

Comprehensive
Electromagnetic
Solutions

FEKO



QUARTERLY: June 2006

ACES'06 Special Session: FEKO Modelling and Analysis

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Up and Coming ...

- Mesh refinement in CADFEKO

The Applied Computational Electromagnetics Society (ACES) annual conference provides an opportunity for developers, analysts and end users to get together to discuss the latest advances in computational methods and the latest applications of computational methods to practical problems. The first ever FEKO session at last years' conference was followed up by two sessions this year. This edition of the FEKO quarterly is dedicated to these two sessions, with abstracts of all the papers given below.

The reaction of FEKO users to this event surpassed the very enthusiastic response achieved last year. In total 12 papers were accepted, covering a very wide variety of applications. The presentations were divided into two sessions, one chaired by Dr. C.J. Reddy and the other by Dr. Ulrich Jakobus.

Dr. Jakobus also presented a paper co-authored by Dr. Johann van Tonder and Dr. Marianne Bingle detailing the latest developments in the FEKO kernel regarding the parallel implementation of the MLFMM and the wave-guide port excitations.

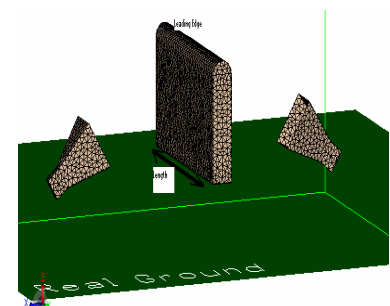
The discussion on the parallelization of the MLFMM highlights the problems encountered during the implementation. Probably the most significant one of these is the new preconditioner that had to be introduced, namely the sparse approximate inverse (SPAI) preconditioner. The speed-up efficiency is shown to be between 95% and 60% from 2 processors to 16 processors.

The new waveguide port excitations available in FEKO were presented, with comparisons between the new method and the existing methods of modeling these feeds. Also shown is the accuracy that can be obtained using these ports for S-parameter extraction.

Thank you to all the people who participated in this event, with special thanks to Dr. C.J. Reddy for facilitating the sessions.

Optimizing Salisbury Screens Using FEKO Randy L. Haupt, Pennsylvania State University, USA.

A Salisbury screen should have zero reflection for normal incidence at the design frequency. Realistically, though, the screen has edge currents that contribute scattering and produces a nonzero return. This paper presents scattering results from small Salisbury screens calculated using FEKO. In addition, results from optimizing the Salisbury screen design are presented.



A notional experimental measurement configuration using aircraft surface mockups.

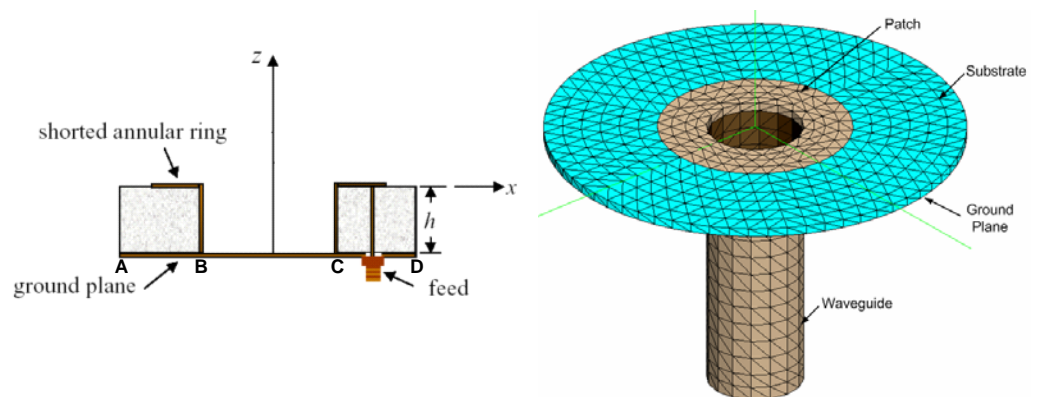
Simulations of Wing Mockup Sizes for EMI Measurements using FEKO. Praveen Anumolu, Ronald Pirich and Danielle Schefer, Northrop Grumman Integrated Systems, Advanced Capabilities Development/ Technology Development Center, USA.

Current and future Electronic Warfare and Intelligence Surveillance Reconnaissance platforms are becoming increasingly more electronically complex. The large number and the resulting near proximity of sources make most systems susceptible to various sources of electromagnetic interference (EMI). Control and mitigation of EMI is prudent in order to ensure interference free operation during active jamming and ISR, as these platforms evolve into more complex, multi-mission ISR networked systems. Northrop Grumman is performing modeling, simulation and validation experiments aimed at quantifying the effectiveness of selected approaches to minimize the effect of electromagnetic interference. Part of this effort requires the accurate modeling, simulation and experimental characterization of various aircraft surfaces. This paper addresses some of the modeling and simulation efforts being used to design appropriate aircraft test surfaces for characterization.

Modeling and Analysis of a Dual-Band Dual-Polarization Radiator Using FEKO. Amir I. Zaghloul¹, C. Babu Ravipati² and M. T. Kawser¹, ¹Virginia Polytechnic Institute and State University, ²Applied EM Inc., USA.

A dual-band antenna element based on shorted annular ring (SAR) design was introduced recently. The use of the central part of the SAR element as a waveguide radiator facilitates an independent radiation at a higher frequency band. This paper presents the modeling and analysis of the hybrid element using the method-of-moment-based software package FEKO. The analysis includes return loss computations showing the element bandwidth at both frequency bands and the radiation patterns in the E- and H-planes. Feeding the element in phase quadrature produces circular polarizations (CP). The radiation patterns of the CP element are also analyzed using FEKO and the axial ratio performance is subsequently assessed.

“It is shown how the synchrotron radiation generated by a single point charge traveling through the vacuum chamber can be calculated with the help of FEKO.”



Microstrip Shorted Annular Ring (left) and the dual band configuration (right)

Meshing Silicon Valley - An HF Antenna over Finite Curved Earth Keith Anthony Snyder, Northrop Grumman Mission Systems, USA.

The purpose of this paper is to show the effect of antenna height, soil conductivity and permittivity, and terrain profile on the radiated antenna pattern of a horizontal HF antenna. The profile of the earth will be modeled using FEKO and will approximate an actual location in Cupertino California in terms of the valley floor and mountains surrounding the antenna. Ground currents and co-pol and cross-pol antenna patterns will be examined.

“FEKO can be easily used to model large finite frequency-selective surfaces with satisfactory accuracy.”

Analysis and Design of a Multiband, Multipolarized Two Arm Sinuous Antenna, Michael C. Buck and Dejan S. Filipović, University of Colorado, USA.

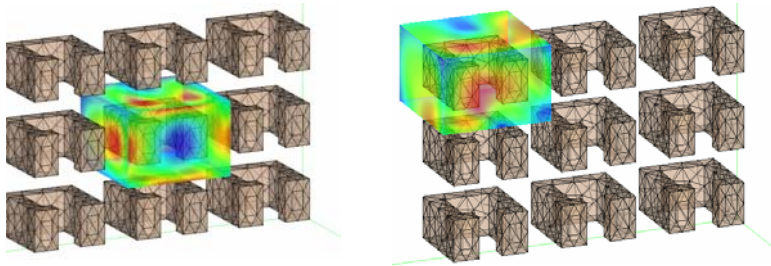
A computational study and design of a two-arm printed sinuous antenna is presented. Most research on sinuous antennas has been limited to geometries with at least four arms for use in applications requiring broadband and dual orthogonally polarized performance. However, we have shown that while achieving broadband performance from a two-arm sinuous antenna is problematic, it is possible to achieve multiband and multipolarized operation with good axial ratio ($AR < 3$ dB) and azimuth pattern symmetry ($WoW3dB < 3$ dB) over several bands with opposite polarization between the neighboring bands.

Coupling between spiral antenna elements of a conformal wideband array, François Chauvet¹, Régis Guinvarc'h¹ and Marc Hélier², ¹SONDRA, Supélec, FRANCE, ²LISIF/Université Pierre et Marie Curie, FRANCE.

An airship platform is planned to be used as a host for conformal wideband array. Its surface allows the assembly of a very large array including many elements. Full modeling of this array cannot be performed with a modeling tool based on method of moment (MoM) as it is too time consuming. Thus, an approximate method must be used for such a large array. The chosen radiating element is a spiral antenna that will be modeled with MoM and integrated in a 1D circular array. Coupling between elements will be evaluated before being neglected in the approximate method. Finally, array radiation patterns for full MoM and the approximate method will be compared.

Method of Simulation of Closely Spaced, Finite, Periodic, Radiating or Reflecting Structures, Including Metamaterials Steven J. Franson¹ and Richard W. Ziolkowski², ¹Motorola Labs, ²University of Arizona, USA.

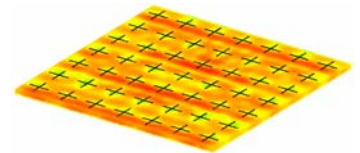
Periodic structures, such as electromagnetic band gap (EBG) or Metamaterial structures, are of increasing interest in antenna design. Typically, these periodic structures are modeled as infinite structures, by using symmetry planes (or perfect E and H planes) in an EM simulator. However, if one wishes to simulate a finite structure in order to investigate coupling or edge effects, the problem can quickly become very memory and time intensive. This paper presents a methodology using the FEKO simulation tool, that will enable the investigation of coupling and finite size structures, which is applicable to any radiating or reflecting structure which has closely spaced elements. In particular, this paper examines an artificial magnetic conductor metamaterial, which has element spacing on the order of a tenth of a wavelength.



Near-field box around center cell (left) and near-field box around top left cell (right)

Modeling Large Finite Frequency-Selective Surfaces with FEKO Rensheng Sun and C. J. Reddy, EM Software & Systems (USA) Inc., USA

It is demonstrated in this article that with the built-in feature of MLFMM, the commercial code FEKO can be easily used to model large finite frequency-selective surfaces with satisfactory accuracy. The scattering from the finite FSS's characterized by planar interfaces with various sizes is studied. The performances on memory usage and CPU-time between different numerical methods are also compared.



Current distribution on a 7x7 crossed dipole array

Self-Adjoint Sensitivity Analysis of High-Frequency Structures with FEKO Jiang Zhu, Natalia K. Nikolaeva, John W. Bandler, McMaster University, Canada

We exploit adjoint sensitivity analysis to extract the gradients of the network parameters in the design parameter space from a Method of Moments (MoM) solution provided by FEKO. We show that an adjoint-problem solution is not needed in the computation of the S-parameter derivatives, which can now be obtained from the full-wave solution with little overhead. We discuss the features of a commercial MoM solver which allow the implementation of our method. We demonstrate this implementation in FEKO through the analysis of a high-temperature superconducting (HTS) bandpass filter. The results are compared with the forward finite-difference derivative estimates.

Using FEKO software for Analysis of Radiated Electric Field by Power Converters Y. Rousset¹, V. Arnavovski-Toseva², C. Pasquier¹, K. El Khamlichi Drissi¹, L. Groev². ¹University 'Blaise Pascal', France, ²Ss. Cyril and Methodius' University Skopje, Macedonia.

In this paper, the authors use FEKO to simulate the electromagnetic field radiated by the power converter circuitry and highlight the effects of modeling the strip as a wire above the PCB, the size of the PCB, the shape of the PCB and position of the load on the PCB. The main objective is to analyze the layout geometry in order to obtain a PCB layout that will reduce the emissions to an acceptable level.

Numerical Simulation of the Generation of Synchrotron Radiation in a Vacuum Chamber with FEKO. Andreas Paech, Thomas Weiland, Technische Universität Darmstadt, Germany

In accelerator physics, deflected charges generate synchrotron radiation. A part of that radiation, generated by a beam passing through a metal vacuum chamber, is used to analyze the characteristics of the accelerated bunch. The aim of this work is to numerically calculate this generation of synchrotron radiation inside the vacuum chamber. Main problems are the very short wavelength and the broad frequency range of interest. As a first step, it is shown how the synchrotron radiation generated by a single point charge traveling through the vacuum chamber can be calculated with the help of FEKO.

Short Course

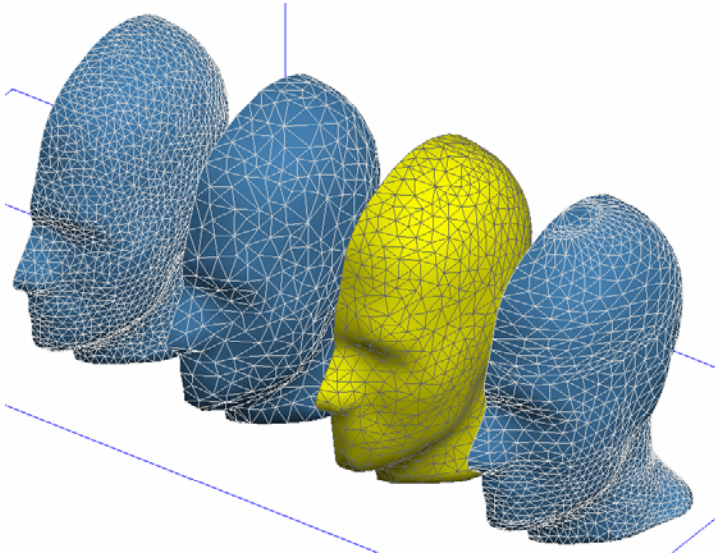
IEEE APS/URSI Symposium, Albuquerque, New Mexico, 7 to 8 July 2006.

Workshop

Antenna Systems 2006, Vienna, Virginia (very close to Washington D.C.) 6-7 September. The workshop "Antenna Design Using FEKO" will be presented the afternoon of the 5th September.

For information on these and other events visit www.feko.info

Up and coming ...



Mesh refinement in CADFEKO

A mesh refinement tool is being incorporated into CADFEKO for the next planned release. This tool is more versatile than the existing tool offered by the RM card in EDITFEKO – It will allow refining of triangle and tetrahedral meshes, as well as coarsening of these meshes. (The RM card subdivides the existing mesh, whereas the new tool creates a new mesh using the original as a reference.)

Pictured above is a mesh import that is relatively badly meshed (bottom right). Note the abundance of very fine triangles near the crown. One run of the refinement tool with the average mesh size from the first mesh produces the far more homogenous mesh to the left of it. The updated mesh uses 1433 triangles opposed to the original 2230, without significantly changing the average edge length.

Shown to the left of the first two images are a slight coarsening and a slight refinement of the original mesh – very useful for analyzing a supplied mesh at an alternate frequency. This tool is expected to improve interaction with imported meshes significantly.

Exhibitions

FEKO will be exhibited at many conferences this quarter – just too many to print! Keep an eye on the website for a more complete list.

We invite all FEKO users to come to the exhibits to discuss any FEKO related issues!

- | | |
|--------------|---|
| 13–15 June | Microwave Theory and Techniques Symposium – San Francisco, California |
| 11–15 June | Bioelectromagnetics Symposium – Cancun, Mexico |
| 9–14 July | Antenna and Propagation Society Symposium – Albuquerque, New Mexico |
| 16–19 July | ANTEM 2006 – Montreal, Canada |
| 14–18 August | IEEE Electromagnetics Symposium – Portland, Oregon |

Comments, queries, contributions or suggestions?

The FEKO Quarterly team wants to hear from you! Please send all correspondence to quarterly@emss.co.za.

Comprehensive Electromagnetic Solutions

APPLICATIONS

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

SOLUTION TECHNIQUES

- Method of Moments (MoM)
- Physical Optics (PO)
- Uniform Theory of Diffraction (UTD)
- True hybridisation of MoM/PO and MoM/UTD

- MoM with Surface and Volume Equivalence Principle for Multiple Dielectric Bodies

- Planar Green's Functions

FAST SOLUTIONS

- Parallel Processing
- Out-of-Core Solving
- Multi-Level Fast Multipole Method (MLFMM)

MODEL IMPORT FORMATS

- Popular Solid model formats (CATIA, Pro-E, ACIS, etc.)
- Many mesh import filters

SERVICES

- Extended Service Contract
- On-site Training (Short Course)

- CAD Preparation
- Runtime Solutions
- Engineering Consulting Services



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