Wire Reflectors

Simulation of reflector antennas can be very challenging for MoM codes. Despite that, WIPL-D Software, as MoM code based on SIE, appears to be very suitable and efficient tool used for simulating reflector antennas.

Reflector, as part of the reflector antenna, is usually made of metallic surface (further, plate reflector). However, it also can be made of relatively thin wires (further, wire reflector).

In this application note, the two mentioned types of reflector will be analyzed. First of all, horn antenna (which will be used as a feeder) will be simulated. After that, simulation of the plate reflector illuminated with the horn will be performed. Also, two wire reflectors with different wire radii, illuminated with the horn will be simulated. Final step will be comparing the obtained results.

In order to reduce the simulation time and amount of occupied computer memory, two symmetry planes will be used in the simulation of each model. Operating frequency will be set to 10.85 GHz.

Horn Antenna

Model of the horn antenna used as feeder is shown in Figure 1.

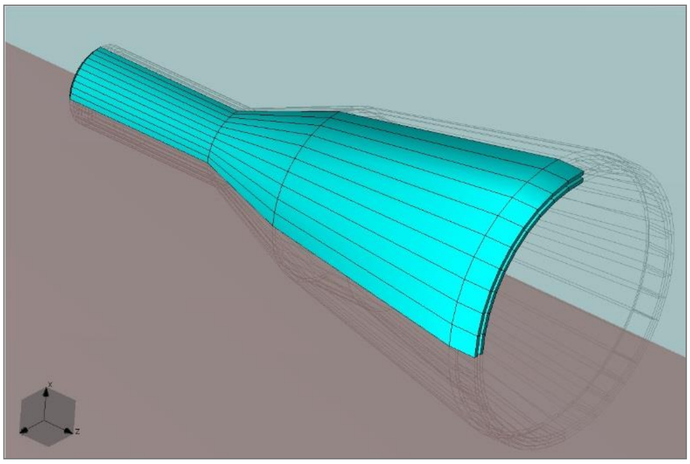

Figure 1. Horn antenna used as feeder.

Convergence of the radiation pattern results was tested with increasing number of unknowns, modifying mesh of the model and increasing Integral accuracy parameter. After the convergence of the results is reached, radiation pattern of the horn is shown in Figure 2. Two cuts are presented: phi = 0 [Degrees] cut and phi = 90 [Degrees] cut.

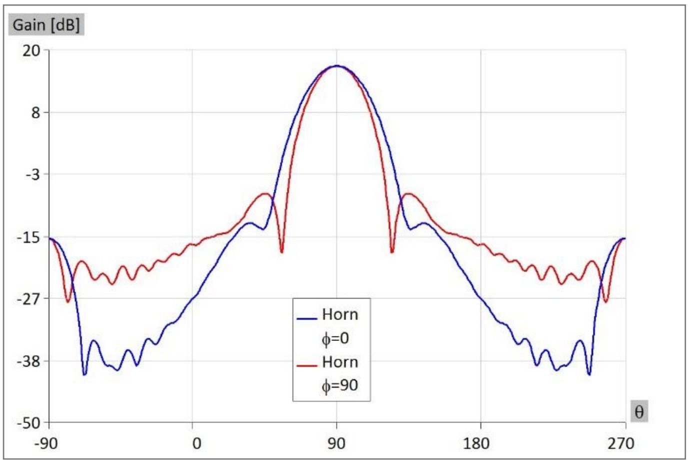

Figure 2. Radiation pattern of the horn antenna in two cuts.

Reflectors

The first reflector antenna which will be simulated consists of the horn and the plate reflector. Diameter of the reflector is about 57.9 wavelengths. After applying convergence tests on the radiation pattern results, model of the plate reflector with 44 plate segments per quarter of circumference was chosen to be used. The entire antenna is shown in Figure 3. Presented models in Figure 3 and Figure 4 differ from the simulated models because of achieving better preview.

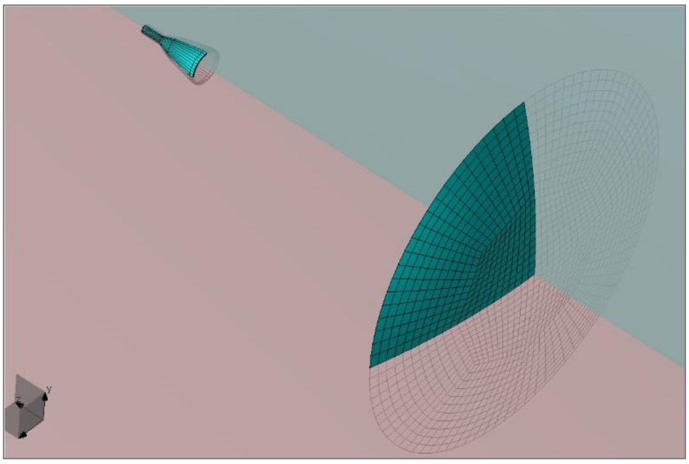

Figure 3. Horn antenna illuminating plate reflector

Antennas with the other reflector (with wire reflector) were modeled using small, C language, application. Two wire reflectors were made according to the plate reflector (Figure 3). Actually, edges of the plates creating plate reflector are utilized for positioning wires. In the first wire reflector, wire radius is set to 1 mm. In the second wire reflector, wire radius is set to 1.5 mm. The other dimensions (e.g. reflector radius and focal distance) of both wire reflectors are the same as the dimensions of the plate reflector.

Horn antenna illuminating wire reflector with wire radii of 1 mm is shown in Figure 4.

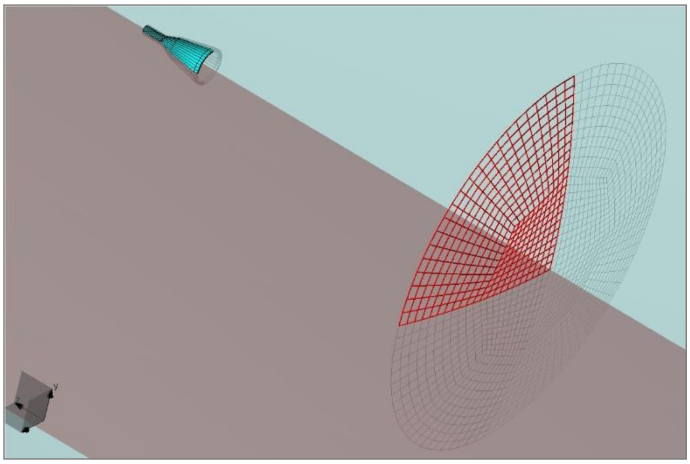

Figure 4. Horn antenna illuminating wire reflector.

Results

Radiation pattern results after simulating the plate reflector and two wire reflectors are obtained using WIPL-D. These are compared and shown in Figures 5-6. Radiation pattern in phi = 0 [Degrees] cut is shown in Figure 5. Markers are used in order to highlight front (main) radiation lobes and back radiation lobes (see also Table 1).

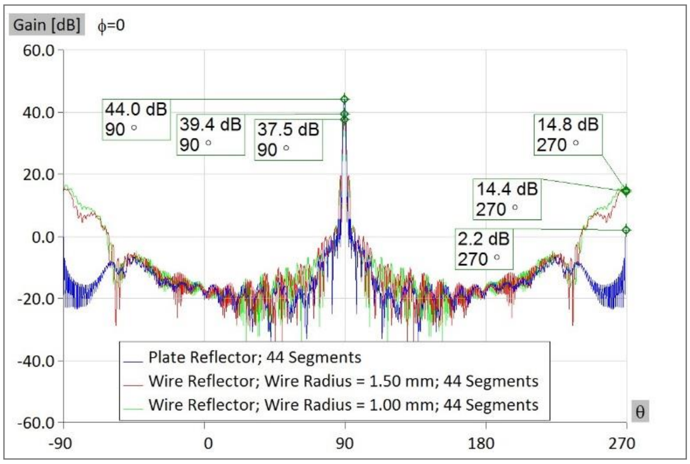

Figure 5. Radiation pattern in phi = 0 [Degrees] cut.

Table 1. Level of front (main) lobe and back lobe in dB for three simulated reflectors.

Model	*Front (main) lobe [dB]*	*Back lobe [dB]*
Horn with plate reflector	44.0	2.2
Horn with wire reflector. Wire radius = 1.50 mm	39.4	14.8
Horn with wire reflector. Wire radius = 1.00 mm	37.5	14.4

Radiation pattern result for phi = 90 [Degrees] cut is shown in Figure 6, while radiation in the vicinity of main lobe for phi = 90 [Degrees] is shown in Figure 7.

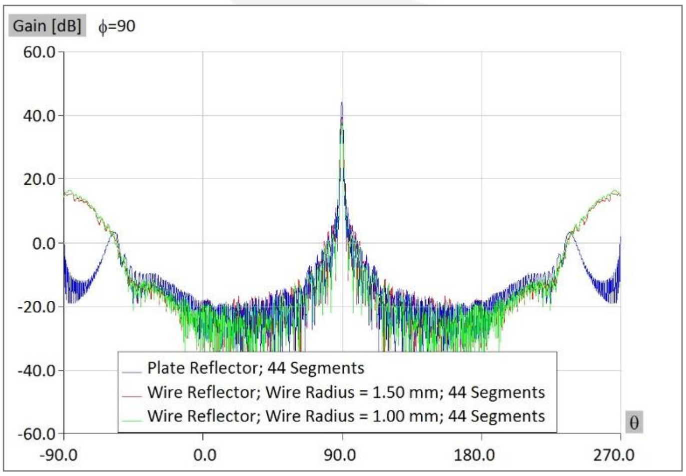

Figure 6. Radiation pattern in phi = 90 [Degrees] cut.

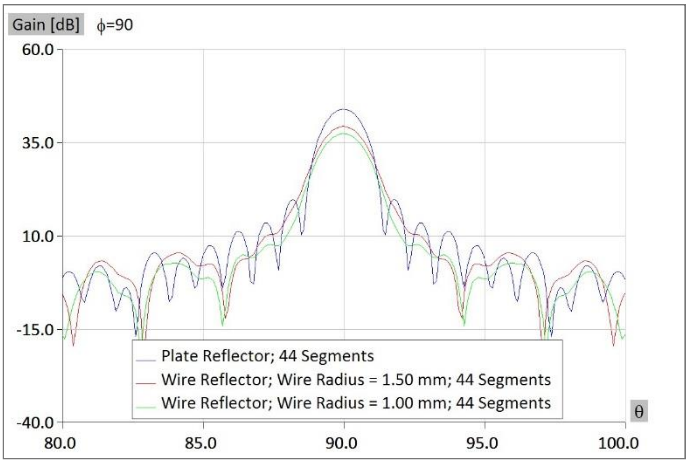

Figure 7. Radiation in the vicinity of main lobe in phi = 90 [Degrees] cut.

Simulations

Computer used for these simulations is inexpensive desktop: Intel® Core™ i7-7700 CPU @3.6 GHz. The matrix inversion phase for the electrically largest problem (plate reflector) was speeded up by GPU solver and low-end NVIDIA GeForce GTX 1080. CPU is used for matrix fill-in and calculation of radiation pattern. Simulation parameters are presented in Table 2.

Table 2. Number of elements, number of unknowns, RAM memory and simulation time for all simulated models.

Model	*Number of elements*	*Number of unknowns*	*Memory [GB]*	*Simulation time [sec]*
Horn	1,142	2,592	0.05	3
Horn with plate reflector	6,950	22,854	3.89	70*
Horn with wire reflector; Wire radius = 1.50 mm	12,846	15,832	1.87	72
Horn with Wire Reflector; Wire radius = 1.00 mm	12,846	15,832	1.87	72

*matrix inversion by WIPL-D GPU solver