Helix Antenna

Helix antennas are used in space applications, satellite systems, radar systems, TV signal transmission, etc. Usually, a helix is manufactured as a wire, coiled around dielectric cylinder.

Main characteristics of helix antennas are

- Circular polarization,
- Broad-band,
- Two operation modes depending of used frequency,
- For unifilar helices, using a reflector is necessary.

Several models of helix antennas are created and simulated in WIPL-D Pro and presented here. One model is made of wires; another model is made of plates while the third model is made of plates coiled around the dielectric. The wire model is shown in Fig. 1, plate model is shown in Fig. 2 and plate model with dielectric rod is shown in Fig. 3. Main dimensions of these antenna models are the same. Some differences exist, because of using wires and plates which are of different geometrical shapes. Parameters of the dielectric are:

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

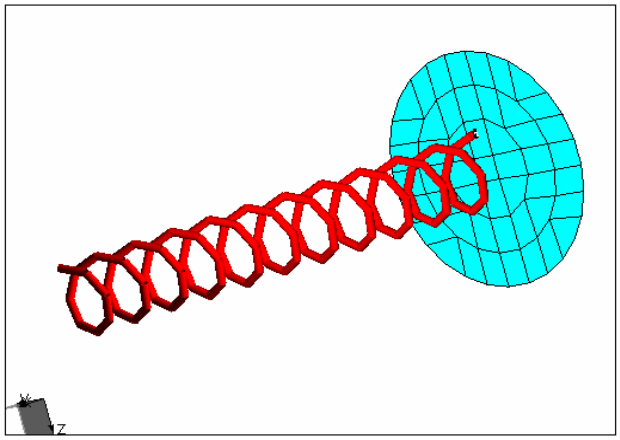

Figure 1. Wire helix model

Analyzed helix antennas consist of radiating elements and a reflector.

Our aim is to compare simulation times, numbers of unknowns and radiation patterns for simulated antennas. We will assume that given antenna is used in I-band (NATO bands classification).

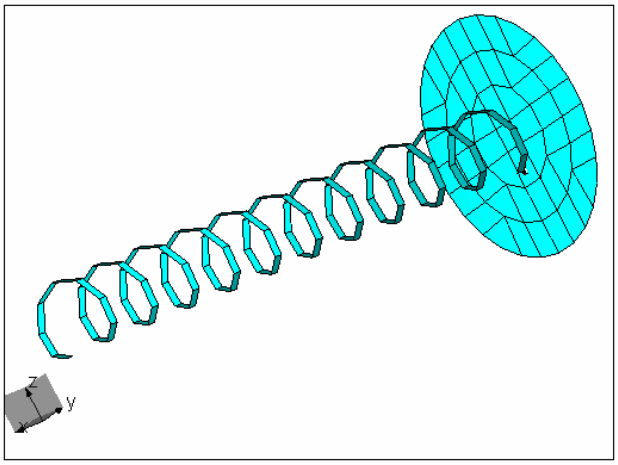

Figure 2. Plate helix model

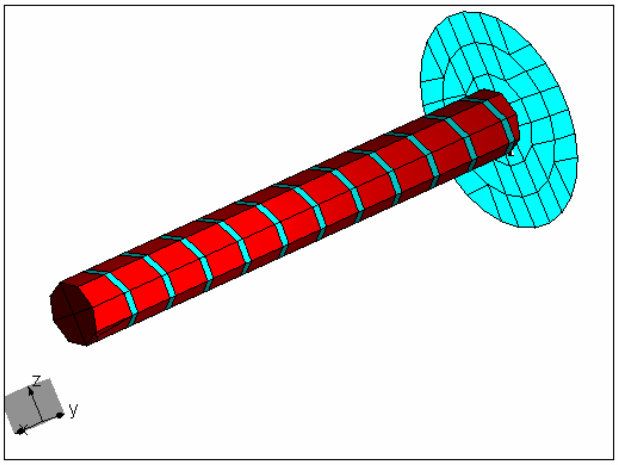

Figure 3. Plate helix model with dielectric

WIPL-D Simulation

In WIPL-D Pro, helix antennas can be designed using the built-in *Helix* object. Antennas shown in Figs 1-3 can be also modeled "manually" (using individual wires as building blocks) but that would make modeling difficult.

Here, metallic parts are considered to be perfectly conducting. Central operating frequency is 9 GHz. All of the antennas are used in axial mode.

Radiation pattern of the wire helix model in 3D is shown in Fig. 4. Overlaid 2D radiation patterns for phi-cuts are shown in Fig. 5. Please note that the theta angle is measured with respect to the xOy plane.

Near field of the wire model is given in Fig. 6. Number of unknowns and simulation time of analysis are given in Tab. 1. Computer used for these calculations is Pentium® Core2 Quad CPU @ 2.83 GHz.

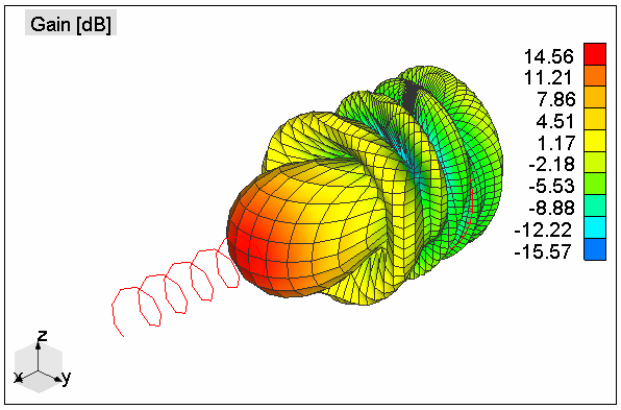

Figure 4. Radiation pattern of wire helix antenna

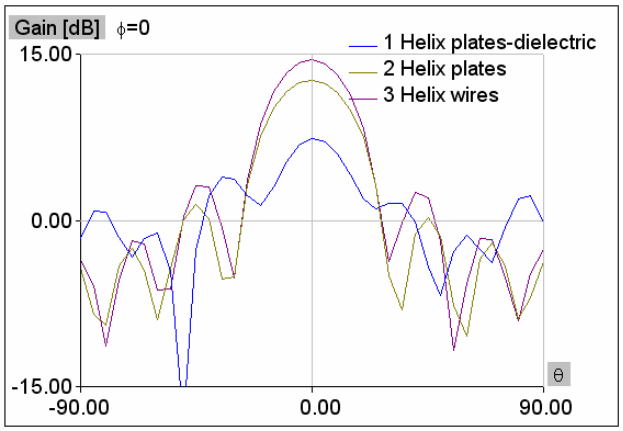

Figure 5. Overlaid 2D radiation patterns for a phi-cut

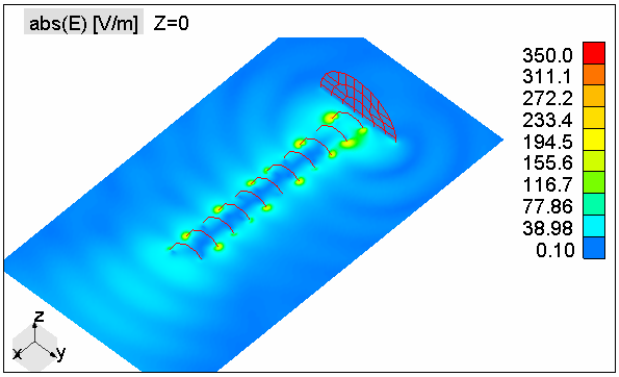

Figure 6. Near field of helix antenna made of wires

Table 1. Analysis characteristics

Model	No. of unknowns	Memory [MB]	Time @ 9 GHz [sec]
Wires	401	1.2	<1
Plates	751	4.5	<1
Plates/dielectric	2245	40.3	3

Conclusion

Using WIPL-D Pro *Helix* object with the possiblities for parameterization, we can easily create and manipulate helicoidal structures.

As we can see in Tab. 1, proper approximation of plate helixes using wires can decrease number of unknowns and simulation time. Gains from replacing plates by wires wherever possible can be much higher for more complex structures.

We can see (Fig. 5) that helix antenna model with dielectric has significantly different radiation pattern. Reason for this is dielectric influence on antenna characteristics. Dielectric is used because of antenna physical solidity, but it changes the operating band of antenna and thus must be considered in the design process. The influence of dielectric is successfully simulated in WIPL-D Pro.