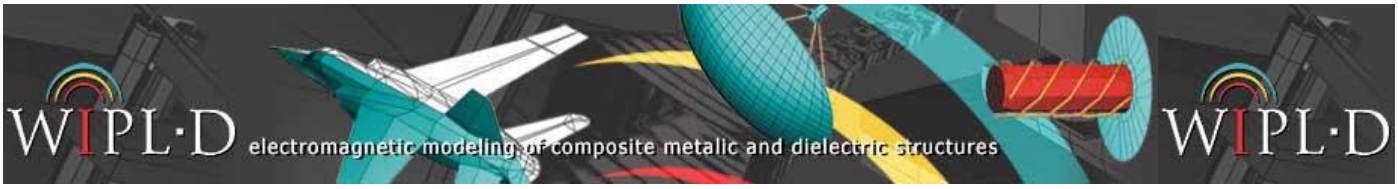

Yagi-Uda Antenna

Yagi-Uda (further Yagi) antenna is array of dipoles. Radiation of all elements is summed in forward direction. Yagi antennas are used in radio links for computer network (Wi-Fi). Some kinds of Yagi are made for receiving TV and FM radio signals.

Theoretical Performances

Main characteristics of Yagi antennas are

- Gain 5-16 dBi,
- Narrow-band (relatively bandwidth is ~10%).

Models of Yagi antennas are simulated in WIPL-D. One model is made of wires, while another model is made of plates. Wire antenna is shown on Fig. 1, plate antenna is shown on Fig. 2 and feeding area is shown on Fig. 3. Dimensions of both models are same. Only structure approximation is different. That means that every wire in wire model is replaced by body of rotation and terminated using circle object in plate model.

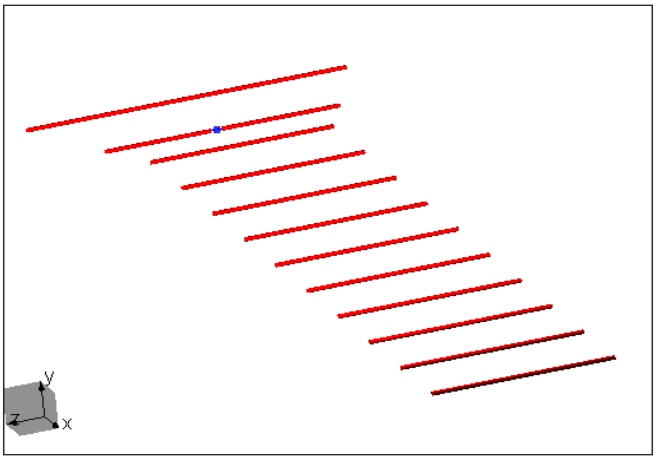

Figure 1. Yagi antenna made of wires

Analyzed Yagi antenna consists of one reflector, one fed dipole and ten directors.

Our aim is to compare simulation times for wire and plate antenna modeling. We will assume that given antenna is used in B-band (NATO band classification).

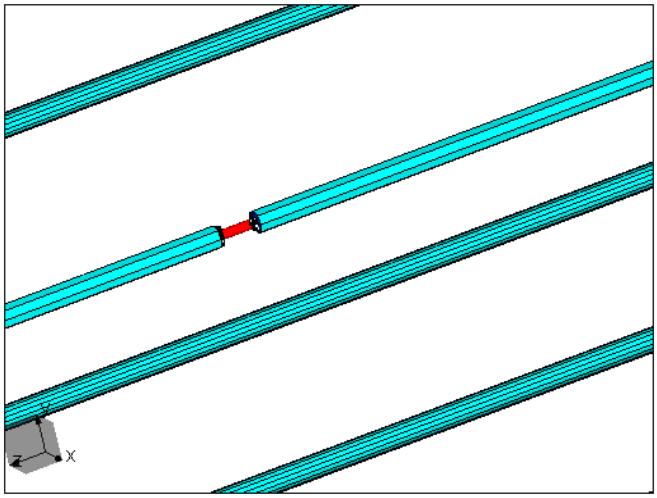

Figure 2. Yagi antenna made of plates

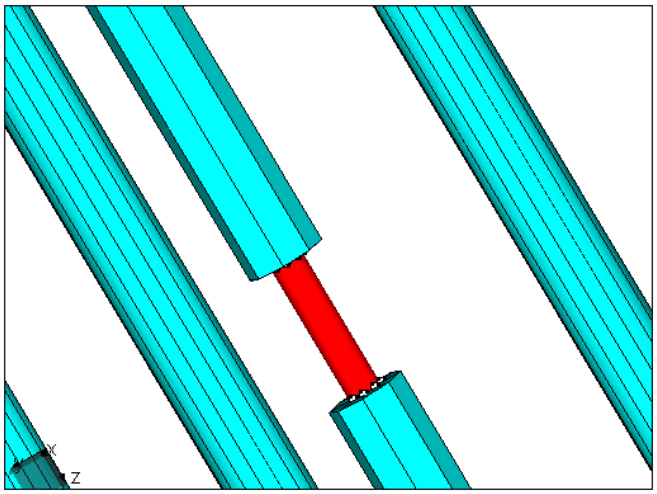

Figure 3. Yagi antenna made of plates – feeding area and plate approximation

WIPL-D Calculation

In WIPL-D software, iterated structures can be designed using built in features. Antennas shown on Fig. 1 and Fig. 2 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 to make antenna design easy. Metallic parts are considered to be perfectly conducting.

Operating frequency is 266 MHz (B-band).

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

Radiation pattern in 3D is shown on Fig. 4. Overlaid 2D radiation patterns for theta 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.

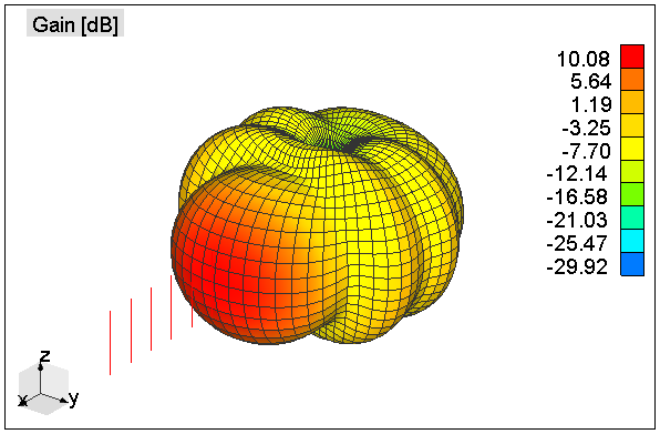

Figure 4. Radiation pattern of Yagi antenna made of wires

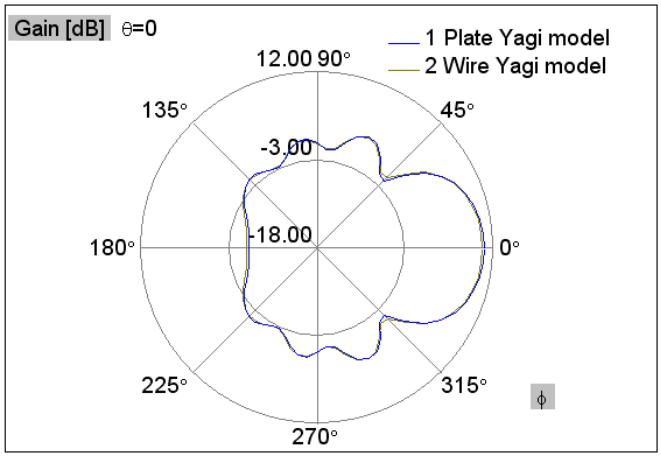

Figure 5. Overlaid 2D radiation patterns for theta cut

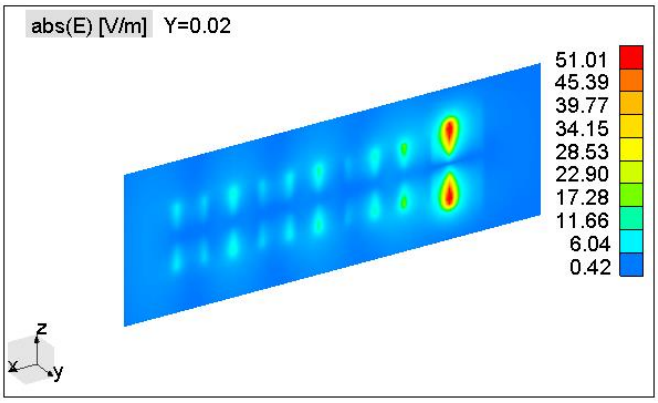

Figure 6. Near field of Yagi antenna made of wires

Table 1. Analysis characteristics

Model	No. of unknowns	Time @ 266 MHz [sec]
Wires	36	0.0056
Plates	1560	12.5

Conclusion

We saw great diminishing simulation time and number of unknowns for Yagi antenna design problem. This simple problem can lead 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, also, see that these two models have almost identical radiation pattern.

If we calculate gain of structure similar to wire, wire model is accurate for wire radius up to $0.1 \cdot \lambda$.