QUARTERLY: March 2010

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The first FEKO quarterly of 2010 highlights existing and new solutions that FEKO offers for the analysis of complex modern-day problems. These include the simulation of anisotropic materials and extensions to the GO (ray launching) method, making it ideally suitable to scattering analysis of large objects at high frequencies.

If you would like to comment or ask questions about the content of this issue, please send us an email, or contact your local distributor. *quarterly@emss.co.za*

Simulating Composite Materials

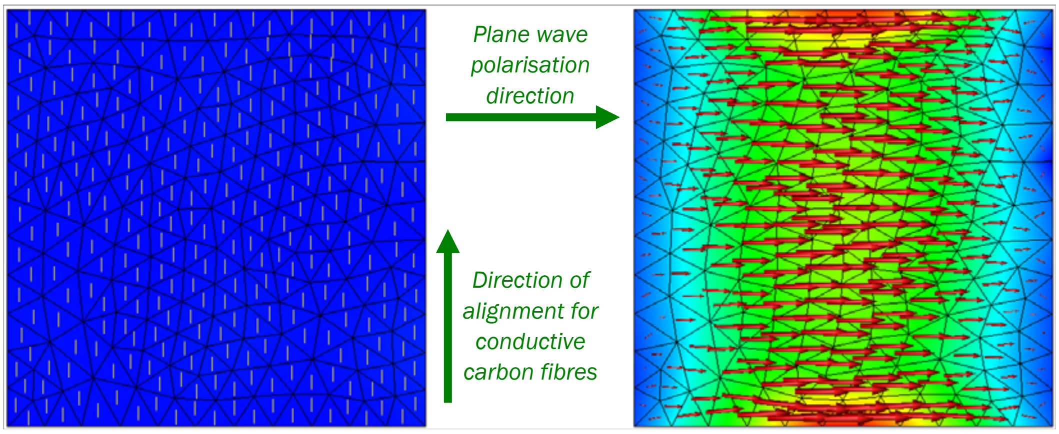
Modern composite materials have given designers the ability to design lighter and stronger aircraft, cars, UAVs, etc. The increased use of these materials for platform construction has created a requirement that antenna engineers must be able to simulated these materials electromagnetically to enable studies of the interaction of antennas and other radiation sources with these materials. FEKO offers the ability to model composite materials via the application of anisotropic layers.

An anisotropic layer is a thin layer of dielectric material that allows the user to specify different conductivities for two orthogonal directions of current flow, e.g. for carbon fibre a high conductivity may be specified in the direction of alignment of the fibres and a low conductivity may be specified in the orthogonal direction, modelling the conductivity of the resin. In cases where multiple layers of composite materials are used and where the alignment direction of the fibres are not the same for the different layers, multiple anisotropic layers may be specified in FEKO to model such materials accurately.

"An anisotropic layer is a thin layer of dielectric material that allows the user to specify different conductivities for two orthogonal directions of propagation..."

The surfaces shown below were placed side-by-side and excited with a normally incident, linearly polarised plane wave. The surface on the left is modelled as an anisotropic layer and the surface on the right is a metallic surface with equal conductivity in all directions. The anisotropic surface has a high conductivity (equal to that of the metal surface) in the vertical direction and very low conductivity in the horizontal direction. The electric field of the incident plane wave is horizontally polarised. The induced current distribution that is computed by FEKO confirms the expectation that almost no current should be induced on the anisotropic material, as polarisation of the incident plane wave is orthogonal to the direction of high conductivity of the anisotropic material.

Anisotropic material can easily be applied to complex, curved surfaces as is demonstrated here with an F5 aircraft model. The wings and main body of the aircraft are modelled as carbon fibre, with the directions of high conductivity indicated by the dashed line arrows. The current distribution and RCS of the aircraft are then compared to those of the same aircraft, consisting only of metal with the same



(a) Carbon fibre surface with vertical fibre alignment (an anisotropic material)

(b) Metallic surface (an isotropic material)

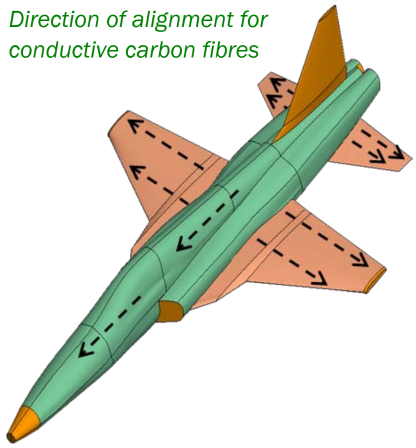
Different current distributions are induced on side-by-side carbon fibre and metallic surfaces when they are excited with a linearly polarised plane wave.

Simulating Composite Materials ... (continued)

conductivity as the fibres of the anisotropic material. The different current distributions and RCS patterns show that the application of anisotropic materials have a very large effect on the EM properties of platforms.

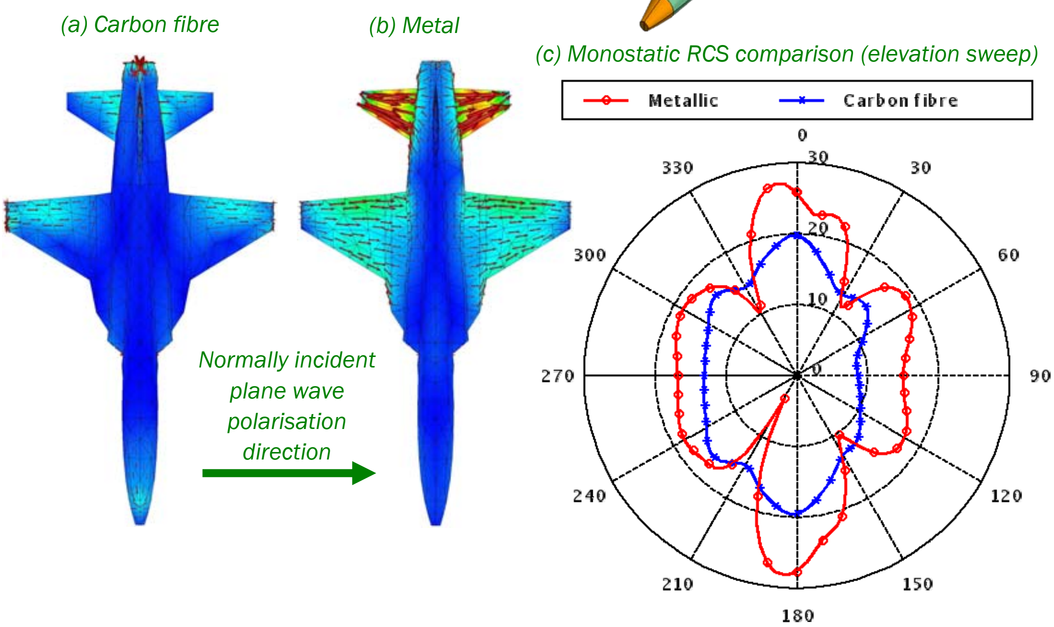
FEKO's anisotropic materials may be applied to any platform and are suitable to be used in full-wave simulation with either the MoM or MLFMM methods. Existing knowledge for the estimation of simulation resource requirements for these methods may thus be applied without modification to problems that include anisotropic materials.

Direction of alignment for conductive carbon fibres



"FEKO's anisotropic materials may be applied to any platform and is suitable to be used in full-wave simulation with either the MoM or MLFMM methods."

Surface current distribution and RCS comparison between carbon fibre and metallic airframes



New Ray Launching GO Based Scattering Analysis

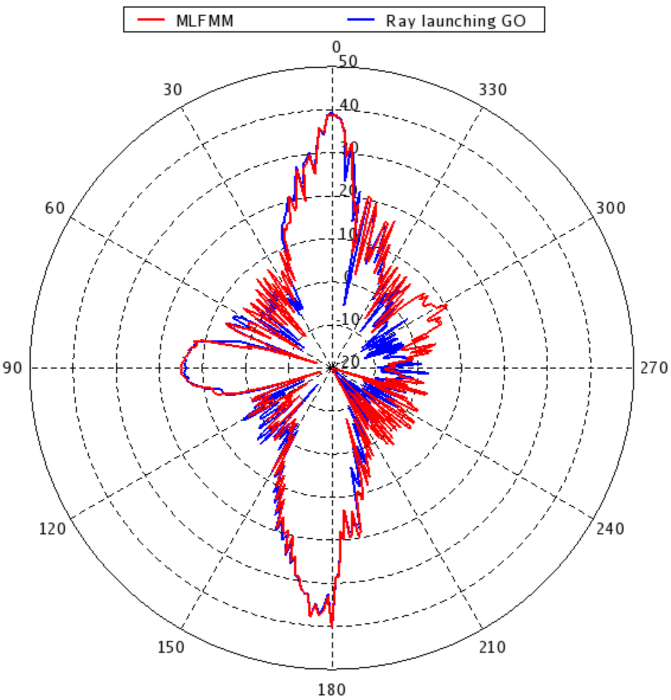
The analysis of the scattering properties of electrically large objects has always been a complex problem. For highly accurate solutions to such problems the premier method is full-wave analysis with the MoM or MLFMM. For electrically very large structures, an asymptotic method such as PO is required.

For very large problems, the full-wave methods result in prohibitive resource requirements, while PO may require a prohibitively large mesh for extremely large problems, while run-time grows exponentially with multiple reflections.

FEKO's Ray Launching Geometrical Optics (RL-GO) method has recently been extended to allow plane wave excitations to address these issues. The RL-GO method (also called "shooting and bouncing rays") is inherently well suited to the solution of large structure scattering problems:

- The mesh only needs to resolve

"The RL-GO method is inherently well suited to the solution of scattering problems for large structures..."



Monostatic RCS of an F5 aircraft, comparing MLFMM (red) and RL-GO (blue) computation methods.

New Ray Launching GO Based Scattering Analysis… (continued)

surface geometry. Smooth surfaces can be meshed into very few triangles, independent of the wavelength.

- The "shooting and bouncing rays" approach is very efficient for arbitrary numbers of multiple reflections.
- Run-time and memory requirements scale almost perfectly for parallel processing. Multi-core CPUs or cluster computers thus operate very efficiently while solving RL-GO problems.
- RCS can be computed with RL-GO, which is not possible with UTD or normal GO due to caustics.

As an example, the RCS of an F5 aircraft was computed at 1 GHz on an azimuthal plane with both the MLFMM and RL-GO methods. The simulation time was roughly the same for the two methods, but the MLFMM required 6.2 GByte of RAM, while the RL-GO only required 190 MByte RAM to solve the same problem! The benefits of scattering analysis with the plane wave RL-GO method thus makes it an ideal tool for the analysis of RCS problems at high frequencies.

Plane wave excitation with RL-GO for the analysis of scattering problems was added to FEKO 5.5 and is now available to customers via FEKO's automatic update mechanism. This update also provides a significant speed-up (up to 4 times) and memory reduction for all RL-GO problems.

CrunchYard: Pay-per-use Simulation on a Large Cluster Computer

EM Software & Systems - S.A. (Pty) Ltd is proud to announce that FEKO is now available to users via CrunchYard, an online simulation service. CrunchYard is operated by CrunchSpace S.A.. The concept for CrunchYard came about a couple of years ago when it was realised that despite the advances in desktop computers, engineers and scientists could often not simulate what they needed to, due to a lack of access to large scale computing power and expensive software licences that are required on such platforms.

CrunchYard offers an engineering software simulation service on a pay per use basis. The service allows scientists and engineers to interactively make use of simulation software via the internet. The benefits of this approach include:

- Reduced cost.
- No infrastructure maintenance is required.
- No hidden costs such as IT support, licensing and computing power.
- Improved performance is shown because simulations are run on a large computing platform.

CRUNCHYARD S1MULAT3 ANYTH1NG !!!

Although CrunchYard is already a powerful simulation platform (50 dual-core CPUs, with roughly 100 GByte RAM), the vision for the system is to grow to a point where the simulation computer will be listed in the TOP500 Super Computers list. In the short term it is planned to double the cluster's capacity in the next 6 months, i.e. add 100 cores and 100 GByte of RAM.

Computational services are currently only offered to existing users of FEKO. Users are able to locally create their simulation models with their own FEKO licences, package the simulation with QUEUEFEKO and then upload the package via the CrunchYard website for simulation.

FEKO users who are interested in testing or using the service should contact their local FEKO distributor for more information.

> **"The vision for the system is to grow to a point where the simulation computer will be listed in the TOP500 Super Computers list."**

Reminder:
The 4th annual International FEKO user meeting will be held on 30 April 2010 in Tampere, Finland, following the ACES 2010 conference.

Please visit the events area on the FEKO website for more information.

FEKO

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Japanese FEKO User Meeting 2009

Dr. Jakobus presenting FEKO 5.5 features

Farad Corporation recently hosted the 2009 Japanese FEKO users meeting. The meeting was held at Akihabara UDX in Tokyo and brought together 24 delegates from all over Japan for two days of lectures, presentations and training relating to FEKO 5.5 (the latest release of FEKO).

Dr. Ulrich Jakobus (FEKO product manager) and Mr. Mel van Rooyen (international support engineer) conducted sessions discussing the new features in FEKO 5.5 and also previewing some of the features that will be released as part of FEKO 6.0, which is scheduled for release during 2010.

A major focus of the meeting was discussions on methods for solving electrically large problems, which were lead by Mr. Toshiyuki Takahashi (FEKO support engineer in Japan).

Farad Corporation has built up a reputation for hosting excellently organised and very informative user meetings and will certainly continue to build on this good work in 2010.

Exhibitions: FEKO will be exhibited at many conferences this quarter, including those listed below.

12 - 16 Apr '10	EuCAP 2010, Barcelona, Spain
25 - 29 Apr '10	ACES 2010, Tampere, Finland
10 - 14 May '10	Radar Conference 2010, Washington D.C, USA
23 - 28 May '10	IMS 2010, Anaheim, California, USA

FEKO Student Competition 2010

Win a notebook computer or a trip to an EM engineering conference of your choice

Submission deadline: September 24, 2010

Who can enter?

- Any under-graduate or post-graduate student working on a project in EM engineering and making use of FEKO
- If your institution does not have a FEKO licence then contact us — it's never too late to start!

Application procedure

For further details, please visit : www.feko.info/educational