Microstrip Array Antenna

Microstrip antennas are used in applications where size, weight, cost and ease of installation are required. These antennas are low-profile and conformable to both planar and non-planar surfaces. Antenna characteristics are also dependent of dielectric parameters.

Antenna arrays are used because of achieving good antenna gain. Usually they have changeably radiation pattern. Antenna arrays are more sophisticated for numerical analysis than single element antenna.

Theoretical Performances

Main characteristic of microstrip array antennas is

- Good directivity

The larger number of antenna elements, the better gain of antenna array is achieved.

One model of microstrip array antenna is simulated in WIPL-D (Fig. 1).

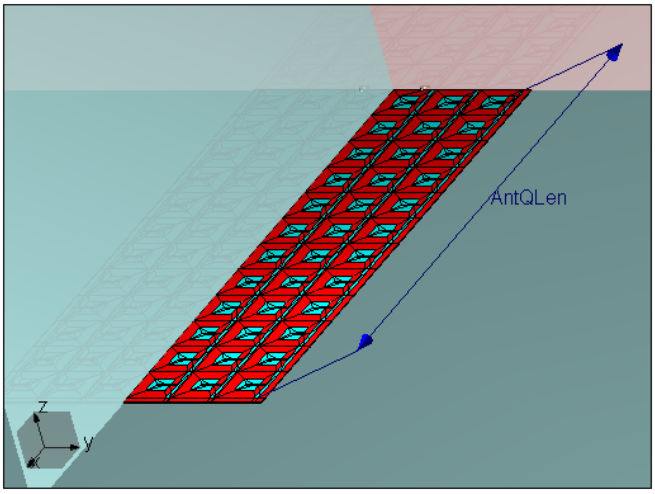

Figure 1. Quarter of microstrip array antenna

Analyzed microstrip array antenna consists of 144 elements. Single element is shown on Fig. 2. This antenna is predicted to be used in anti-collision radar application.

We will focus on only one parameter

- Length of quarter model of antenna (AntQLen)

Because of elements set-up, we can estimate that width of array is approximately four times less than length.

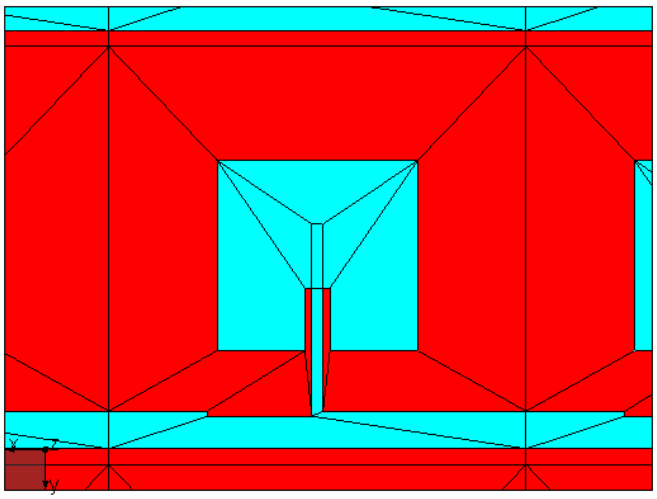

Figure 2. Element of microstrip array

WIPL-D Calculation

In WIPL-D software antenna arrays can be designed using built in features. Microstrip array antenna shown on Fig. 1, can be modeled in several ways because of diminishing simulation time and number of unknowns. One can use WIPL-D feature (Anti-) Symmetry and Object/Copy, so in this problem only quarter of given antenna is easy modeled (Fig. 1). Metallic parts are considered to be perfectly conducting.

Operating frequency is 24.2 GHz, what means that free space frequency is 12.4mm. Dielectric parameters are:

- $\varepsilon_r = 2.2 + j \cdot 0$
- $\mu_r = 1 + j \cdot 0$

For parameters given in Tab. 1, we will calculate gain. Computer used for these calculations is Intel® Core(TM) i7 CPU 950 @3.07 GHz, 8GB RAM, 1 GPU card Nvidia GeForce GTX 470.

Table 1. Parameter of analysis

Parameter	Value [mm]	Value [multiplication wavelength]
AntQLen	107.8	~9

Radiation pattern in 3D is shown on Fig. 3 and phi-cut, where phi=0, of radiation pattern is shown on Fig. 4.

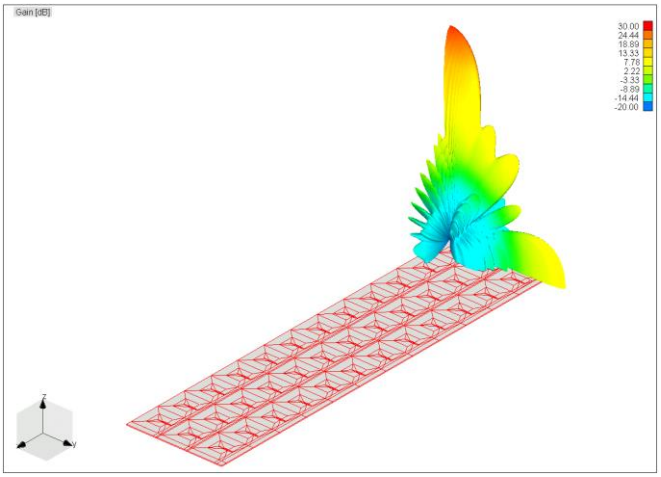

Figure 3. Radiation pattern with antenna array

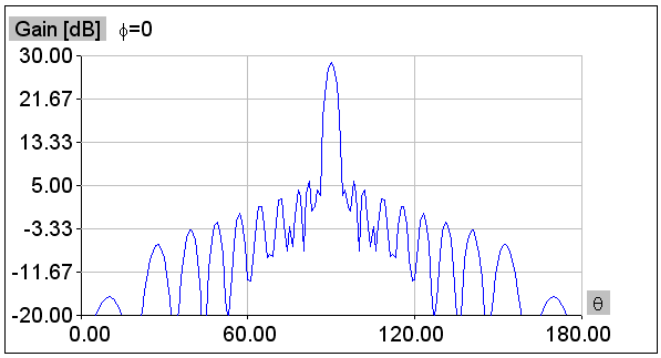

Figure 4. Radiation pattern, phi-cut

Number of unknowns and simulation time of analysis are given in Tab. 2.

Table 2. Analysis characteristics

Model	No. of unknowns	CPU Time @ 24.2 GHz [sec]	GPU Time @ 24.2 GHz [sec]
quarter	23705	1100	545

Conclusion

We saw that proper using of WIPL-D features (for example, Symmetry and Object features) enables easy designing of structure and calculation using only quarter of structure, which is very important during analysis of electrically big structures. That means, that we can get faster solution using little amount of memory.

Microstrip array antenna is sort of antenna usually analyzed using FEM. However, WIPL-D successfully analyses that antenna using MoM.