

NASA Almond RCS in Time-Domain

In this application note, simulation of the RCS in time-domain is described in WIPL-D Software suite. The products used are WIPL-D Pro and WIPL-D Time Domain Solver. Well known metallic object NASA almond was illuminated by plane wave and near field results in time domain are shown.

Introduction

An almond shaped object, Fig 1, was illuminated using Gaussian modulated sine waveform plan wave. The waveform of the illuminating wave is shown in the Fig 2. Object is about 60 wavelengths long, about 4 wavelengths high and about 0.2 wavelengths thin. Polarization is parallel to the longer semi-axes of the almond's cross section.

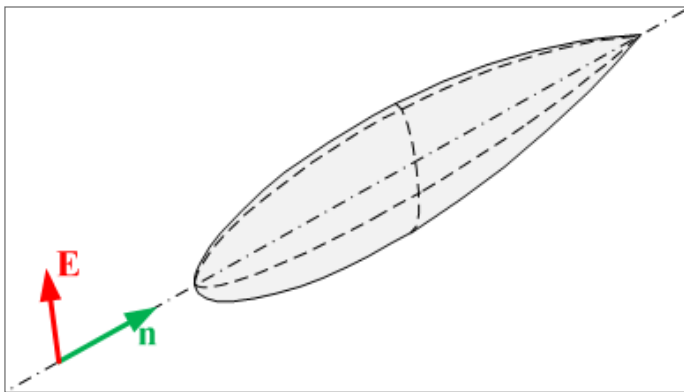


Figure 1. An almond shaped object and direction of illuminating wave

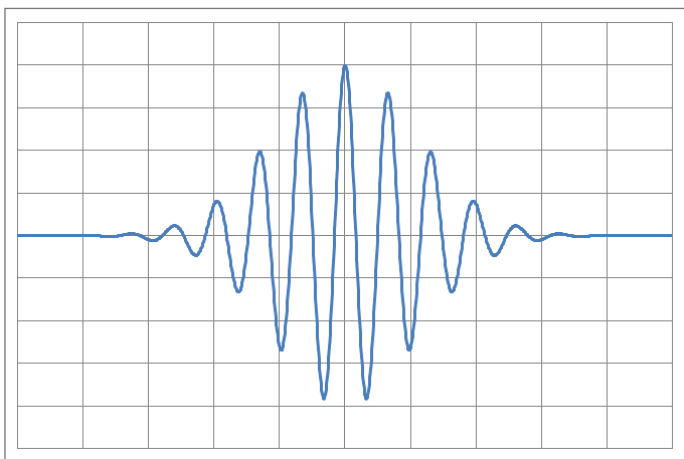


Figure 2. Waveform of the excitation

WIPL-D Pro Model – Metallic

Model of almond scatterer is made using WIPL-D Pro software, Fig 3. Two symmetry planes are used in order to reduce required number of unknowns for current approximation. It is made using pre-defined object named BoR (Body of Rotation).

Model without and with distribution loading is simulated. Skin effect, with conductivity of 1 MS/m is specified. The simulation time in WIPL-D Pro is identical for the model with and without the distributed loading.

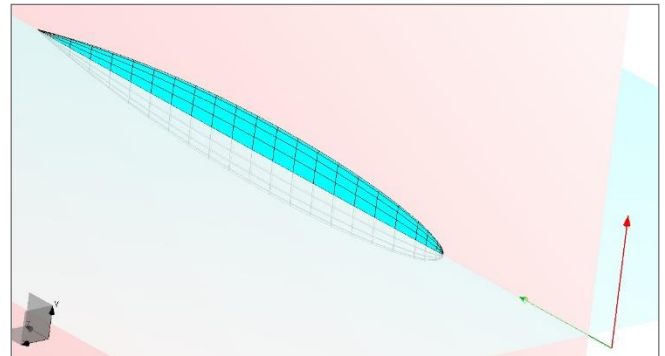


Figure 3. Almond shaped scatterer in WIPL-D Pro

WIPL-D Time-Domain Solver

By running Time-Domain Solver from the Run menu, new window shows up, Fig 4. In the first section, Excitation & Waveform, the aforementioned should be specified. For each wave user defines different type and waveform. Phi and Theta polarizations are possible. There are a few pre-defined waveforms, and, of course, possibility for user defined excitation. For any of waveforms there are a set of parameters which should be defined, such as amplitude, rise time, delay, etc.

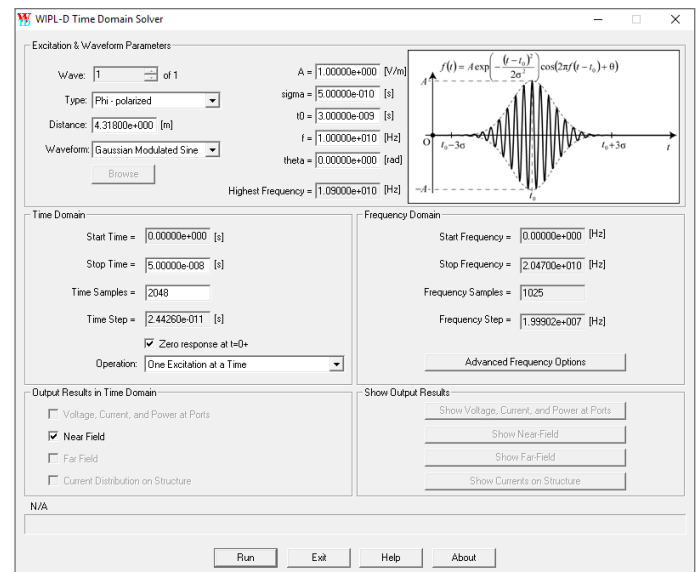


Figure 4. WIPL-D Time Domain Solver window

In the second section, Time Domain, time parameters should be specified. Start and stop time are expressed in seconds. Time Samples should be number 2^n , in order to get less frequency samples using DFT (Discrete Fourier Transformation). The third section, Frequency Domain, is generated by values defined in the

previous two sections. Advanced Frequency Options, Fig 5, offers user to define certain advanced but yet again important features, such as Maximum Relative Energy Loss, Avoid WIPL-D Run, etc.

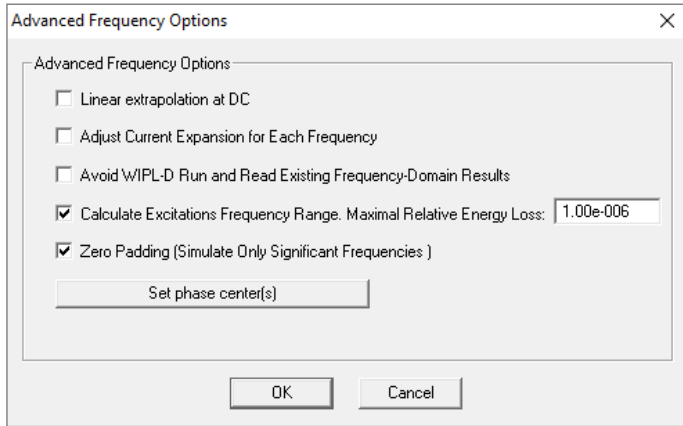


Figure 5. Advanced Frequency Options

The fourth section is just a check list for defining which output results should be calculated in time-domain using Inverse DFT.

The sections describe above are pre-simulation sections, while the last one, Show Output Results, is post-simulation.

Simulation

Simulation is performed on the inexpensive desktop machine (any regular desktop or laptop will do), Intel® Core™ i7 CPU 7700@ 3.60 GHz. Simulation parameters are shown in Tab 1.

Distribution loading does not change number of unknowns for current distribution, so simulations parameters are identical in both cases.

Table 1. Simulation parameters

Number of elements	Number of unknowns	Memory [MB]	Number of Frequencies	Total simulation time [sec]
104	6219	295	113	916

After simulation, which consists of 3D EM simulation in frequency domain and IDFT, one can observe results obtained using WIPL-D Time-Domain Solver in the WIPL-D Graph Viewer. The tool is capable to display both frequency domain or time domain results.

Results

Result of interest in this simulation is Near Field. Near field calculations 120 wavelengths distant from the object in time domain is shown in Fig 6, for model without distribution loading, and Fig 7, for the model with distribution loading.

Response for PEC model is slightly higher than response for the finite conductive model, Fig 8.

Conclusion

This application note presented a time domain EM simulation, using WIPL-D Time-Domain Solver. One can conclude that WIPL-D Time-Domain Solver combined with extremely efficient MoM solver WIPL-D Pro is very applicable for the time domain simulation. Simulation time is measured in minutes for over 100 frequency points.

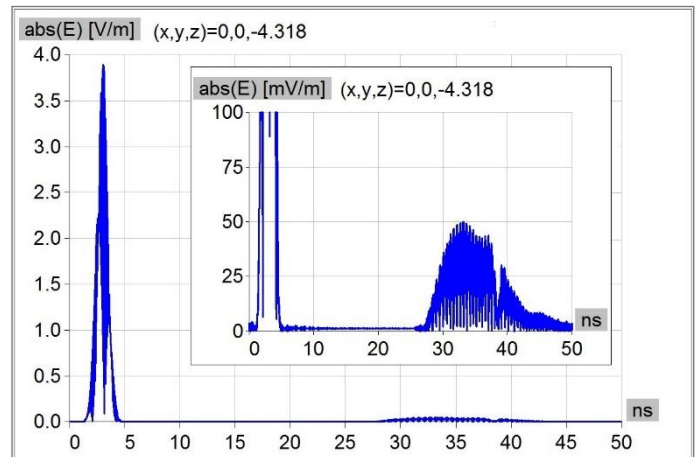


Figure 6. Time domain near field, lossless metallic object.

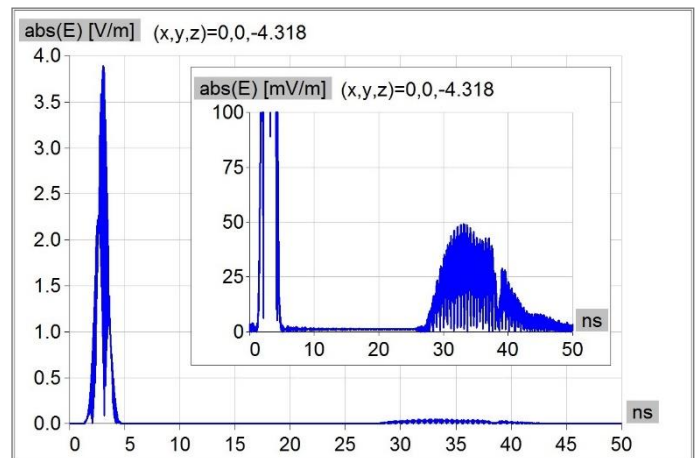


Figure 7. Time domain near field, lossy metallic object.

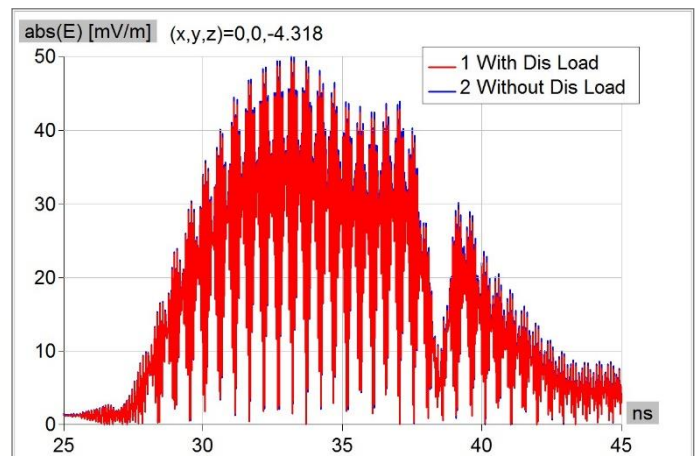


Figure 8. Difference between results.