Cassegrain Antennas with Diameters Up to 200 λ

Owing to the usage of Method-of-Moments with higher-order basis functions, WIPL-D Pro provides very efficient simulation of reflector antennas. Even for a very large size reflector that would require application of an asymptotic method in some other EM simulation tool, WIPL-D Pro rigorous simulation accurately calculates radiation patterns using commonly available resources of a modern PCs. Three models of Cassegrain antennas with reflector diameters D=50·λ, D=100·λ, and D=200·λ, shown in Figs 1-3 respectively, have been simulated in WIPL-D Pro.

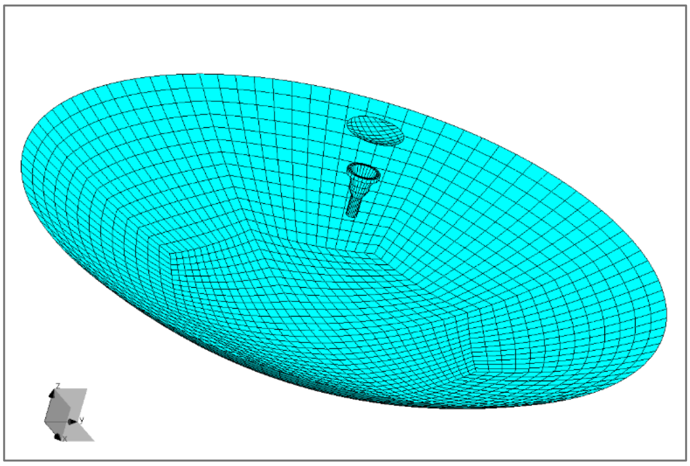

Figure 1. Model-Cassegrain antenna with diameter D=50·λ

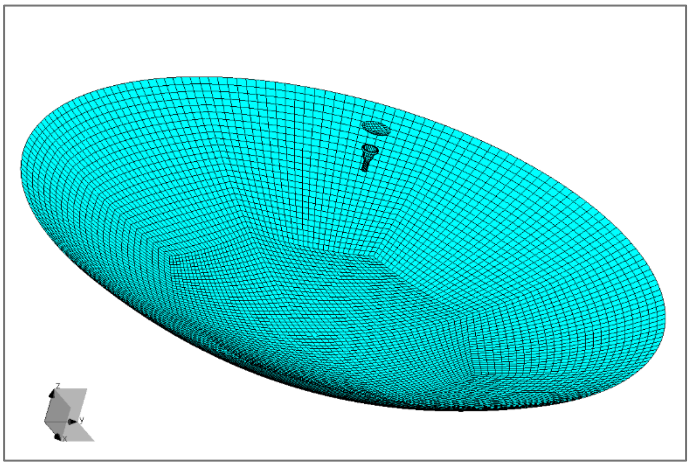

Figure 2. Model-Cassegrain antenna with diameter D=100·λ

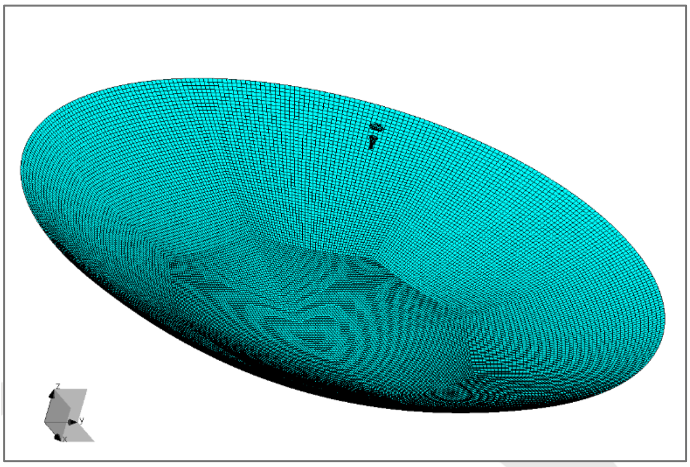

Figure 3. Model-Cassegrain antenna with diameter D=200·λ

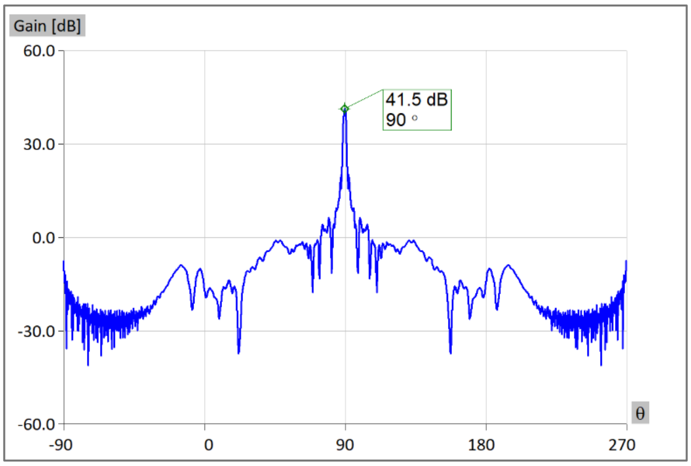

Figure 4. Gain-Cassegrain antenna with diameter D=50·λ

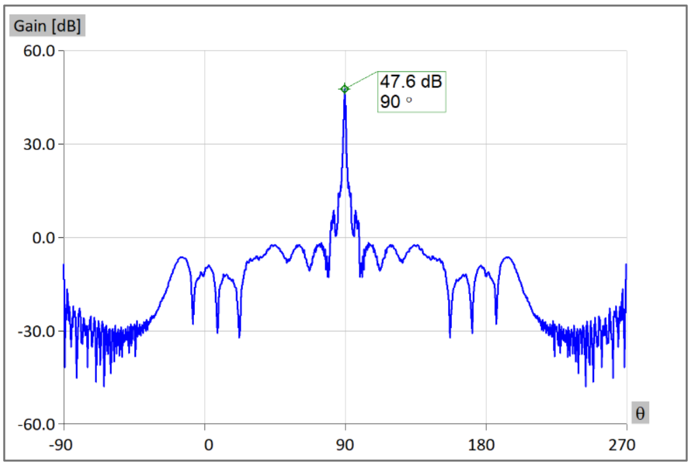

Figure 5. Gain-Cassegrain antenna with diameter D=100·λ

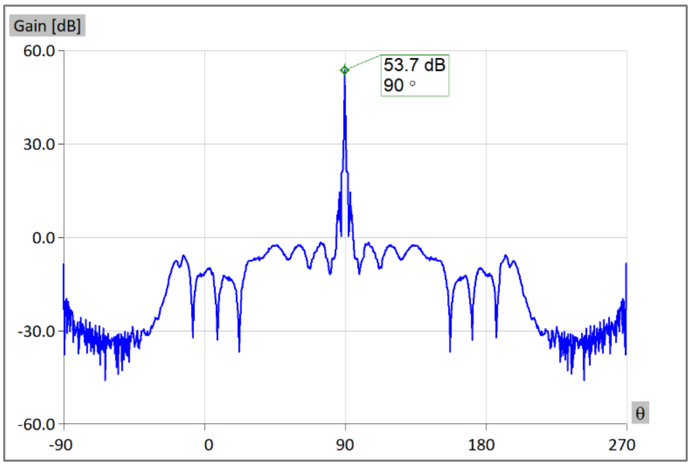

Figure 6. Gain-Cassegrain antenna with diameter D=200·λ

Reflectors and feeders in the presented models were designed using built in parameterized objects (for instance, a parabolic reflector is a single object). All the model parts are considered to be perfectly conducting. The antenna structures exhibit two-fold symmetry which can be exploited to simulate only a quarter of the entire structure.

Radiation patterns for antennas shown in Figs 1-3 are presented in Figs 4-6 in Cartesian coordinate systems. In Fig. 7, radiation patterns of three Cassegrain antennas are compared with special attention given to fine details regarding the shape of the radiation pattern in the proximity of the main beam.

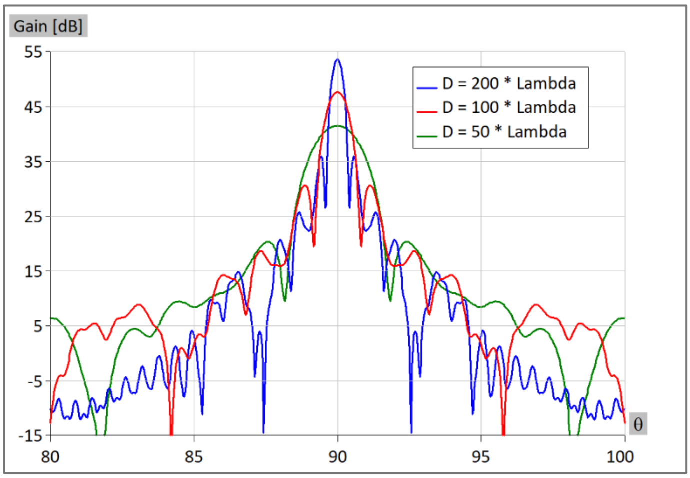

Figure 7. Comparison of gains of simulated Cassegrain antennas in Cartesian coordinate system.

Number of unknowns and simulation times dependencies on reflector diameter are given in Table 1. Diameters of the reflectors are listed in the first column, while a number of unknowns required for a simulation is presented in the second column.

Each Cassegrain antenna has been simulated using two computational scenarios. In the first one, all operations (e.g. matrix fill, matrix inversion…) were performed on CPU. Total simulation time for this scenario is presented in the third column (under the name *CPU matrix inversion*). In the second scenario, all operations except matrix inversion were performed on CPU. Matrix inversion was performed using GPU card and add-on tool named GPU Solver. Total simulation time required when using GPU Solver is presented in the fourth column (under the name *GPU matrix inversion)*.

Computer hardware used for simulations was Intel® Xeon® CPU E5-2650 v4 @ 2.2 GHz (2 processors) with 256 GB RAM and NVIDIA GeForce GTX 1080 Ti GPU card.

Table 1. Size of the reflector, number of unknowns and simulation times

D[λ]	No. of unknowns	CPU matrix inversion. Total simulation time [sec]	GPU matrix inversion. Total simulation time [sec]
20	2,191	2	4
30	3,820	3	5
40	5,326	4	6
50	8,215	7	9
60	10,561	11	13
70	14,710	21	21
80	17,896	29	29
90	23,305	53	48
100	27,731	79	63
110	34,000	135	98
120	38,866	190	128
130	46,795	310	187
140	52,501	420	247
150	61,690	648	344
160	68,236	853	409
200	106,006	2,934	1,112

Conclusion

Very large Cassegrain antennas are usually simulated using specialized asymptotic methods. However, WIPL-D Pro simulates antennas of this type using very accurate and very fast Method-of-Moments with higher order basis functions which results in very high numerical efficiency. Due to the efficient parallelization on modern multi-core computers, CPU simulations are very fast for problems of this size. Further acceleration can be achieved by using GPU Solver and inexpensive Nvidia GPU cards.

The application note presents number of unknowns and CPU/GPU simulation time for a series of reflector sizes (from 20 to 200 lambda).