Spiral Antenna

Helix antennas are found by scientist Krauss in 1946. Helix antenna is used in space applications, satellite systems, radar systems, TV signal transmission... Usually, it is manufactured as wire, coiled around dielectric cylinder. Helix antenna is structure, very difficult both for analysis and synthesis. One species of helix antenna is spiral antenna.

Theoretical Performances

Main characteristics of spiral antennas are

- Circular polarization,
- Broad-band,
- Poor directivity.

Models of duofilar spiral antennas are simulated in WIPL-D. One model is made of plates immersed in air (Fig. 1), while another model represents plates printed on dielectric (Fig. 2). Parameters of dielectric are:

- $\varepsilon_r = 2 + j \cdot 0$,
- $\mu_r = 1 + j \cdot 0$.

Both of models have reflector.

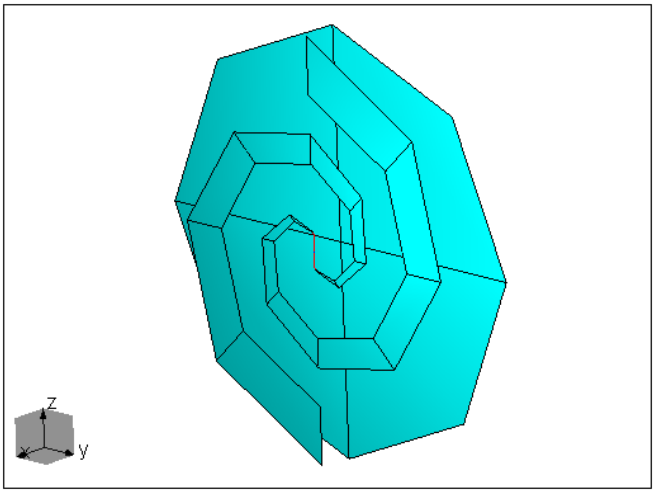

Figure 1. Spiral antenna

Dimensions of metallic radiating elements are the same. Difference exists only in added dielectric in second model.

Our aim is to compare simulation times and numbers of unknowns for these two models. We will observe antennas' gain starting from 1 GHz up to 5 GHz (D, E, F and G bands–NATO band classification).

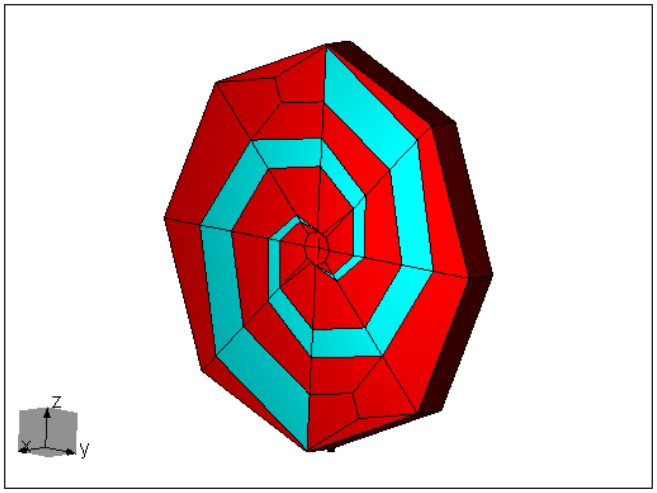

Figure 2. Spiral antenna printed on dielectric

WIPL-D Calculation

In WIPL-D software, spiral antennas can be designed using powerful built in feature Object/Helix. Antennas shown on Figs 1-2 can be also modeled "manually" what would makes design process very difficult.

We will calculate gain for each antenna and near field for plate model in vacuum. Computer used for these calculations is Intel® Core(TM) i7 CPU 950@3.07 GHz.

Frequency for calculation radiation pattern and near field is 3 GHz.

Radiation pattern of spiral antenna immersed in air, in 3D, is shown on Fig. 3. Overlaid 2D radiation patterns for main direction are shown on Fig. 4. Near field of model immersed in air is given on Fig. 5. Number of unknowns and simulation time of analysis are given in Tab. 1 and they are measured only for 3D radiation patterns calculations.

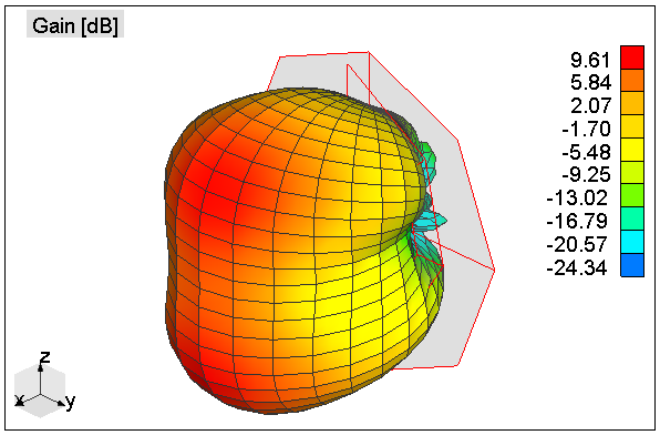

Figure 3. Radiation pattern of spiral antenna immersed in air

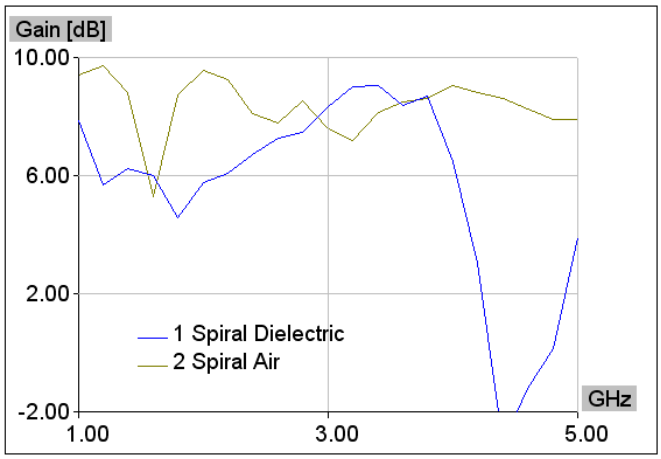

Figure 4. Overlaid gains for main radiation direction

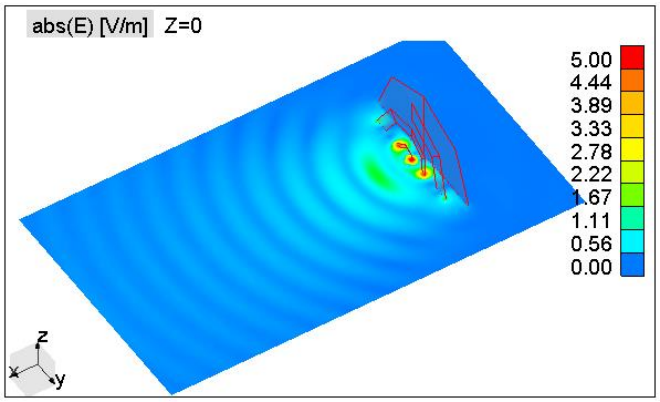

Figure 5. Near field of spiral antenna

Table 1. Analysis characteristics

Model	No. of unknowns	Time @ 3 GHz [sec]
Air	885	0.26
Dielectric	5817	14.4

Conclusion

As we have already said, plate helix antenna is structure very difficult both for analysis and synthesis. Using WIPL-D Object/Helix feature with Symbols feature, we can easy manipulate helicoidal structures.

We can see that great difference exist between gains of antenna immersed in vacuum and antenna printed on dielectric (Fig. 4). Reason for this is placement of dielectric in the second model. Dielectric is necessary in antenna design because of structure solidity (i.e. dielectric increases solidity). Dielectric also shifts gain vs. frequency characteristic, (changing maximal gain) and increases number of unknowns and simulation time (Tab 1).

Results given by WIPL-D and presented here coincide with theoretically assumptions.