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About this issue

In this first edition of 2011, the focus falls on antenna analysis using the Finite Element Method (FEM). The design of a conformal microstrip patch array with Antenna Magus and FEKO is showcased. Details on past and future events, such as the FEKO student competition, user meetings and exhibitions are included in this newsletter.

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Finite Element Method (FEM) Antenna Analysis

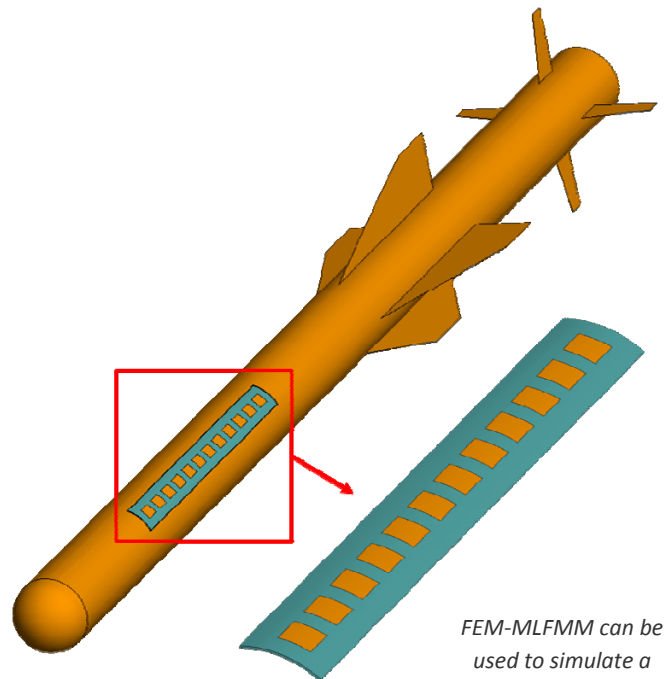
FEKO has built its reputation as an excellent antenna simulation tool on account of its Method of Moments (MoM) solver. In FEKO this solution method has been optimised extensively for antenna design. Complex geometries do however exist where MoM is not the optimal simulation method. FEKO offers users the option of simulating such geometrically or dielectrically complex antennas with the FEM. The FEM problem is confined by a finite element boundary integral. This allows users to specify the FEM region's boundary reasonably close to the radiating structure, saving on computational resources. FEKO was the first commercial electromagnetic simulation software to implement this formulation (July 2005) and is also unique in its hybridisation of the FEM with the MoM and with the Multilevel Fast Multipole Method (MLFMM). With these hybridisations, it is possible to simulate a complex antenna with the FEM, while placing the antenna in the proximity of an electrically large structure.

A case study was performed to demonstrate how these simulation techniques would be applied to different parts of a design. A microstrip patch antenna array was designed and placed on a mock-up of an air defence missile, where it could be used as part of the missile's proximity fuse.

The following specifications were set for the antenna:

- Gain > 10 dBi in the main lobe;
- Side lobe level < -20 dB in all forward-looking directions;
- 45° main lobe squint (measured from the nose of the missile);
- Must conform to the body of the missile;
- Centre frequency of 2.4 GHz.

The design was implemented in three steps. Firstly, an initial design for the antenna array was obtained with Antenna Magus. The antenna's estimated performance from Antenna Magus was then compared to FEKO simulation results. Finally, the antenna was placed on the missile body and simulated in FEKO to establish its performance in its actual operating environment.



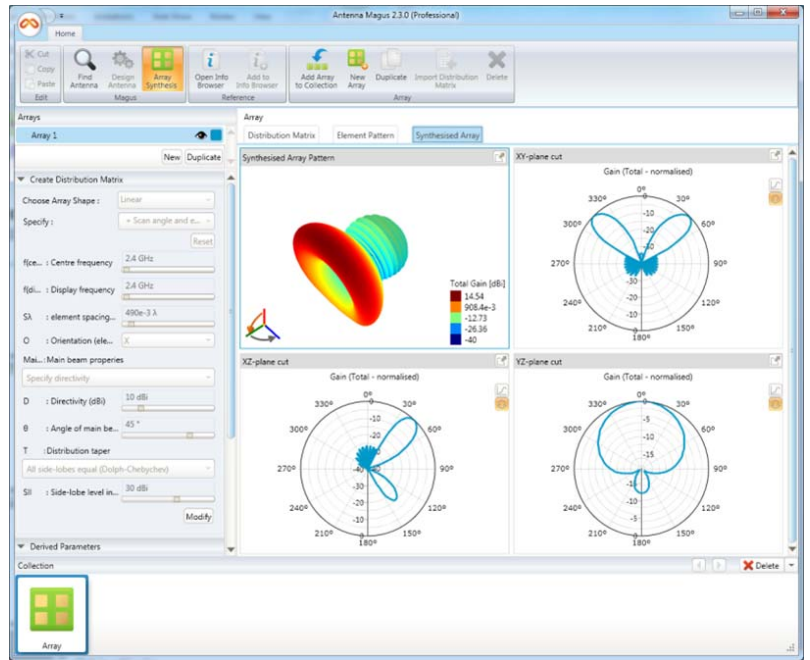
FEM-MLFMM can be used to simulate a conformal array antenna mounted on a large structure, such as this mock-up of an air defence missile.

“FEKO was the first commercial electromagnetic simulation software to implement this formulation (July 2005) and is also unique in its hybridisation of the FEM with the MoM and Multilevel Fast Multipole Method (MLFMM).”



The specified array antenna was designed with the following three steps in Antenna Magus:

- Design the excitation distribution matrix. Specify a linear array, with a 45° scan angle and a Dolph-Chebyshev excitation taper to control the side lobes to below -20 dB.
- Select an appropriate radiating element. Due to the conformal requirements this is dictated to be a microstrip patch antenna. FR4 is used as substrate.
- Estimate the performance of the array. This gives a first order estimate of whether the design will satisfy all requirements.

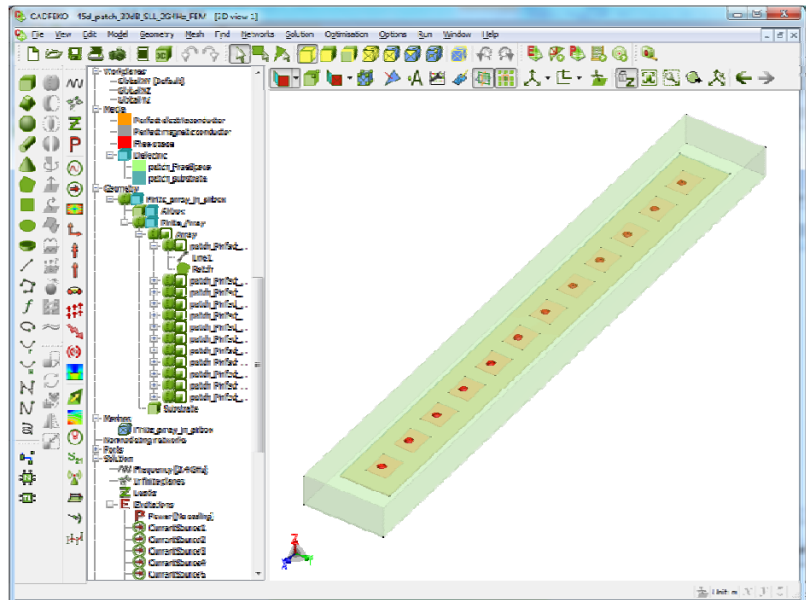


Array design made easy with Antenna Magus.

“The model was exported from Antenna Magus and imported into FEKO...”

The antenna’s predicted radiation patterns were saved in a FEKO file format. The model was exported from Antenna Magus and imported into FEKO where the following two simulation methods were used to test the antenna:

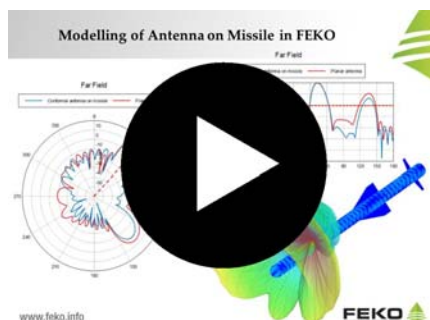
- A model based on the MoM planar Green's function (MoM-GF): This method takes into account mutual coupling, but not finite ground plane effects. It provides a fast solution for the verification of the antenna design.
- A model based on the FEM-MLFMM: This combination of full-wave solution methods includes both mutual coupling and finite ground plane effects in the analysis. (This problem can be solved using other methods, like the FEM-MoM, but the FEM-MLFMM was chosen as it saves on resources and makes it possible to run on a normal desktop computer within reasonable duration.)



FEM-MLFMM model of finite ground plane microstrip antenna array in CADFEKO.

“The detailed workflow of this example can be followed by watching the demonstration video available online...”

Watch the video



The detailed workflow of this example (the simulation of an antenna array mounted on a missile) can be followed by watching the Conformal Antenna Design and Placement demonstration video available online at <http://www.feko.info/product-detail/videos>.

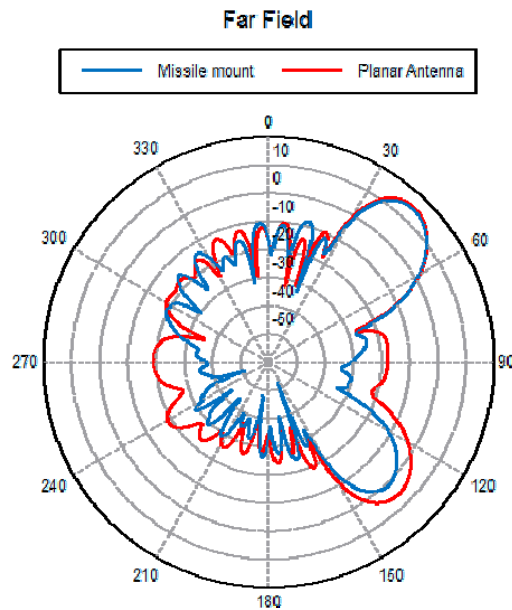
This video follows the simulation cycle in a step-by-step manner, from the synthesis of a microstrip patch array in Antenna Magus to the export of the model into CADFEKO where it is mounted on a mock-up of an air defence missile (constructed using CADFEKO) and the display of FEKO simulation results in POSTFEKO.

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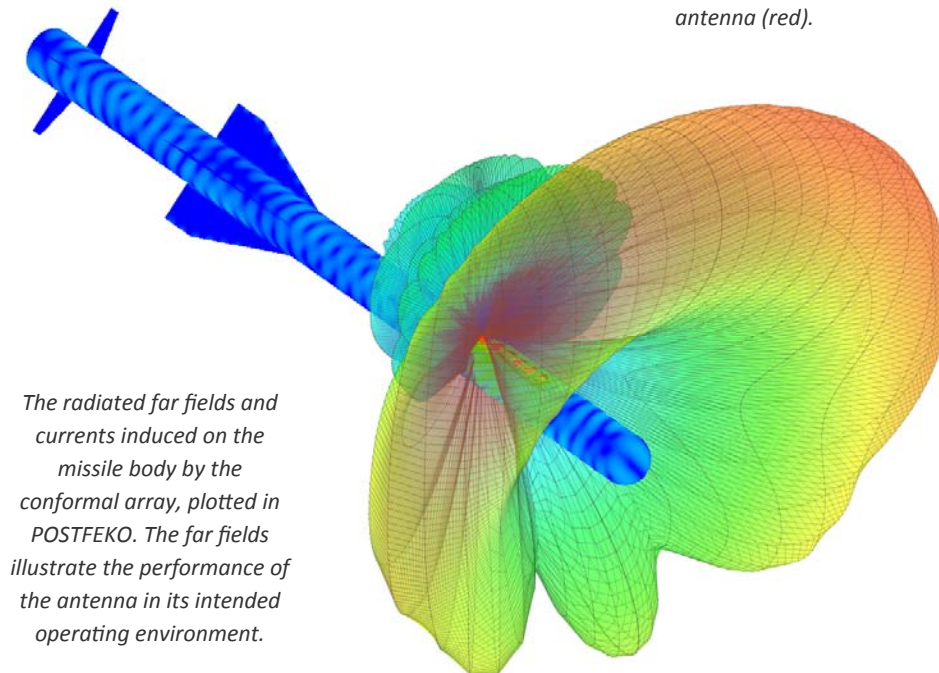
The antenna's predicted performance (estimated with antenna theory in Antenna Magus) was compared to its true performance (accurately simulated in FEKO), showing good correlation. The design of the antenna was complete, with the antenna adhering to the design specifications.

It still remained to be seen whether the antenna would function correctly in its operating environment. The antenna was subsequently integrated onto a mock-up of an air defence missile. The true strength of the FEM-MLFMM hybrid formulation was exploited in this case, treating the complex conformal dielectric antenna and the cavity it resides in with the FEM and the electrically large missile with the MLFMM.

Comparisons between the radiation patterns of the planar array and the conformal array mounted on the missile confirmed that the antenna was performing as required. The antenna's performance was not degraded significantly by conforming it to the missile body and little spurious effects were introduced by the proximity of the missile.



The main lobe of the antenna (blue) has the required 45° squint when mounted on the missile, comparing well to the planar antenna (red).



The radiated far fields and currents induced on the missile body by the conformal array, plotted in POSTFEKO. The far fields illustrate the performance of the antenna in its intended operating environment.

“Comparisons between the radiation patterns... confirmed that the antenna was performing as required.”

FEKO 2011 Student Competition

Students and supervisors alike can look forward to this year's FEKO student competition with exciting prizes up for grabs. A laptop computer or a trip to an international EM engineering conference is the prize for the winning student, and the winner's supervisor will receive a US\$400 Amazon gift voucher for their involvement in the project.

Last year's winner was Christopher Thajudeen from Villanova University (Pennsylvania, USA). Christopher submitted a concise PDF report of five pages in article format. His project focused on through-the-wall radar imaging (TWRI). In his study, he investigated the design of a Dual Stacked Peano Top Loaded Monopole antenna. He included photographs of the fabricated antenna prototype and a comparison between measured and FEKO simulated results. He used this antenna's simulated radiation pattern as radiation point source, along with OPTFEKO, to model Synthetic Aperture Radar (SAR) TWRI scenarios. Christopher received prize money to the value of US\$2000, to put towards a workstation computer for his research.

The FEKO student competition is open to all under-graduate and post-graduate students working on projects in EM engineering and making use of FEKO. Students who would like to start using FEKO in order to enter, but do not have FEKO available at their institution, are welcome to contact us to arrange for a licence. The online entry form and more information can be found at <http://www.feko.info/about-us/student-competition>.

“Students and supervisors alike can look forward to this year's FEKO student competition with exciting prizes up for grabs.”

Local and international FEKO user meetings, where lively discussions take place, are regularly organised by distributors.

Local user meetings were held in Germany, Italy, the UK, South Korea and Japan during the last quarter of 2010.

Farad Corporation hosted the annual Japanese FEKO user meeting in Tokyo on December 6, 2010. The meeting registered its largest attendance figure since its inception. The focus of the meeting was the simplification of POSTFEKO workflows and the future outlook for FEKO development. Feedback from users was very positive and Farad is already planning the next meeting.



Dr Matthys Botha, presenting the development outlook for FEKO at the Japanese FEKO user meeting.

The 2011 International FEKO user meeting will be held in Williamsburg, Virginia, USA, on the 1st of April, after the conclusion of the ACES conference. Dr Ulrich Jakobus, the FEKO product manager, will present the new features that are available in FEKO Suite 6.0 and give an outlook on the next release. Users will be given the opportunity to deliver presentations and participate in open discussions. Registration can be completed online by following the links from www.feko.info/about-us/events. The deadline for registration is the 28th of March 2011. For more information contact Ms Kathy Accolla via email (feko_admin@emssusa.com) or telephone (+1 757 224 0548).

“The 2011 International FEKO user meeting will be held on the 1st of April in Williamsburg, Virginia, USA.”

Exhibitions

FEKO will be exhibited at many conferences this quarter, including those listed below. For a complete list of events and for more information, visit www.feko.info/about-us/events.

15 - 17 March 2011	EMV 2011, Stuttgart, Germany
27 - 31 March 2011	ACES 2011, Williamsburg, Virginia, USA
1 April 2011	International FEKO User Meeting, Williamsburg, Virginia, USA
11 - 15 April 2011	EuCAP 2011, Rome, Italy
7 - 13 May 2011	ISMIRM 2011, Montreal, Canada
5 - 10 June 2011	IMS 2011, Baltimore, Maryland, USA

About FEKO

Applications

- Antenna Design
- Antenna Placement
- EMC Analysis
- Scattering Analysis
- Biomedical

Solution Techniques

- Method of Moments (MoM)
- Multi-level Fast Multipole Method (MLFMM)
- Finite Element Method (FEM)
- Physical Optics (PO)
- Ray-Launching Geometrical Optics (GO)

- Uniform Theory of Diffraction (UTD)
- Planar and Periodic Green Functions
- True Hybridisation of MoM/FEM, MoM/PO, MoM/GO and MoM/UTD
- MoM for Multiple, Complex Dielectric Bodies

Fast Solutions

- Parallel Processing (Multi-Core CPUs, Clusters)
- Fast Frequency Sweep
- Out-of-Core Solving

Model Formats

- Solid Models (Parasolid, DXF, ACIS, CATIA, Pro-E, IGES, STEP, Unigraphics)
- Meshes (CADFEKO, FEMAP, NASTRAN, AutoCAD DXF, STL, PATRAN, ANSYS CDB, ABAQUS, ASCII data format, GID)

Services

- Extended Service Contract
- On-site Training (Short Course)
- CAD Preparation
- Runtime Solutions
- Engineering Consulting Services

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