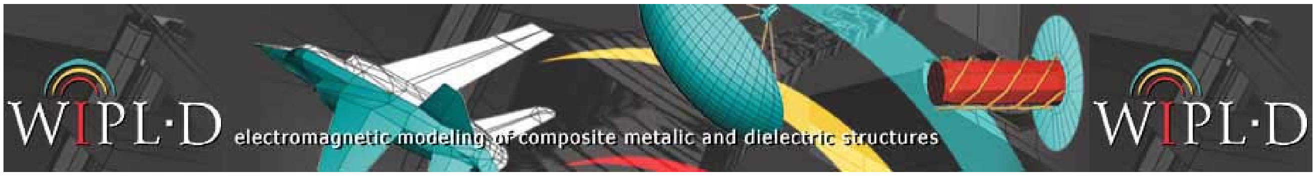


WIPL-D Pro v7.0 Announcement

WIPL-D Pro v7.0 brings important features for simulation of electrically very large structures, as well as for design productivity and visualization of results. Main features:

- **Multilevel fast multipole method (MLFMM)** featured in WIPL-D Pro is the first commercially available application of this advanced method to a higher order MoM code. The higher order MoM is inherently able to simulate structures far beyond reach of any other rigorous CEM method. The already great computational efficiency of the method is now extended multifold. The results are staggering: **WIPL-D MLFMM solves structures** that were **so far only reachable by** high frequency asymptotic methods.
- **Parametric sweep** feature enhances user productivity by making parametric studies easy. What-if exploration of the design space is now facilitated by the fully automatic integration of a new interface module, the EM simulator and Graph displays. Parametric sweep is also a good pre-cursor for a parametric optimization. **Any project symbol** (variable) **can be swept** over a range of values in order to inspect its influence on the design.
- The main user interface and graph diagrams have undergone a series of improvements to enhance the overall user experience.

Multilevel Fast Multipole Method

WIPL-D Pro is a frequency-domain MoM based code which enables very accurate EM simulation of arbitrary 3D structures. Owing to application of sophisticated techniques, such as **higher order** polynomial basis functions (HOBFs), very large structures are simulated on PC computers or inexpensive workstations.

The **WIPL-D MoM** approach adequately models a large structure with about **ten times less unknowns** than other MoM codes commonly using triangular meshing and Rao-Wilton-Glisson (RWG) basis functions. This is achieved thanks to the application of HOBFs on a quad **mesh containing electrically small and large elements** within the same model.

However, due to the ever-increasing electrical sizes (very large scatterers, antenna placement issues,...), even the most efficient MoM code is not able to meet all the industry demands. This is mostly the case in analysis of EM effects in car, aircraft or ship industry.

Hence, a new option has been added to WIPL-D Pro to extend its limits even further. **Multilevel Fast Multipole Method (MLFMM)** has been applied to the higher order MoM setup. This enables huge memory savings and very fast simulation.

MLFMM is applied to the same models previously treated by MoM, with no **changes to the mesh**. **Maximally orthogonalized HOBFs**, developed by WIPL-D, and system preconditioning enhance the convergence of the iterative solution algorithm, making it applicable to scatterers, antennas, metallic-dielectric structures, etc.

In MoM, interactions between all basis functions in the model are calculated independently. The **MLFMM groups basis functions**. In case when groups are far-apart in the model, it calculates interactions between groups, rather than between individual basis functions.

In the higher order MoM, **first-level** groups are comprised of all basis functions residing on a single mesh patch. This level produces a dramatic memory saving when a lot of **electrically large mesh elements** are present in the model.

The **second-level** groups are formed by neighbouring patches. This level produces a dramatic memory saving when a lot of **electrically small mesh elements** are present in the model. For areas with electrically large mesh elements, it introduces an incremental improvement to what is already achieved by the first-level grouping.

MLFMM is **much more scalable** then the MoM, i.e. the memory requirements and lentgh of simulation rise much slower with electrical size. The method enables WIPL-D Pro to remain the number one choice for accurate simulation of electrically very large structures.

Case Study – RCS of a Fighter Airplane

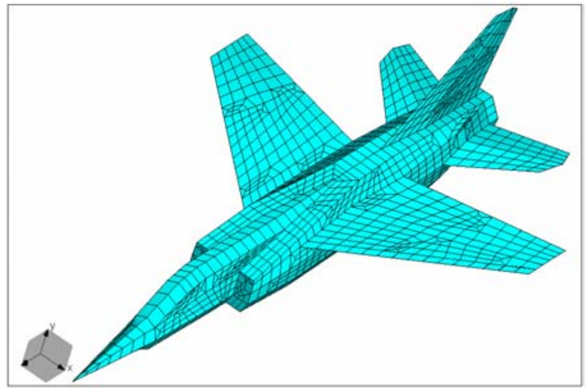
The fighter airplane is excited with a plane wave, coming in from 30° under the horizon. Fuselage is 12 m long, wing span is 7 m. The airplane is simulated at 3 GHz (**120 λ long)** and 4 GHz (**160 λ long)**.

Higher order MoM formulation results in:

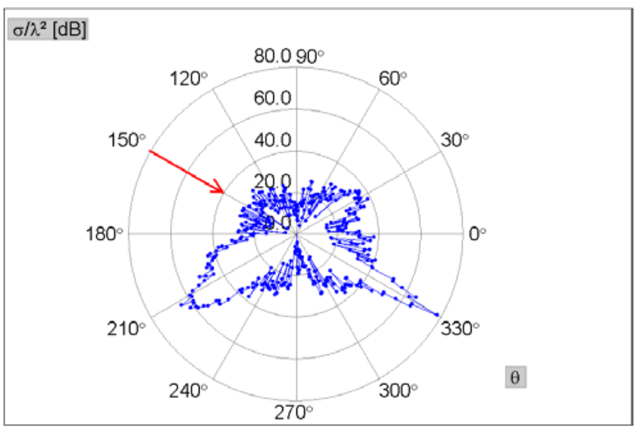
- **153646 unknowns** and **188.9 GB** of memory at **3 GHz –** equivalent to **1.5 million RWG** unkn.,
- **307170 unknowns** and **754 GB** of memory at **4 GHz -** equivalent to **3 million RWG** unkn.

By applying the **MLFMM**, memory requirements are **reduced to 3.2 GB and 7.2 GB** respectively.

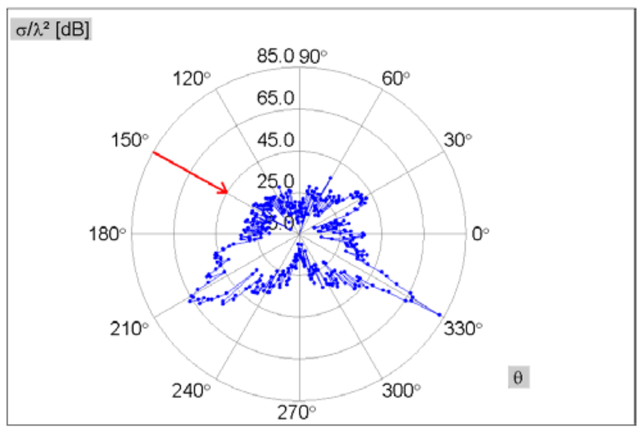
At 3 GHz the simulation was done on a Intel Core2 CPU at 2.66 GHz clock and 4 GB of RAM. At 4 GHz the simulation was done on a Dell PowerEdge 2900 workstation comprising 2.33 GHz Xeon and 24 GB RAM. Multi-core capabilities were not used.



No. of unknowns	No. of iterations	Memory allocation	Simulation time
153646	65	3.2 GB	2.3 hours
307170	83	7.2 GB	10.6 hours



Radiation pattern in the incident plane at 3 GHz



Radiation pattern in the incident plane at 4 GHz

Parametric Sweep

Parametric Sweeper is a new module, seamlessly integrated into WIPL-D Pro user interface. A very simple and easy-to-use interface enables the user to choose what project symbols (variables) should be swept across a range of values. The rest of the work is done automatically: sweeper drives the EM simulator with different values of the sweep parameters and saves the results. The results are displayed the same way as for fixed-parameter simulation since the visualization tools automatically recognize the parametric sweep data formats.