

Helix Antenna

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.

Theoretical Performances

Main characteristics of helix antennas are

- Circular polarization,
- Broad-band,
- Two operation modes depending of used frequency,
- If designing unifilar helix, using of reflector is necessary.

Models of helix antennas are simulated in WIPL-D. One model is made of wires; another model is made of plates while the third model is made of wires coiled around dielectric. Wire antenna is shown on Fig. 1, plate antenna is shown on Fig. 2 and plate antenna with dielectric is shown on Fig. 3. Start dimensions of these antenna models are the same. Differences exist, because plate width in plate model is equal to wire diameter, what is not theoretically proper plate approximation of wire. Parameters of used dielectric are:

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

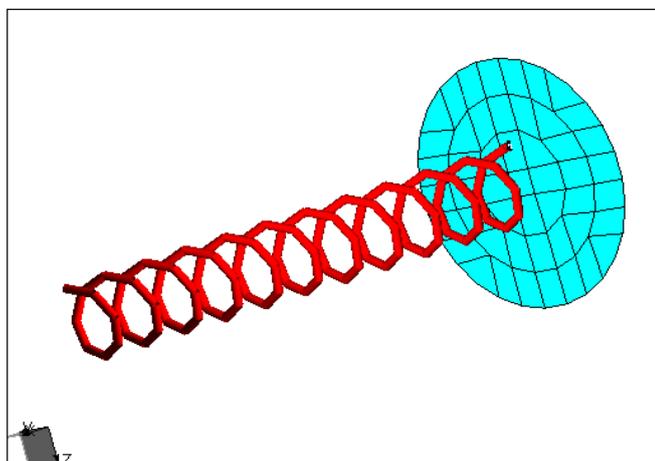


Figure 1. Wire helix

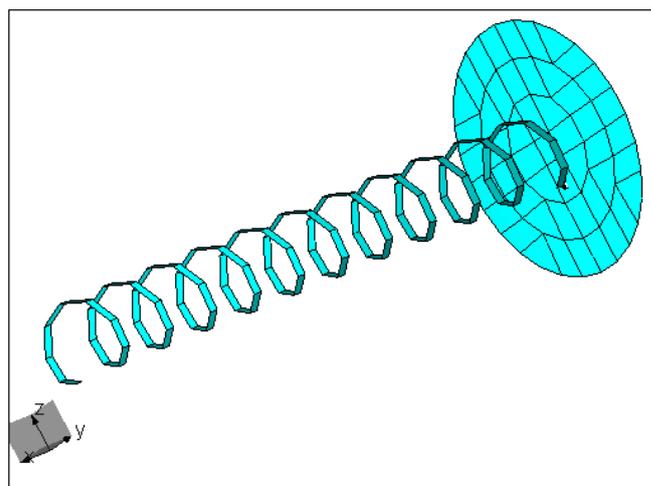


Figure 2. Plate helix

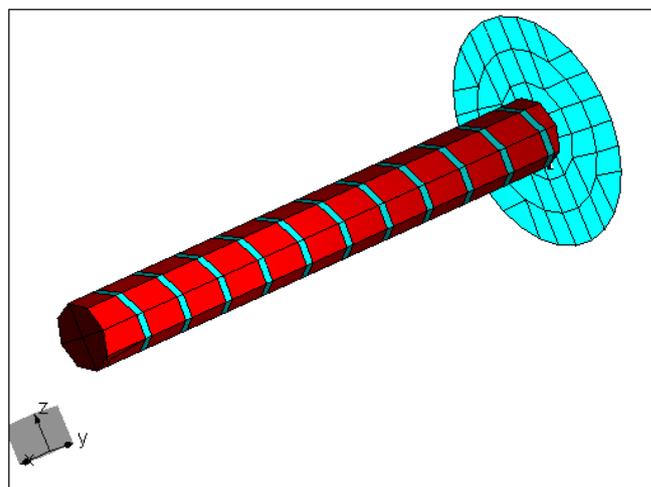


Figure 3. Plate helix with dielectric

WIPL-D Calculation

In WIPL-D software, helix antennas can be designed using powerful built in feature Object/Helix. Antennas shown on Figs 1-3 can be also modeled “manually” what would makes design process very 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.

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

Radiation pattern of wire helix in 3D is shown on Fig. 4. Overlaid 2D radiation patterns for phi cut are shown on Fig. 5. Near field of wire model is given on Fig. 6. Number of unknowns and simulation time of analysis are given in Tab. 1.

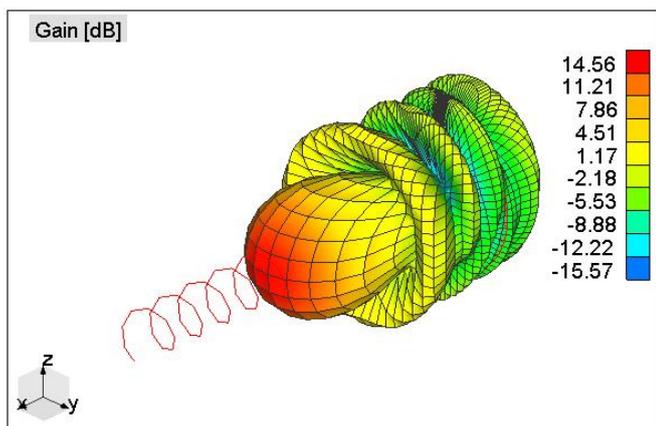


Figure 4. Radiation pattern of wire helix antenna

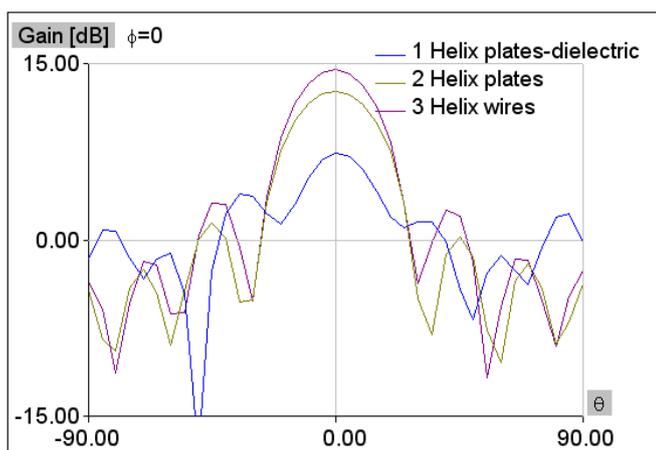


Figure 5. Overlaid 2D radiation patterns for phi cut

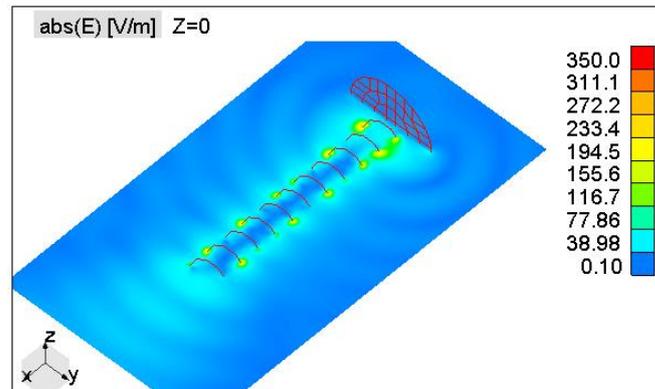


Figure 6. Near field of helix antenna made of wires

Table 1. Analysis characteristics

Model	No. of unknowns	Time @ 9 GHz [sec]
Wires	401	0.07
Plates	751	0.15
Plates/dielectric	2256	3.43

Conclusion

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

Knowledge of electromagnetic theory is necessary for decreasing simulation time. As we can see in Tab. 1, proper approximation of plate helices using wires can decrease number of unknowns and simulation time. This simple problem leads us to solution of very complex problems. That means that some kind of structures can be approximated using wire models, not plate models.

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 dielectric changes operating band of antenna and thus must be considered in design process. The influence of dielectric is successfully simulated in WIPL-D software.