Microstrip Patch Antenna Array

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 in order to achieve higher gain. The larger number of antenna elements, the better gain of antenna array is achieved. Antenna arrays are more demanding for EM simulation than single element antennas due to their electrical size.

A model of a microstrip patch array is simulated in WIPL-D Pro (Fig. 1). Analyzed microstrip array consists of 144 elements. A single element is shown in Fig. 2. The feeding lines are also modeled. This antennas intended application is in anti-collision radars.

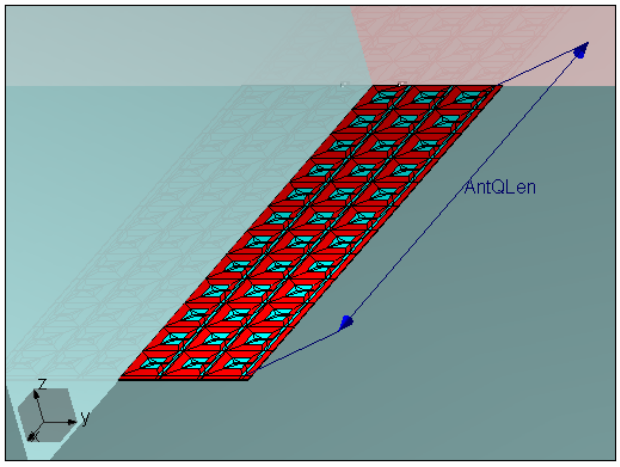

Figure 1. Quarter of microstrip patch array

We will focus on only one parameter to illustrate the electrical size of the array:

- length of quarter model of antenna (AntQLen)

The width of entire the array is approximately four times less than length.

WIPL-D Simulation

In WIPL-D Pro antenna arrays can be designed using convenient built in features. One can use *Copy* and *Move* manipulations to build just the basic array element and then easily extend it into an array. Also, (*Anti*-) *Symmetry* feature can be used to diminish memory requirements and simulation time, so in this case only a quarter of given antenna is needed (Fig. 1). Metallic parts are considered to be perfectly conducting.

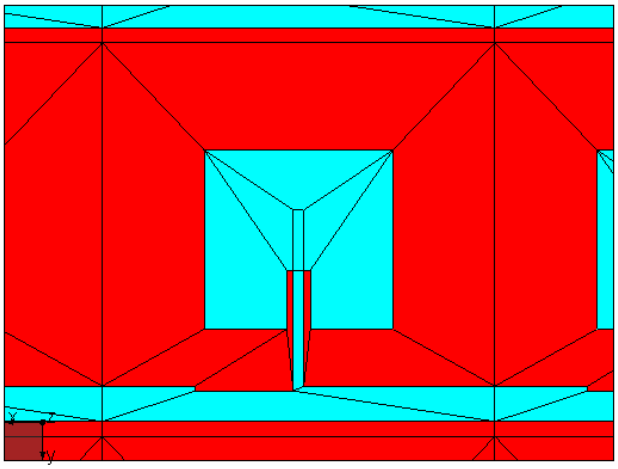

Figure 2. Element of microstrip array

Operating frequency is 24.2 GHz, which means that free space wavelength is 12.4 mm. 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. The array is about 18 λ by 4.5 λ at this operating frequency. Computer used for these calculations has two Intel® Core™2 Quad CPUs (8 cores in total) and 24 GB of RAM.

Table 1. Parameter of analysis

Parameter	Value [mm]	Value [number of wavelengths]
AntQLen	107.8	~ 9
Whole array length	215.6	~ 18

Radiation pattern in 3D is shown in Fig. 3 and its phi-cut, where *phi*=0, is shown in Fig. 4. Please note that the theta angle is measured with respect to the xOy plane.

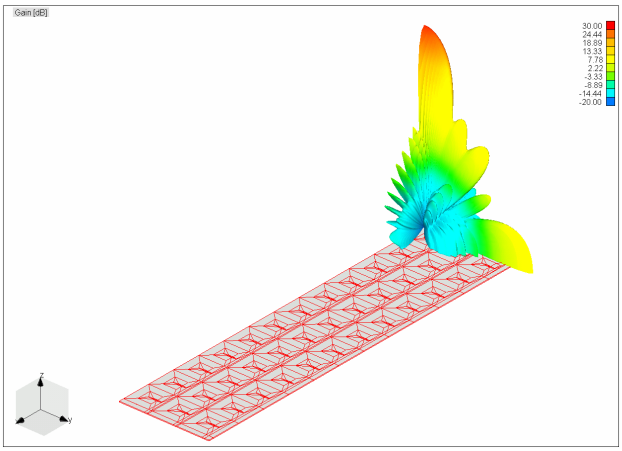

Figure 3. Radiation pattern with antenna array

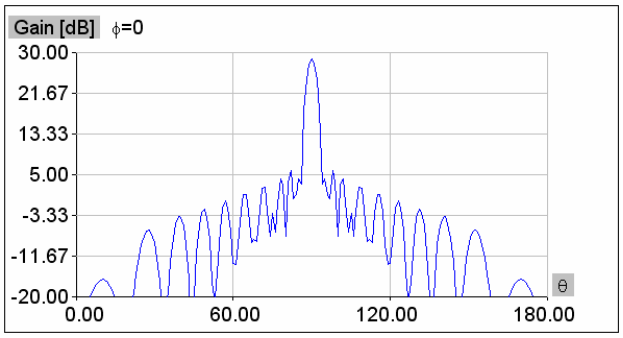

Figure 4. Radiation pattern, phi-cut

Number of unknowns, memory requirements, and simulation time are given in Tab. 2.

Table 2. Analysis characteristics

Model	No. of unknowns (memory [GB])	Time @ 24.2 GHz [min]
quarter	23705 (4.5)	20.2

Conclusion

We saw that usage of WIPL-D Pro advanced features such as *Symmetry* and *Copy/Move* enables easy modeling of structure and simulation using only a quarter of structure, which is very important for simulation of complex or electrically large structures.

This paper demonstrates that WIPL-D Pro is successfully used in simulation of large printed arrays, taking into account all the couplings between arrays elements. The model is simulated completely realistically (finite size), whereas many other competitor tools would require approximating this array as infinite (applying periodic boundary conditions) or simulating it element-by-element (neglecting coupling between elements).