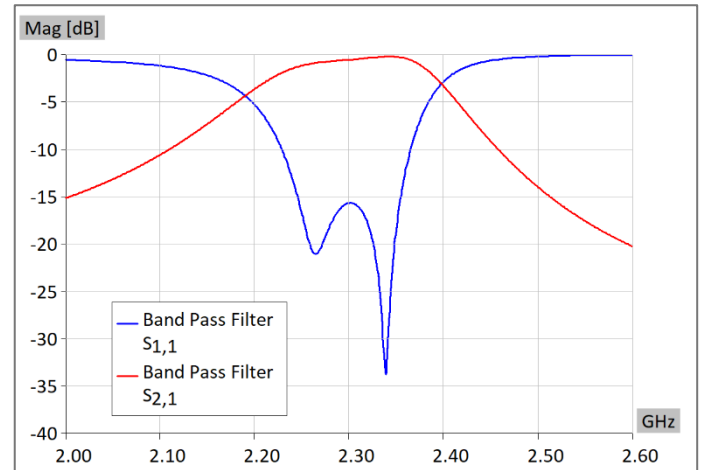
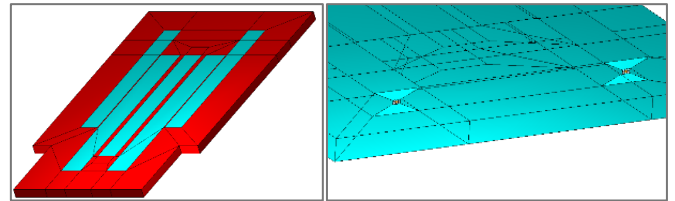
Fighter Plane RCS

A model of approximately 12 m long a fighter airplane was simulated using WIPL-D Pro. The model is shown in the following figure. The aircraft is illuminated with EM plane wave. Bistatic scattering is calculated at 0.3 GHz at $1 \times 721 = 721$ points. One symmetry plane was applied, so only half of the model was simulated.

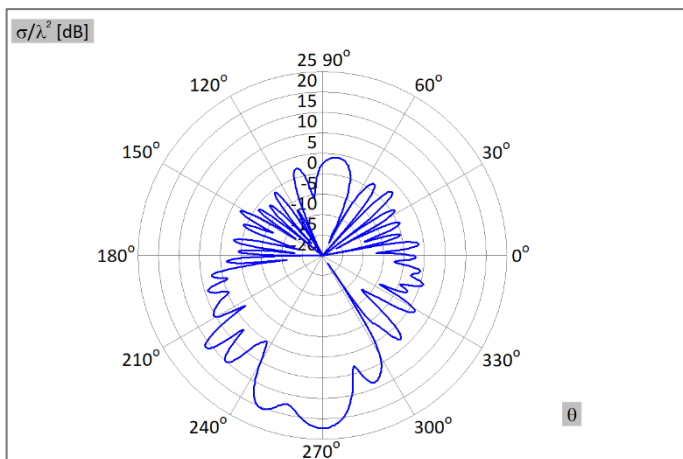


computer memory required, simulation time per frequency, and graphical representation of S-parameters shown.

Number of unknowns	Computer memory required [MB]	Simulation time per frequency [sec]
2,149	35	8



Number of unknowns	Computer memory required	Simulation time
2,739	57.2 MB	4.5 sec

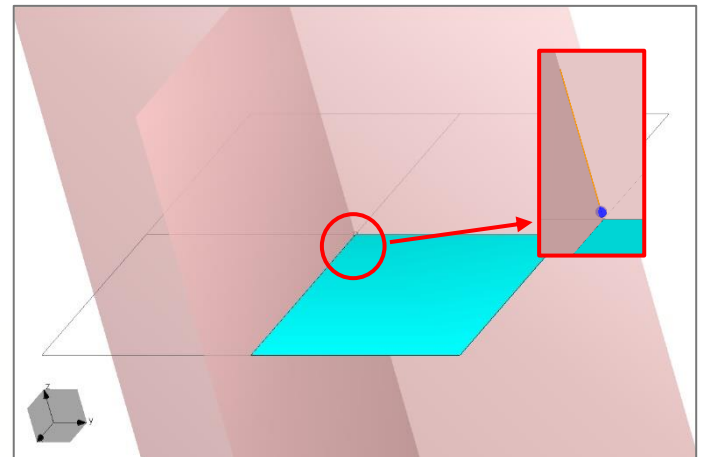


Band Pass Filter

The model of the microstrip band pass filter is presented and simulated. In addition, two feeding areas are also presented. The band pass filter was printed on the substrate with thickness of 1.524 mm and relative dielectric permittivity of 3.38. The project was simulated at 15 frequency points. Number of unknowns,

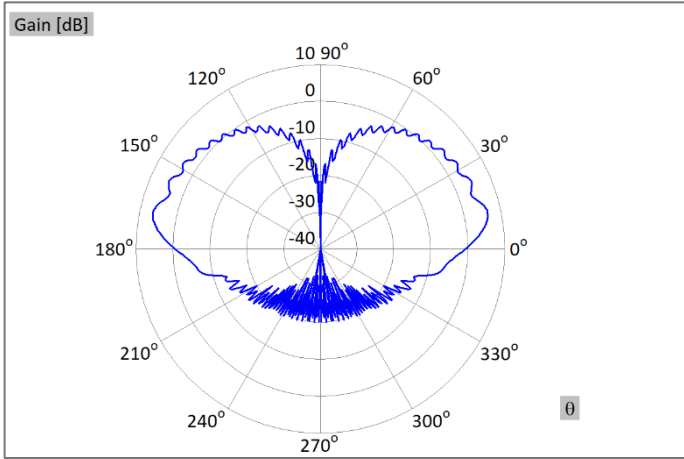
Monopole Antenna on a Square Plate

The model of a monopole antenna on a square plate was simulated. The model was created after applying two symmetry planes. The monopole antenna represents a quarter-wave monopole at 300 MHz. The edge of the square plate is 30 m (30 wavelengths) long.



The radiation pattern was calculated in phi cut at 451 points.

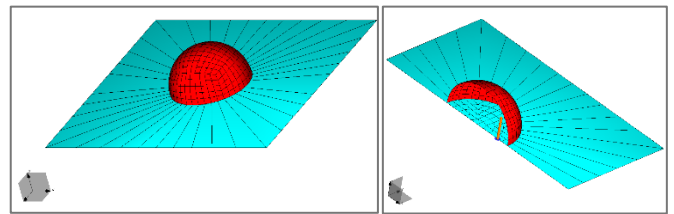
Number of unknowns	Computer memory required [MB]	Simulation time [sec]
5,839	260	5.6



Hemispherical Dielectric Antenna

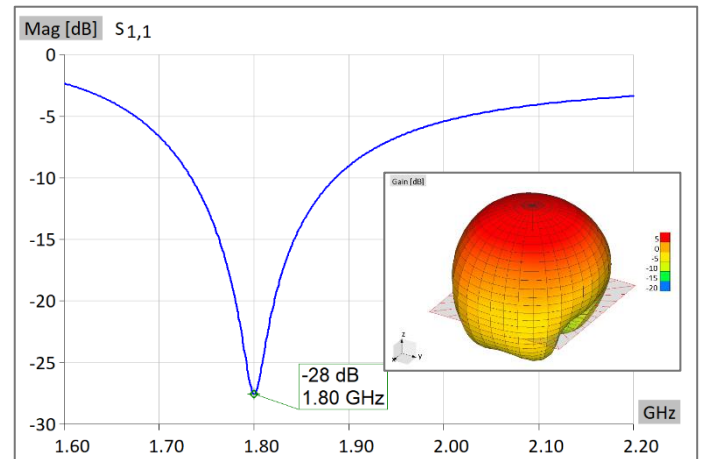
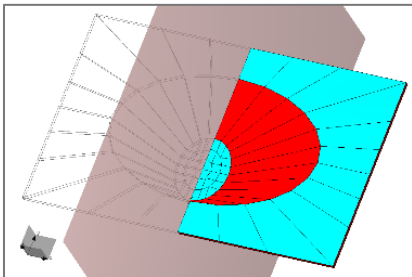
Full model of monopole antenna covered with hemispherical dielectric was simulated. In order to show the interior of the structure, the half of the model was shown. Used dielectric is with relative dielectric permittivity of 8.9. The antenna was simulated at 19 frequency points. The radiation pattern was calculated for 1.8 GHz.

Number of unknowns	Computer memory required [MB]	Simulation time per frequency [sec]
1,762	24	1.5



Ultra-Wideband Elliptical Antenna

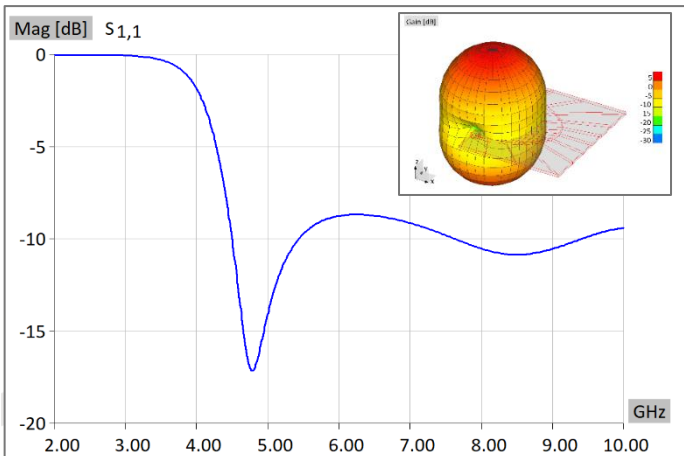
The model of the ultra-wideband elliptical antenna was simulated. A symmetry plane was utilized - thus, only half of the model was simulated. The substrate used in the model of the antenna is with thickness of 0.381 mm and relative dielectric permittivity of 9.1. The antenna was simulated at 11 frequency points. Number of unknowns, computer memory required, simulation time per frequency, graphical representation of S-parameters, and 3D radiation pattern at 6 GHz are also presented.



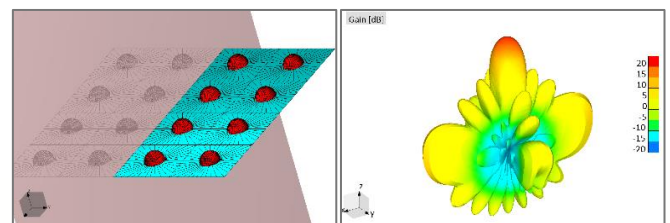
Hemispherical Dielectric Antenna (Arrays)

4x4 array of monopole antenna covered with hemispherical dielectric was simulated. One symmetry plane was utilized. Simulation time encompasses calculation of 3D radiation pattern at 1.8 GHz.

Number of unknowns	Computer memory required [MB]	Simulation time per frequency [sec]
2,096	34	3.5



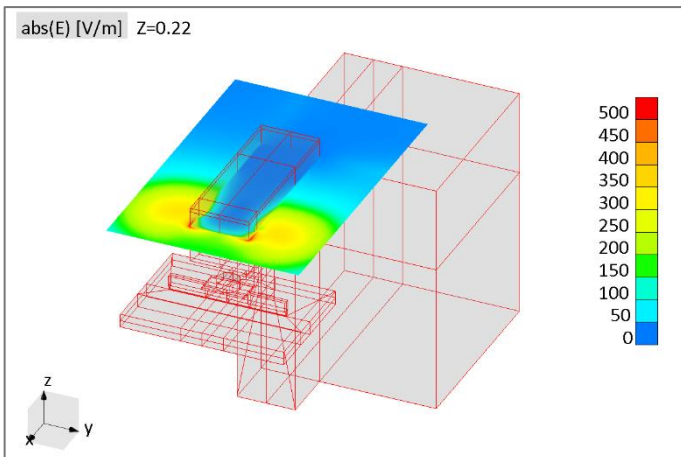
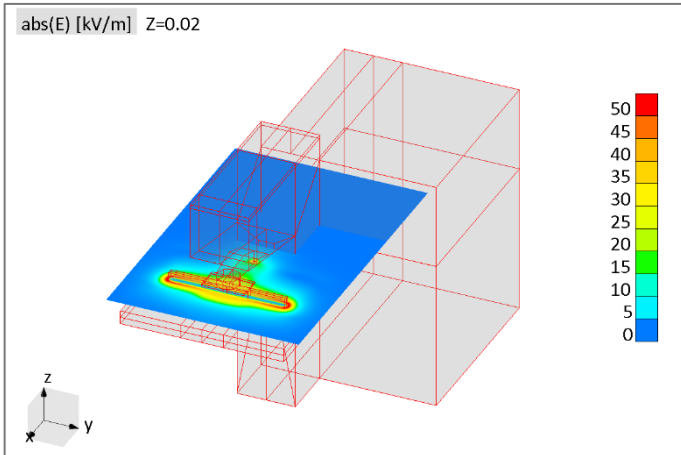
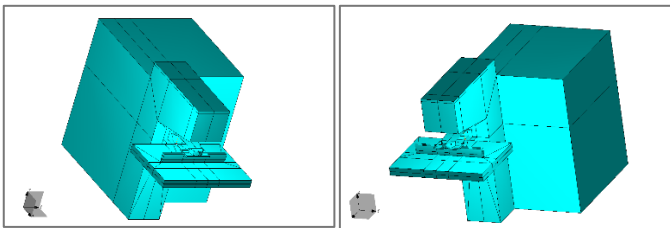
Number of unknowns	Computer memory required [MB]	Total simulation time [sec]
14,196	1,538	181



Welder Machine

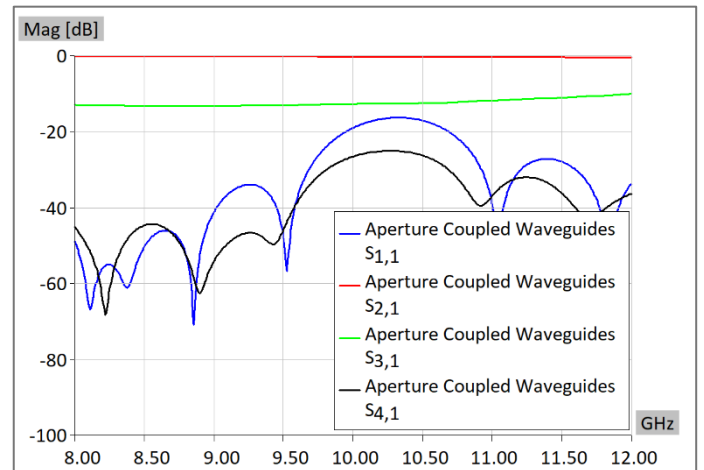
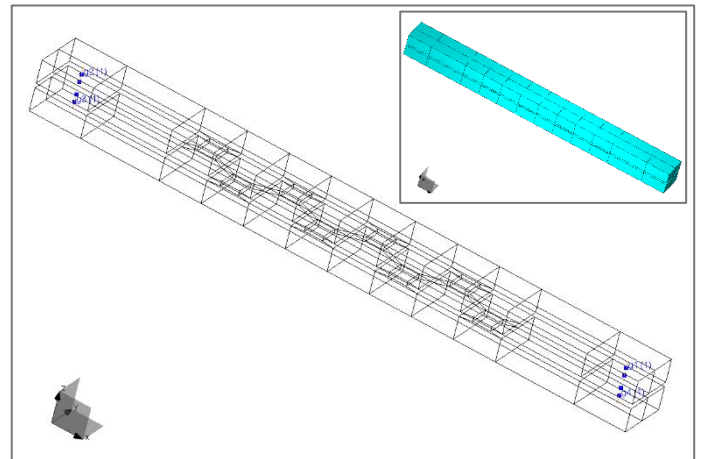
A model of Welder machine was created and simulated using WIPL-D Pro. Near field distribution is calculated at 2 planes, at totally $150 \times 100 \times 2 = 30,000$ points. Welder machine, the output results, number of unknowns, computer memory required and total simulation time are presented below.

Number of unknowns	Computer memory required [MB]	Total simulation time [sec]
1,348	14	3.2



shown below. Also, the number of unknowns, computer memory required, and simulation time per frequency are presented in the table, below. Simulation time per frequency is presented for coupled waveguides, only. Simulation time of the feeder (which is required for *de-embedding*) is considered to be small and it is not published in this application.

Number of unknowns	Computer memory required [MB]	Simulation time per frequency – aperture coupled waveguides[sec]
5,068	196	8



Aperture Coupled Waveguides

A model of the aperture coupled waveguides was created and simulated using WIPL-D Pro. The simulation of the model required usage of WIPL-D Pro *de-embedding* feature. The structure, the interior of the structure, and S-parameters are