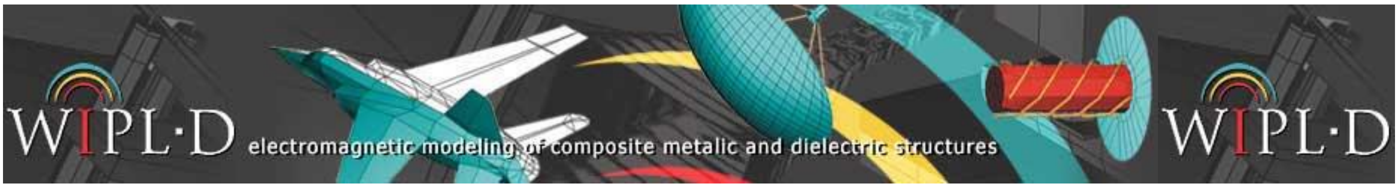

Cassegrain Antenna

Cassegrain antennas are subcategory of reflector antennas. Reflector antennas have been used from discovery of electromagnetic wave propagation. However, the most important application of reflector antennas was in radar manufacturing. Also, they have been used in space communications and radio astronomy.

Theoretical Performances

Main characteristics of Cassegrain antennas are

- Good directivity
- In some applications they can substitute antenna arrays.

The bigger diameter of antenna reflector is used, the better gain is achieved.

One model of Cassegrain antenna is simulated in WIPL-D. We will assume that given antenna is used in Ka band and that it is used for satellite communications (Fig. 1).

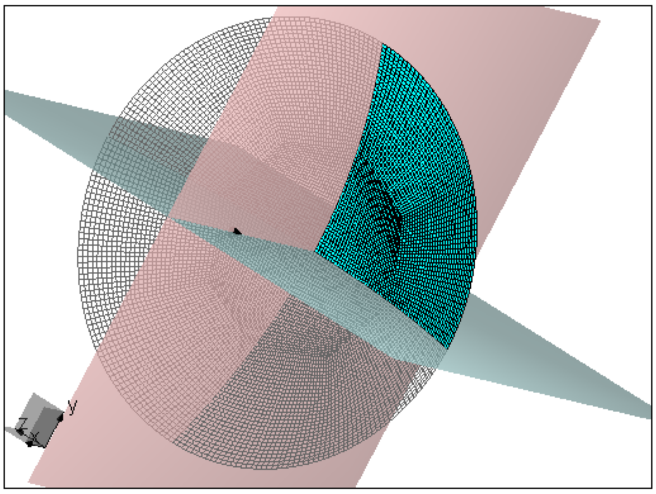

Figure 1. Cassegrain antenna

Cassegrain antenna consists of two reflectors (primary and secondary) and feeder. Note that primary reflector is curved (Fig. 2).

In reflector antenna system, function of feeder is done by horn antenna (Fig. 3). In this project, feeder is specially designed to suppress back radiation. That was done by adding a choke to horn aperture edge. Length of choke is equal to quarter of free-space wavelength (parameter Lam/4 on Fig. 3). Axial two-level design enables dual mode electromagnetic wave propagation.

We will assume that whole system is optimized, and that we want to enlarge secondary reflector. Thus we focus on

- Secondary reflector radius (R)

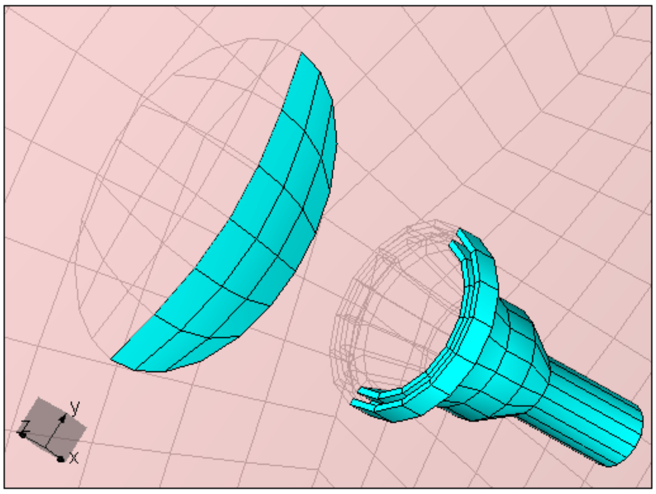

Figure 2. Cassegrain primary reflector. Half antenna model

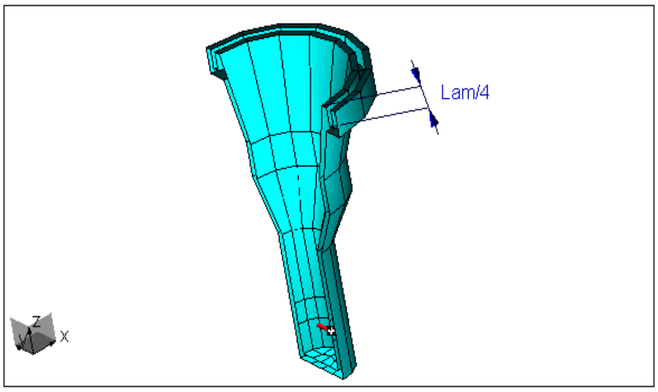

Figure 3. Feeder. Half antenna model

WIPL-D Calculation

In WIPL-D software reflectors and feeder can be designed using built in features. Cassegrain antenna shown on Fig. 1, can be modeled in several ways because of diminishing simulation time and number of unknowns. One can use WIPL-D feature (Anti-) Symmetry, so in this problem only quarter of given antenna is modeled (Fig. 1). Metallic parts are considered to be perfectly conducting.

Operating frequency is 26.5 GHz (Ka-band).

For parameters given in Tab. 1, we will calculate gain. Intel® Core(TM) i7 CPU 950 @3.07 GHz, 24GB RAM, 1 GPU card Nvidia GeForce GTX 470. Simulation was performed using 1 GPU card to achieve the best performance.

Since we claim that R is the most important for antenna performances, we will not be involved in analysis of other antenna dimensions. Also, we will not analyze antenna matching.

Table 1. Parameter of analysis

Parameter	Value [mm]	Value [multiplication wavelength]
R	1132	100

Radiation pattern in 2D (phi-cut), where phi=0, is shown on Fig. 4.

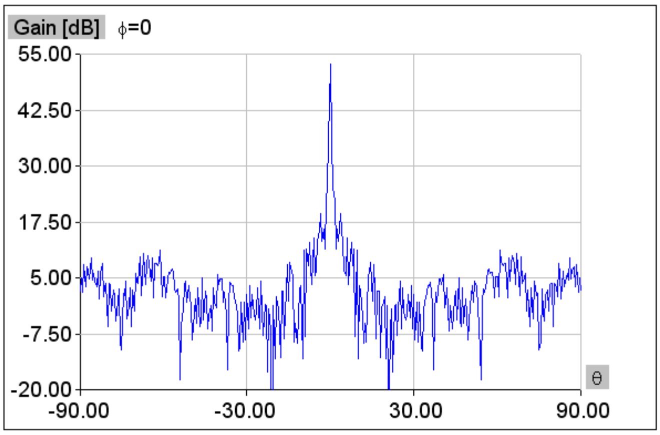

Figure 4. Radiation pattern, phi-cut

Number of unknowns and simulation time of analysis are given in Tab. 2.

Table 2. Analysis characteristics

Model	No. of unknowns	CPU Time @ 26.5 GHz [min]	GPU Time @ 26.5 GHz [min]
quarter	38525	44.9	11.6

Conclusion

We saw that proper using of WIPL-D features (for example, Symmetry feature), enables calculation using only quarter of structure, which is very important during analysis of electrically big structures. That means, that we can get faster solution using little amount of memory.

Cassegrain antenna is sort of antenna usually analyzed using geometrical optics method. However, WIPL-D successfully analyses that antenna using MoM.