ADF Antenna Mounted on Helicopter

Magnetic antenna system [1], patented by G. Wennerberg, is efficiently used as direction finding antenna. This invention relates to magnetic systems, and more particularly to an improved flush type magnetic antenna, suitable for mounting on an aircraft, which employs no moving parts. The WIPL-D model of the antenna was created according to [1].

WIPL-D Pro is well-known full wave 3D EM Solver, based on **Method-of-Moments** (MoM) and empowered with **quadrilateral mash** and **higher-order basis functions (HOBFs)**. A unique combination of HOBFs and MoM allows us to accurately simulate electrically large models. In the other words, HOBFs **decrease number of required unknowns** and **speed up simulation time**. Finally, WIPL-D offers very efficient **CPU** and **GPU** simulation on inexpensive hardware platforms.

MoM codes have been often challenged when the simulated device is electrically small. In this particular application note, we demonstrate that this state-of-the-art MoM code can be used for **electrically small structure efficiently**, with extremely **accurate and fast** simulation. Furthermore, in this application note, normalized radiation pattern results of an automatic direction finder antenna (further, ADF antenna) will be presented. Two scenarios will be investigated. The first scenario represents the ADF antenna in the free space. The second scenario represents the ADF antenna mounted on the real-life model of a helicopter.

WIPL-D Models

Basic antenna structure is shown in the Figure 1. The antenna consists of relatively fat wires covering the square magnetic element. WIPL-D model of the antenna was created from the scratch using **WIPL-D Pro**. Creation of the antenna model is simplified by using WIPL-D Pro **built in objects and manipulations**.

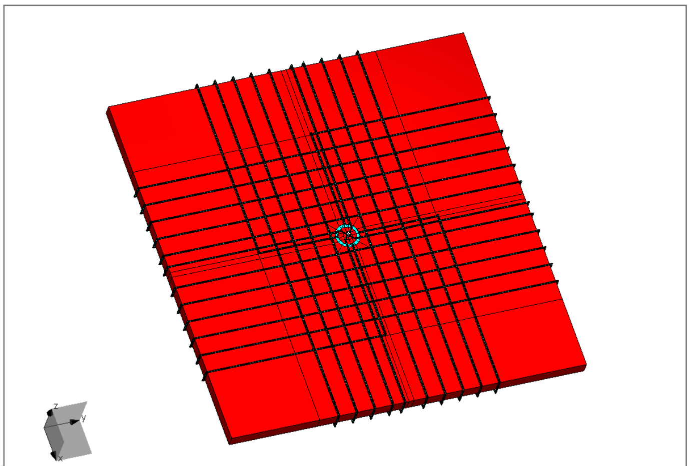

Figure 1. ADF antenna – WIPL-D model

On the other hand, **WIPL-D Pro CAD** software is suited for easy and fast creation of complex **3D geometries from the scratch**, using built-in primitives. Besides that, it allows **importing** models from **various CAD formats**. For this particular case, the model of the helicopter was imported in WIPL-D Pro CAD and meshed to WIPL-D Pro native format. The ADF antenna was imported to the meshed model of the helicopter and positioned on the aircraft (Figure 2).

The antenna was simulated in both scenarios (in free space and on the helicopter) at two frequencies (190 kHz and 535 kHz). The antenna operates in *One generator at time* (OGAT) mode and it is excited by two generators. In order to stabilize results, numerical kernel parameter *Integral accuracy* was increased. Also, parameter *precision* was set to *double*.

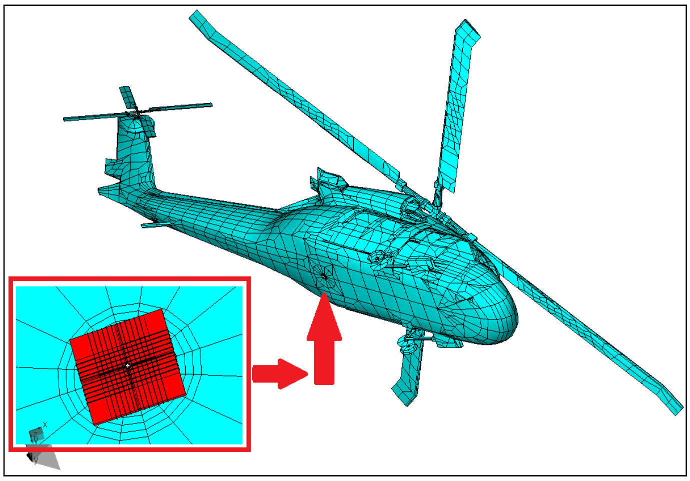

Figure 2. ADF antenna mounted on the helicopter

Antenna in Free Space

Normalized radiation pattern results for the antenna in free space, excited by two separate generators, at two frequencies are presented in Figures 3-6.

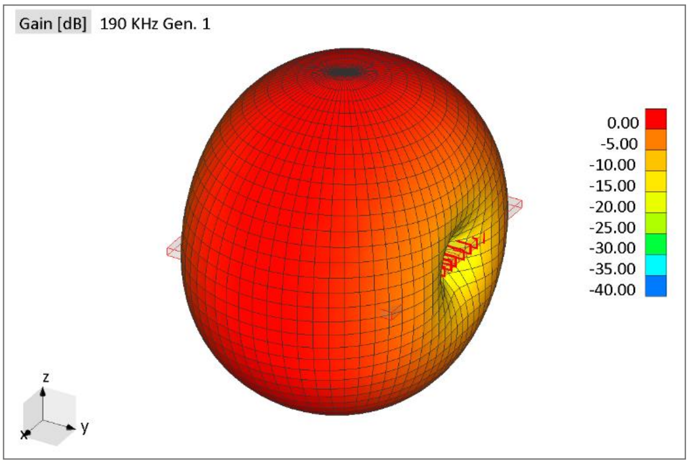

Figure 3. ADF antenna in free space (190 kHz) – normalized radiation pattern with the first generator active

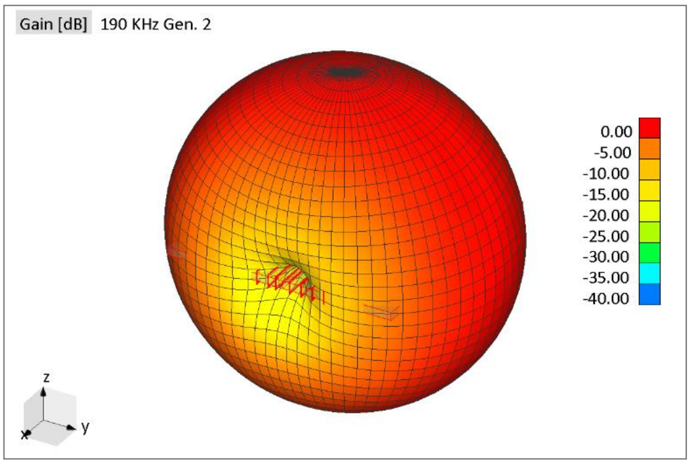

Figure 4. ADF antenna in free space (190 kHz) – normalized radiation pattern with the second generator active

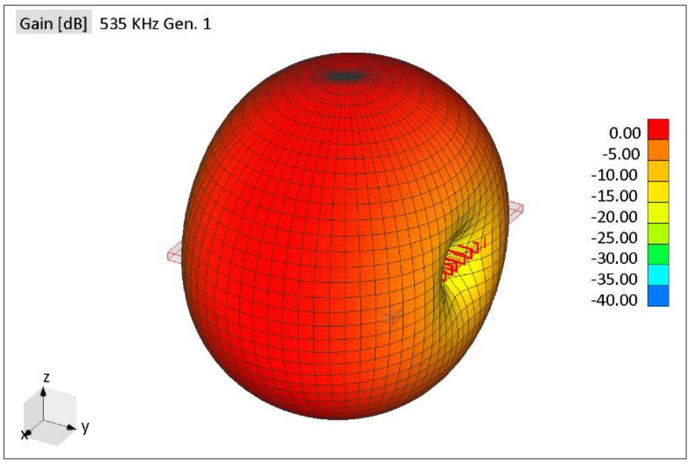

Figure 5. ADF antenna in free space (535 kHz) – normalized radiation pattern with the first generator active

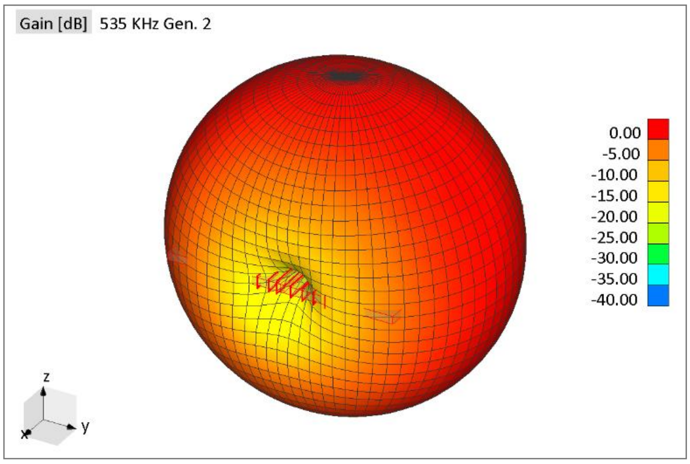

Figure 6. ADF antenna in free space (535 kHz) – normalized radiation pattern with the second generator active

Antenna Mounted on the Helicopter Platform

Normalized radiation pattern results for the antenna mounted on the helicopter, excited with two separate generators, at two frequencies are presented in Figures 7-10.

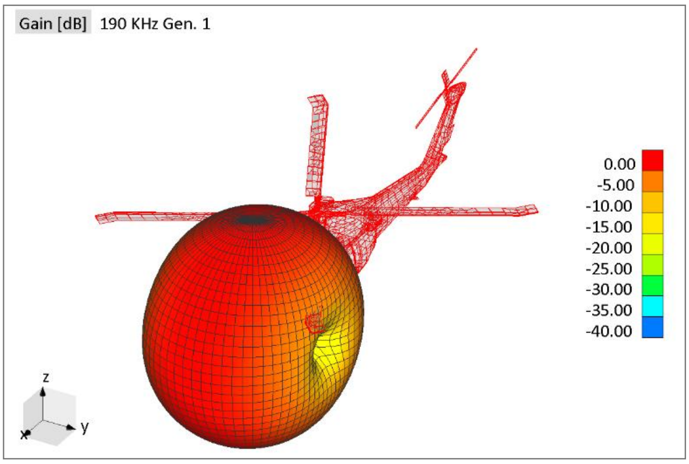

Figure 7. ADF antenna mounted on the helicopter (190 kHz) – normalized radiation pattern with the first generator active

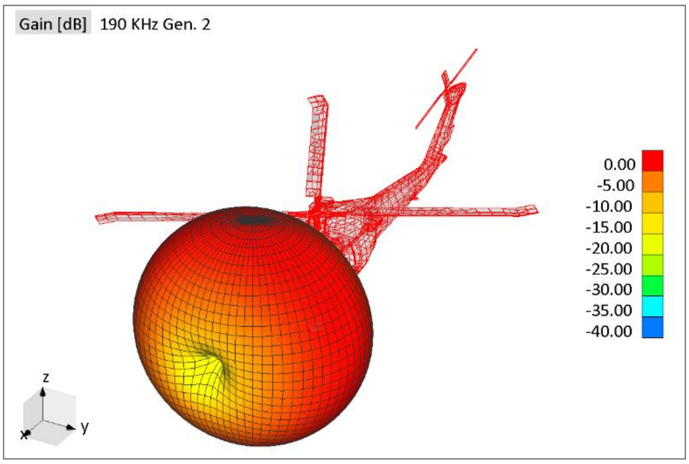

Figure 8. ADF antenna mounted on the helicopter (190 kHz) – normalized radiation pattern with the second generator active

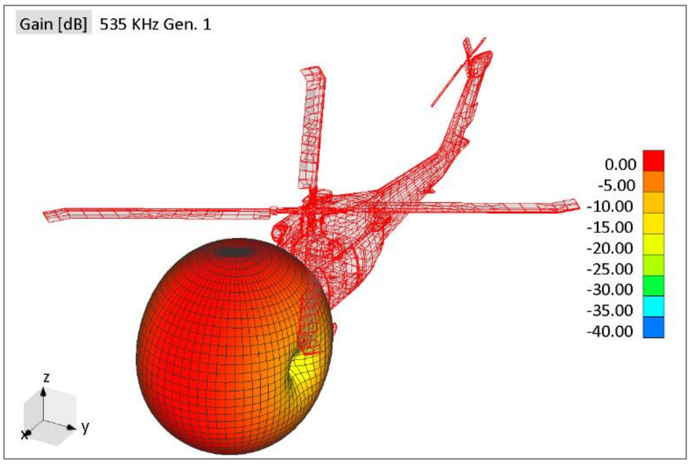

Figure 9. ADF antenna mounted on the helicopter (535 kHz) – normalized radiation pattern with the first generator active

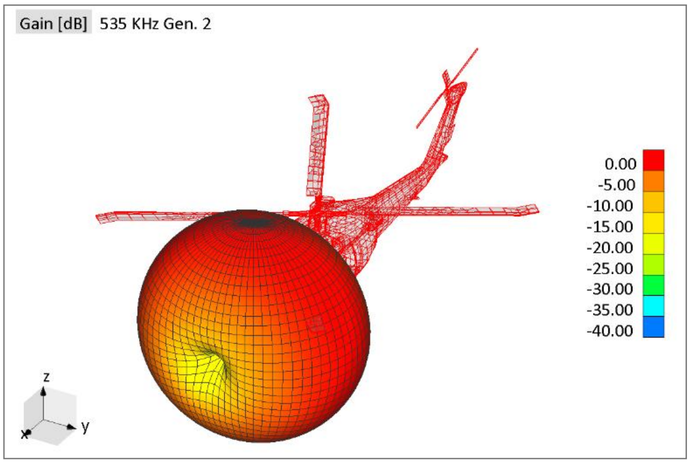

Figure 10. ADF antenna mounted on the helicopter (535 kHz) – normalized radiation pattern with the second generator active

Simulations

Computer used for carrying out these simulations is Intel® Core™ i7-7700 CPU @ 3.60 GHz. Numbers of unknowns and simulation times are presented in Table 1. The simulation time is a sum of three intervals: time spent in matrix filling, time spent in matrix inversion and time spent in calculation of radiation pattern.

Table 1. Number of unknowns and simulation time per frequency for simulated models

Model	Number of unknowns	Simulation time per frequency [sec]
ADF antenna	10,756	640.1
ADF antenna mounted on helicopter	22,583	814.9

Conclusion

This application note demonstrated that WIPL-D Pro could be used for **low frequency simulations** which are not usually the default application of MoM. However, the special techniques for treatment of low frequency problems allow the accurate simulations. For example, the special techniques could encompass some meshing techniques (a form of "imaging"), involving the *double* precision for storing the MoM system matrix, and increasing numerical kernel parameter *Integral accuracy*.

This application note also demonstrated that **WIPL-D Pro** can be efficiently used with **WIPL-D Pro CAD.** Combining these products of WIPL-D Company, after importing EM models or creating EM models from the scratch, one can successfully create various structures ready for simulation.

Finally, no expensive hardware is necessary for the simulations. For example, the simulations can be carried out at regular desktop PC or laptop.

References

1. G. Wennerberg, "Magnetic Antenna Systems" U.S. Patent 3,031,663, issued April 24, 1962. www.patentimages.storage.googleapis.com/pdfs/US3031663.pdf