

# **27th Annual Review of Progress in Applied Computational Electromagnetics 2011**

**Williamsburg, Virginia, USA  
27-31 March 2011**

**Volume 1 of 2**

**ISBN: 978-1-62276-237-8**

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2011) by The Applied Computational Electromagnetics Society (ACES)  
All rights reserved.

Printed by Curran Associates, Inc. (2012)

For permission requests, please contact The Applied Computational Electromagnetics Society (ACES)  
at the address below.

The Applied Computational Electromagnetics Society (ACES)  
ECE Department, Room EC-3983  
10555 West Flagler Street  
Miami, FL 33174

Phone: (662) 915-5382  
Fax: (662) 915-7231

[atef@olemiss.edu](mailto:atef@olemiss.edu)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2634  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

# TABLE OF CONTENTS

## VOLUME 1

### UNSTRUCTURED MESH TIME DOMAIN TECHNIQUES

Session Organizer: Joe LoVetri - Session Chairs: Joe LoVetri and Ian Jeffrey

<b>A Generalized Dispersive Material Model for FVTM Method.....</b>	1
<i>L. J. Prokopeva, A. S. Lebedev, M. P. Fedoruk, A. V. Kildishev</i>	
<b>Modelization of Plasma Breakdown by Using Finite Volume Time Domain Method.....</b>	7
<i>A. Hamiaz, R. Klein, X. Ferrieres, O. Pascal, J. P. Boeuf</i>	
<b>Finite-Volume Time-Domain Simulations of MRI RF Coils by Subcell Circuit-Driven Thin-Wire Models.....</b>	13
<i>Ian Jeffrey, Joe LoVetri</i>	
<b>On the Development of a Scattered-Field Formulation for Objects in Layered Media Using the FVTM Method.....</b>	19
<i>Dustin Isleifson, Lot Shafai, Joe LoVetri, David G. Barber</i>	
<b>An Empirical Study of the Effects of Flux Reconstruction on the FVFD Solution of Maxwell's Equations on Unstructured Grids.....</b>	25
<i>Ian Jeffrey, Joe LoVetri</i>	

### SYSTEM-ON-PACKAGE (SoP) WIRELESS COMPONENTS

Session Organizers: Atif Shamim and Langis Roy - Session Chairs: Atif Shamim and Langis Roy

<b>Tunable Ferrite LTCC Embedded Phase Shifters and Isolators.....</b>	31
<i>Joey R. Bray, Atif Shamim</i>	
<b>A Miniaturized Wide-Band LTCC Based Fractal Antenna .....</b>	35
<i>Farhan A. Ghaffar, Atif Shamim, Khaled N. Salama</i>	
<b>A 24 GHz LTCC SOP with Integrated Multi-Dielectric Fresnel Lens.....</b>	41
<i>Muhammad U. Khalid, Atif Shamim, Khaled N. Salama</i>	
<b>A 60GHz Aperture-Coupled Micromachined Microstrip Antenna for Heterogeneous 3D Integration (System-In-Package).....</b>	46
<i>Tristan Sarrazin, Romain Crunelle, Olivier Lafond, Mohamed Hmid, Nathalie Rolland, Langis Roy</i>	
<b>Multi-Layer LCP Technology for Millimetre Wave Applications.....</b>	52
<i>Markku Lahti, Vasily Kondratyev</i>	

### MODELING OF METAMATERIALS AND TRANSFORMATION BASED DEVICES

Session Organizers: Yang Hao and Raj Mittra - Session Chairs: Yang Hao and Raj Mittra

<b>Study of the Optical Black Hole with the FDTD Method.....</b>	57
<i>Christos Argyropoulos, Eftymios Kallos, Yang Hao</i>	
<b>Embedded Transformation Optics Lenses for Antenna Performance Enhancement.....</b>	63
<i>Jeremiah P. Turpin, Zhi Hao Jiang, Pingjuan L. Werner, Douglas H. Werner, Do-Hoon Kwon</i>	
<b>Tuning of Waveguide Bandstop Filter Properties by Changing the Physical Dimensions of Metamaterial Unit Cell.....</b>	69
<i>Jafaar Khalilpour, H. Dalili Oskouei</i>	
<b>Cloud Computing for the Science of Light: Nanophotonics Tools at nanoHUB.org.....</b>	75
<i>Xingjie Ni, Fan Gu, Ludmila Prokopeva, George B. Adams III, Alexander V. Kildishev</i>	
<b>Reduction of Mutual Coupling between Two Closely-Spaced Dielectric Resonator Antennas Using Metamaterial Superstrates.....</b>	81
<i>S. H. Zainud-Deen, Mourad S. Ibrahim, A. Z. Botros</i>	

### OPTIMIZATION TECHNIQUES FOR ELECTROMAGNETICS

Session Organizer: Mohamed Bakr - Session Chair: Mohamed Bakr

<b>Optimal Design of Layered Structures Composed of Materials with Arbitrary Anisotropy .....</b>	87
<i>Nikolay Komarevskiy, Valery Shklover, Leonid Braginsky, Christian Hafner</i>	
<b>Design of Microstrip to Substrate Integrated Waveguide Transitions with Enhanced Bandwidth Using Protruding Vias and EM-Driven Optimization .....</b>	91
<i>Stanislav Ogurtsov, Slawomir Koziel</i>	
<b>The Solution of Thin-Region Inverse Source Problems with Noisy Field Data using the TLM Method.....</b>	97
<i>Yu Zhang, Mohamed H. Bakr, Natalia K. Nikolova</i>	

<b>Adaptive, Black-Box Model Order Reduction Using Radial Basis Functions .....</b>	101
<i>Matthew B. Stephanson, Jin-Fa Lee</i>	

## **30 YEARS OF RWG BASIS FUNCTIONS**

*Session Organizer: Don Wilton - Session Chairs: Don Wilton and S. M. Rao*

<b>Approximating Electromagnetic Field Quantities .....</b>	107
<i>A. W. Glisson, S. M. Rao, D. R. Wilton</i>	
<b>Accuracy Improvement of the Numerical Solutions to the Second-Kind Integral Equations for Electromagnetic Scattering Analysis.....</b>	111
<i>Su Yan, Jian-Ming Jin, Zaiping Nie</i>	
<b>Beyond RWG/Galerkin Solutions of the EFIE: Investigations into Pointmatched, Discontinuous, and Higher Order Discretizations .....</b>	117
<i>Andrew F. Peterson</i>	
<b>A Fast Direct Matrix Solver for Surface Integral Equation Methods for Electromagnetic Wave Problems in <math>\mathbf{R}^3</math> .....</b>	121
<i>Jian-Gong Wei, Zhen Peng, Jin-Fa Lee</i>	
<b>Surface Integral Equation Solution by Fast Fourier Transform Accelerated Multilevel Green's Function Interpolation for Conducting and Impedance Boundary Objects.....</b>	127
<i>Dennis T. Schobert, Thomas F. Eibert</i>	
<b>Hierarchical Vector Basis Functions for Meshes with Hexahedra, Tetrahedra, and Triangular Prism Cells .....</b>	133
<i>Roberto D. Graglia, Andrew F. Peterson</i>	
<b>High-Fidelity Modeling of Complex Multi-Scale Structures through the Method of Moments.....</b>	137
<i>F. Vipiana, M. A. Francavilla, G. Vecchi</i>	
<b>Generalized Impedance Boundary Condition Based on the Finite Element Method and Its Applications to Aid RFID Antenna Design.....</b>	141
<i>Shiquan He, Peng H. Yang, Lijun Jiang, W. C. Chew, Zaiping Nie</i>	
<b>MERCURY MOM™ an Applied RWG EM Scattering Code for Electrically Large Bodies .....</b>	147
<i>John Shaeffer</i>	
<b>LL Basis Functions: Half-Order Increase over RWG Functions Significantly Improves MFIE and CFIE Results .....</b>	153
<i>Levent Gurel, Ozgur Ergul</i>	

## **STUDENT PAPER COMPETITION**

*Session Chairs: Sami Barmada and Gerald DeJean*

<b>Overset Grid Generation Method for the Study of Electromagnetic Field in Rotating Environment .....</b>	159
<i>Shafrida Sahrani, Hiroshi Iwamatsu, Michiko Kuroda</i>	
<b>Analysis of Transient Electromagnetic Scattering from an Overfilled Cavity Embedded in an Impedance Ground Plane .....</b>	165
<i>Robert S. Callihan, Ahhua W. Wood</i>	
<b>Electro-Magnetic Simulation in Design of High Sensitivity NMR Probes using High-Temperature-Superconductors .....</b>	171
<i>Vijaykumar Ramaswamy, Jerris Hooker, Richard S. Withers, Robert E. Nast, Thomas M. deSwiet, Arthur S. Edison, William W. Brey</i>	
<b>Layered <math>\mathcal{H}</math>-Matrix Based LU factorization of Significantly Reduced Complexity for Direct Finite-Element-Based Computation of Large-Scale Electromagnetic Problems .....</b>	177
<i>Haixin Liu, Dan Jiao</i>	
<b>Modeling the Transmission of Ku-Band Communication Signals Through Rocket Plumes.....</b>	183
<i>Bartel van der Veen, Rudy F. Bun, Daniel R. Kirk, Hector Gutierrez, James E. Stanley, Ronald W. Brewer, Dawn Trout</i>	
<b>Equivalent Current Loop Model for the Study of Radiated Electromagnetic Field Interference in Multi-Machine Electric Drives .....</b>	189
<i>M. R. Barzegaran, Ali Sarikhani, Osama A. Mohammed</i>	
<b>Comparison of T-matched and Double T-matched Short Dipole Tag Antennas for UHF RFID Systems .....</b>	195
<i>Toni Björninen, Leena Ukkonen, Atef Z. Elsherbeni, Lauri Sydänheimo</i>	
<b>Adaptive, Black-Box Model Order Reduction Using Radial Basis Functions .....</b>	201
<i>Matthew B. Stephanson, Jin-Fa Lee</i>	
<b>Accuracy Improvement of the Numerical Solutions to the Second-Kind Integral Equations for Electromagnetic Scattering Analysis.....</b>	207
<i>Su Yan, Jian-Ming Jin, Zaiping Nie</i>	

<b>A Fast Direct Matrix Solver for Surface Integral Equation Methods for Electromagnetic Wave Problems in <math>\mathbf{R}^3</math></b> ..... <i>Jian-Gong Wei, Zhen Peng, Jin-Fa Lee</i>	213
<b>Surface Integral Equation Solution by Fast Fourier Transform Accelerated Multilevel Green's Function Interpolation for Conducting and Impedance Boundary Objects</b> ..... <i>Dennis T. Schobert, Thomas F. Eibert</i>	219
<b>Application of a Multi-Solver Domain Decomposition Method for Antenna Placements on a Large Air Platform</b> ..... <i>Xiaochuan Wang, Zhen Peng, Jin-fa Lee</i>	225

## **STUDENT MICROWAVE DESIGN PROJECTS WITH SONNET**

*Session Organizer: Serhend Arvas - Session Chairs: Serhend Arvas and Greg Alton*

<b>3 dB Meander Line Coupler</b> ..... <i>S. Taha Imeci, Ismail Sisman, S. Taha Hazar, Erdem Demircioglu</i>	231
<b>3 dB Offset Wideband Coupler</b> ..... <i>Ismail Sisman, S. Taha Imeci</i>	237
<b>6 dB Hybrid Stripline Coupler</b> ..... <i>S. Taha Imeci, Ismail Sisman</i>	243
<b>4.77 dB Hybrid Stripline Coupler</b> ..... <i>S. Taha Imeci, Ismail Sisman, Erdem Demircioglu</i>	249
<b>Dual-Band Patch Antenna at 15 GHz</b> ..... <i>S. Taha Imeci, Hakan Hizarciooglu, Derya Arican</i>	255
<b>Wideband Microstrip Patch Antenna at 7 GHz</b> ..... <i>S. Taha Imeci, Derya Arican, Hakan Hizarciooglu</i>	261
<b>Dual-Resonance Microstrip Patch Antenna</b> ..... <i>Nesem Keskin, S. Taha Dmeci</i>	267
<b>Patch Antenna with L-Shaped Radiators</b> ..... <i>Z. Merve Sencan, S. Taha Imeci</i>	273

## **ELECTROMAGNETIC SIMULATION USING FEKO**

*Session Organizer: C. J. Reddy - Session Chairs: Ulrich Jakobus and William Coburn*

<b>Adaptive Design Specifications and Coarsely-Discretized EM Models for Rapid Optimization of Microwave Structures with FEKO</b> ..... <i>Slawomir Koziel</i>	279
<b>The Computational Electromagnetic Modelling of the CH-146 Griffon Helicopter Using FEKO</b> ..... <i>Sarah A. Rogers, Joey R. Bray</i>	285
<b>On the Dispersive Properties of Planar Spiral Antennas</b> ..... <i>Mohamed A. Elmansouri, Dejan S. Filipovic</i>	290
<b>Simulation of a GPS Antenna Located at the Roof of an Automobile</b> ..... <i>M. Tecpoyotl-Torres, J. G. Vera-Dimas, J. A. Damian-Morales, J. J. Escobedo-Alatorre</i>	296
<b>Computational Electromagnetic Modeling of SansEC™ Sensors</b> ..... <i>Laura J. Smith, Kenneth L. Dudley, George N. Szatkowski</i>	302
<b>Selection of New Features in the Electromagnetic Solution Kernel of FEKO Suite 6.0</b> ..... <i>Ulrich Jakobus, Marlize Schoeman, Johann van Tonder, Danie Ludick, Willem Burger</i>	308
<b>Electromagnetic Launch Vehicle Fairing and Acoustic Blanket Model of Received Power using FEKO</b> ..... <i>Dawn H. Trout, James E. Stanley, Parveen F. Wahid</i>	314
<b>Development of a Deployable UHF Crossed Dipole Antenna Suitable for Nano Satellites</b> ..... <i>Wendy Lippincott</i>	319
<b>Wire Realization of a Tapered Slot Antenna with Reconfigurable Elements</b> ..... <i>William O'Keefe Coburn, Amir I. Zaghloul</i>	324
<b>VHF Antennas on Unmanned Air Vehicles (UAV) for a Simplified Synthetic Aperture Radar (SAR)</b> ..... <i>Taeyoung Yang, William A. Davis</i>	330
<b>The Use of FEKO in Providing High Fidelity Radar Simulation</b> ..... <i>Erin L. Kashiwada, Eric P. Lam</i>	336
<b>CADFEKO Curve Primitive Geometry Functions to Create a Reduced-Drag, Low-Profile Wideband Antenna</b> ..... <i>Christian W. Hearn</i>	341
<b>RCS Enhancement of Concealed/Hidden Objects at Terahertz (THz)</b> ..... <i>Yoginder Kumar Negi, Venkat Prasad Padhy, N. Balakrishnan</i>	347
<b>Using FEKO for Electromagnetic Analysis of Carbon-Fiber Composite Structures</b> ..... <i>Mohammadali Ansarizadeh, Alper Ozturk, Robert Paknys</i>	351

## **ELECTROMAGNETIC SIMULATIONS USING SONNET**

*Session Organizer: Serhend Arvas - Session Chairs: Serhend Arvas and Greg Alton*

<b>Sonnet EM Simulation of Printed Baluns Using PCB Data Extraction</b>	357
<i>Claudio M. Montiel</i>	
<b>Simulation and Design of a Tunable Patch Antenna</b>	363
<i>Benjamin D. Horwath, Talal Al-Attar</i>	
<b>Design of a Multi-Spiral Solenoidal Inductor for Inductive Power Transfer in Biomedical Applications</b>	369
<i>Ashraf B. Islam, Syed K. Islam</i>	
<b>Derivative-Free Design Optimization of Sonnet-Simulated Structures Using Shape-Preserving Response Prediction and Space Mapping</b>	375
<i>Slawomir Koziel</i>	
<b>Tuning Space Mapping for Microwave Design Optimization</b>	381
<i>Slawomir Koziel, John W. Bandler, Qingsha S. Cheng</i>	
<b>RFIC Test Board Design and Modeling using Sonnet™</b>	387
<i>Koh Minghao, Regina Gani, Grant A. Ellis</i>	
<b>Sonnet in RF Power Amplifier Design</b>	393
<i>Abdullah Eroglu</i>	
<b>Sonnet Modelling and Simulation of Broadband Branchline Coupler</b>	398
<i>Abdulkadir Yilmaz, Emine Rumeysa Cetiner, Moamer Hasanovic</i>	
<b>Sonnet Modeling and Simulation of Wilkinson Power Divider with OhmegaPly Resistor</b>	403
<i>Velid Kasapovic, Samir Prcanovic, Moamer Hasanovic</i>	
<b>Sonnet in Directional Coupler Design</b>	408
<i>Abdullah Eroglu</i>	
<b>Driving Sonnet through a Python-based Interface</b>	412
<i>Daniel Becerra-Perez, Jose E. Rayas-Sanchez</i>	
<b>Design of a V-band Phase Shifter Using SP4T RF-MEMS Switches with Sonnet</b>	418
<i>Songbin Gong, N. Scott Barker</i>	

## **DIELECTRIC RESONATOR ANTENNAS**

*Session Organizer: Yahia Antar - Session Chairs: Ahmed Kishk and Slawomir Koziel*

<b>Design Optimization of a Dielectric Ring Resonator Antenna for Matched Operation in Two Installation Scenarios</b>	424
<i>Stanislav Ogurtsov, Slawomir Koziel</i>	
<b>Finite Element Analysis of a QWCCR with Dielectric Slugs</b>	429
<i>Andrew D. Lowery, Mike Spencer, Franz A. Perl, James E. Smith</i>	
<b>Curved Dual-Band Dielectric Resonator Tag Antenna for RFID Applications</b>	435
<i>S. H. Zainud-Deen, H. A. Malhat, K. H. Awadalla</i>	
<b>Circular Polarized Dielectric Resonator Antenna for Portable RFID Reader Using a Single Feed</b>	441
<i>S. H. Zainud-Deen, H. A. Malhat, K. H. Awadalla</i>	
<b>Radiation Characteristics of Cylindrical Dielectric Resonator Antenna Mounted on Superquadric Cylindrical Body</b>	447
<i>S. H. Zainud-Deen, Noha A. El-Shalaby, K. H. Awadalla</i>	

## **NEW ELECTROMAGNETIC TECHNIQUES AND MEASUREMENTS**

*Session Organizers: Leo Kempel and Shankar Balasubramaniam - Session Chairs: Shankar Balasubramaniam and Kubilay Sertel*

<b>The Method of Auxiliary Sources for Solving Low-Frequency Electromagnetic Induction Problems in Underwater Environments</b>	453
<i>Fridon Shubitidze, Benjamin E. Barrowes, Juan Pablo Fernández, Irma Shamatava, Kevin O'Neill</i>	
<b>Antenna Diagnostics and Measurement Postprocessing Using Equivalent Source Technique</b>	459
<i>L. J. Foged, L. Scialacqua, F. Mioc, M. Sabbadini, J. L. Araque Quijano, G. Vecchi</i>	
<b>Iterative Method to Reduce Truncation Errors in Partial Spherical Near-Field Antenna Measurements</b>	464
<i>E. Martini, S. Maci, L. J. Foged</i>	
<b>Proposed Approach to a Three-Dimensional, High Speed Magnetic Tracking System with a Permanent Magnetic Source</b>	470
<i>Andrew D. Lowery, Franz A. Perl, James E. Smith</i>	
<b>Advanced Modeling and Simulation for Test and Evaluation of Electromagnetic Threat Assessment</b>	476
<i>Vijaya Shankar, Touraj Sahely, Willian Hall, Chris Rowell</i>	

## **ADVANCES AND CHALLENGES IN COMPUTATIONAL ELECTROMAGNETIC MODELING OF RFID SYSTEMS**

*Session Organizers: Leena Ukkonen and Lauri Sydänheimo - Session Chairs: Leena Ukkonen and Lauri Sydänheimo*

<b>IE Analysis of Scattering From Multilayered Doubly Periodic Array Of 3-D PEC Objects Using Equivalence Principle And Connection Scheme .....</b>	482
<i>Fu-Gang Hu, Jiming Song, Telesphor Kamgaing</i>	
<b>Energy Transfer Function of the Human Torso: RFID EMR Power to CRMD Voltage .....</b>	488
<i>Ajay Ogirala, Joshua R. Stachel, Marlin H. Mickle</i>	
<b>Important Equations for Designing Very Small Normal-Mode Helical Antennas.....</b>	494
<i>Nguyen Quoc Dinh, Naobumi Michishita, Yoshihide Yamada, Koji Nakatani</i>	
<b>Comparison of T-matched and Double T-matched Short Dipole Tag Antennas for UHF RFID Systems .....</b>	500
<i>Toni Björnininen, Leena Ukkonen, Atef Z. Elsherbeni, Lauri Sydänheimo</i>	
<b>Analysis of Electromagnetic Interference to Cardiac Implantable Electronic Devices from RFID using Tissue Interface Circuit.....</b>	506
<i>Ajay Ogirala, Michael A. Rothfuss, Joshua R. Stachel, Ravikiran Yalamanchili, Marlin H. Mickle, Samir Saba</i>	

## **VOLUME 2**

### **ELECTROMAGNETIC SIMULATION OF ELECTRICALLY LARGE PROBLEMS**

*Session Organizer: C. J. Reddy and Deb Chatterjee - Session Chairs: Robert Burkholder and C. J. Reddy*

<b>Experimental Verification of New Hybrid MM/PO Method.....</b>	512
<i>Maria A. Buzova</i>	
<b>An Efficient Locally Implicit Discontinuous Galerkin Finite-Element Time-Domain Scheme Based on the Combination of Crank–Nicolson Method and Block Gauss–Seidel Iteration .....</b>	517
<i>Jiefu Chen, Luis Tobon, Mei Chai, Jason A. Mix, Qing H. Liu</i>	
<b>Computational Design and Analysis of Radomes.....</b>	522
<i>Henry A. Burger</i>	
<b>Physics Based High-Frequency Asymptotic Extrapolation of the Radiation from a Source Near a Large Structure.....</b>	528
<i>Alejandro Casanova, Robert J. Burkholder, Prabhakar H. Pathak</i>	
<b>An <math>\mathcal{H}^2</math> -Matrix Based Fast Volume Integral Equation Solver for Electrodynamic Analysis .....</b>	534
<i>Saad Omar, Dan Jiao</i>	
<b>Application of a Multi-Solver Domain Decomposition Method for Antenna Placements on a Large Air Platform.....</b>	540
<i>Xiaochuan Wang, Zhen Peng, Jin-Fa Lee</i>	
<b>Fields in Electrically Thick Materials via the Sommerfeld Integral and FDTD.....</b>	546
<i>Michael S. Kluskens, Henry J. Bilow, Richard S. Schechter</i>	
<b>Aircraft Resonant Cavity and Cabin Interference Coupling to a Remote Sensing, Wing-Mounted Antenna Array .....</b>	552
<i>Kyle Byers, Sarah A. Seguin, Michael Cracraft</i>	
<b>Application of AIM to High-Resolution Bioelectromagnetics Simulations.....</b>	558
<i>Tahir Malas, Fangzhou Wei, Jackson Massey, Cemil S. Geyik, Ali E. Yilmaz</i>	
<b>An Ultra-Wideband FMM for Multi-scale Electromagnetic Simulations.....</b>	564
<i>M. Vikram, C. Knowles, B. Shanker, L. C. Kempel</i>	
<b>RCS Estimation of Complex Shaped Aircraft and RCS Reduction using Partial RAM Coating .....</b>	570
<i>A. Upendra Raju, Yoginder Kumar Negi, Jyothi Balakrishnan</i>	

### **ELECTROMAGNETIC-SIMULATION-DRIVEN-DESIGN: MODELING AND OPTIMIZATION**

*Session Organizer: Slawomir Koziel - Session Chairs: Slawomir Koziel and John W. Bandler*

<b>Response Correction Techniques for Microwave Design Optimization.....</b>	576
<i>Slawomir Koziel</i>	
<b>Simulation-Driven Design of Microstrip-to-CPW Transitions Using Variable-Fidelity EM Models .....</b>	582
<i>Slawomir Koziel, Stanislav Ogurtsov</i>	
<b>S-parameter Sensitivity Analysis of Planar Antennas using Self-adjoint Approach with the Method of Moments .....</b>	588
<i>Yifan Zhang, Manoj K. Meshram, Natalia K. Nikolova</i>	

<b>Optimal Position for an Antenna using a Genetic Algorithm .....</b>	594
<i>Jamie Knapil Infantolino, M. Jeffrey Barney, Randy Haupt</i>	
<b>Parametric Modeling and Fast optimization of a 3D Multiband Antenna using Neural Network Technique .....</b>	599
<i>Venu-Madhav-Reddy Gongal-Reddy, Yazi Cao, Qi-Jun Zhang</i>	
<b>Cantilever-based Microwave Biosensors: Analysis, Designs and Optimizations.....</b>	605
<i>Chenhai Jiang, Tom K. Johansen, Saevar Jonasson, Lei Yan, Anja Boisen</i>	
<b>Electro-Magnetic Simulation in Design of High Sensitivity NMR Probes using High-Temperature-Superconductors .....</b>	611
<i>Vijaykumar Ramaswamy, Jerris Hooker, Richard S. Withers, Robert E. Nast, Thomas M. deSwiet, William W. Brey, Arthur S. Edison</i>	
<b>Computer Aided Design of a Short Base Line Interferometer with Quadrature Balancing .....</b>	617
<i>Ryan Fillman, Steven Pizzo, Brian LaRocca</i>	
<b>High Frequency Electromagnetic Field Model for the Evaluation of Parasitic Elements in Power Converters.....</b>	623
<i>Mohammadreza Barzegaran, Arash Nejadpak, Osama A. Mohammed</i>	
<b>Characterization of a Planar Two-Arm Self-Complementary Square Spiral Antenna Using the Numerical Electromagnetic Code (NEC).....</b>	630
<i>Ricardo Matias</i>	
<b>Overset Grid Generation Method for the Study of Electromagnetic Field in Rotating Environment .....</b>	636
<i>Shafrida Sahrani, Hiroshi Iwamatsu, Michiko Kuroda</i>	

### **ADVANCES IN FINITE ELEMENT METHOD AND APPLICATIONS**

*Session Organizer: Osama Mohammed - Session Chairs: Osama Mohammed and Andrew Peterson*

<b>Analysis of Transient Electromagnetic Scattering from an Overfilled Cavity Embedded in an Impedance Ground Plane .....</b>	642
<i>Robert S. Callihan, Aihua W. Wood</i>	
<b>Dispersion Analysis for Mixed Finite Element Method for Maxwell's Equations .....</b>	648
<i>Luis Tobon, Jiefu Chen, Qing H. Liu</i>	
<b>Equivalent Current Loop Model for the Study of Radiated Electromagnetic Field Interference in Multi-Machine Electric Drives .....</b>	654
<i>Mohammadreza Barzegaran, Ali Sarikhani, Osama A. Mohammed</i>	
<b>A Spectral Element Time Domain Method for Two Dimensional Electromagnetic Scattering of Dispersive Materials .....</b>	660
<i>Ma Luo, Qing Hua Liu</i>	
<b>Adaptive Refinement for the Locally-Corrected Nyström Method Based on an Implicit Error Estimation Scheme .....</b>	666
<i>Usman Saeed, Andrew F. Peterson</i>	

### **REFLECTARRAY ANALYSIS AND DESIGN**

*Session Organizers: Fan Yang and Atef Elsherbeni - Session Chairs: Fan Yang and Wenhua Yu*

<b>Radiation Analysis of Reflectarray Antennas: Array Theory Approach versus Aperture Field Approach .....</b>	671
<i>Payam Nayeri, Fan Yang, Atef Z. Elsherbeni</i>	
<b>Scattering Analysis of Periodic Microstrip Reflectarrays Using Scale-Changing Technique .....</b>	677
<i>Farooq Ahmad Tahir, Herve Aubert</i>	
<b>An Effective Technique for Enhancing Anti-Interference Performance of Adaptive Virtual Antenna Array.....</b>	683
<i>Wenxing Li, Yipeng Li, Lili Guo, Wenhua Yu</i>	
<b>A Novel Electrical Model to an Antenna Array .....</b>	689
<i>Abdelhak Ferchichi, Nejib Fadhlallah, Ali Gharsallah</i>	

### **TOPICS IN RADAR SCATTERING**

*Session Organizers: M. D. Abouzahra and J. Wilson - Session Chairs: M. D. Abouzahra and J. Wilson*

<b>A Scattering Center-Based Prediction Method for Shadowing and Two-Body Interactions .....</b>	695
<i>Joshua L. Wilson, Brian W. Rybicki, Lea E. Johnson, Douglas M. Koltenuk</i>	
<b>Extended Radar Return from a Rocket Engine: A Thermal Model.....</b>	701
<i>Michael Burrows</i>	
<b>Wind Turbine RCS Modeling and Validation.....</b>	705
<i>Audrey J. Dumanian, Douglas M. Koltenuk, Joshua L. Wilson</i>	

<b>Efficient Analysis of Two-Dimensional RCS Scattering Analysis using the MRFD Technique</b>	710
<i>Mesut Gokten, Atef Z. Elsherbeni, Ahmet F. Yagli</i>	
<b>Scattering from Small Grooves on a Conical Surface</b>	716
<i>Andrew N. O'Donnell, Robert J. Burkholder</i>	

## **ELECTROMAGNETIC SIMULATION USING WIPL-D**

*Session Organizers: Branko Kolundzija and Milos Pavlovic - Session Chairs: Branko Kolundzija and Saad Tabet*

<b>A Compact Cavity-Backed Dipole Design using WIPL-D</b>	722
<i>Pranjal Borah, G. Shankar</i>	
<b>Cavity Filter Design and Optimization in WIPL-D</b>	727
<i>J. Lyn Alford, Milos Pavlovic</i>	
<b>Benchmarking GPU Accelerated WIPL-D Out-of-Core Solver</b>	733
<i>Dusan P. Zoric, Dragan I. Olcac, Branko M. Kolundzija</i>	
<b>Analysis and Design of Horn Antenna at 10GHz using WIPL-D</b>	739
<i>V. Rajya Lakshmi, G. Raju</i>	
<b>Bandwidth Enhancement of a Dipole-Disk Feed using WIPL-D</b>	744
<i>G. Sankar, B. Hanumanth Rao</i>	
<b>Optimization of Reception Antenna Composed with Unbalanced Fed Inverted L Element for Digital Terrestrial Television</b>	749
<i>Daisuke Yagyu, Mitsuo Taguchi</i>	
<b>Validating the Magnetostatic Frill Source with WIPL-D</b>	755
<i>Ted Simpson, Milos Pavlovic</i>	
<b>Efficient Large Array Modeling with WIPL-D</b>	761
<i>Lance Bradstreet, Harvey K. Schuman, Donald McPherson</i>	
<b>Mutual Coupling of Internal Transmit/Receive Pair in Launch Vehicle Fairing Model using WIPL-D</b>	766
<i>Dawn H. Trout, James E. Stanley, Parveen F. Wahid</i>	
<b>AntNet: A Fast Antenna Network Analysis Add-On for WIPL-D</b>	772
<i>Daniel S. Weile, Derek S. Linden</i>	
<b>Electric Field Enhancement with a Porous Spherical Cavity Resonator Excited by an External Plane Wave</b>	777
<i>Paul A. Bernhardt</i>	
<b>Numerical Modeling for the Design of a Vivaldi Antenna as Transmitter in a Reverberation Chamber</b>	783
<i>Jean-Pierre Ghys, Divitha Seetharamdoo, Isacco M. Coccato, Milos Pavlovic, Marion Berbineau</i>	
<b>Simulation and Analysis of HEMP Coupling Effect on Wires Inside a Shielding Cavity with Apertures</b>	789
<i>Shu-Ting Song, Hong Jiang, Yu-Lan Huang</i>	
<b>Analysis of H-Plane Slot Coupled Tee Junction using WIPL-D</b>	795
<i>P. Anthony Sunny Dayal, V. Rajya Lakshmi, G. Raju</i>	

## **ADVANCES IN ANTENNA DESIGN AND APPLICATIONS**

*Session Chairs: Anne McKenzie and Amir Zaghloul*

<b>Improving the Performance of Loop Antenna by Using a Dual Feeding System</b>	800
<i>Saad Mohamed Alhossin</i>	
<b>Kernel Approximation for Efficient Computation to Solve the Straight-Wire Antenna</b>	805
<i>William A. Davis</i>	
<b>Octafilar Helical Antenna for Handheld UHF RFID Reader</b>	810
<i>S. H. Zainud-Deen, H. A. Malhat, K. H. Awadalla</i>	
<b>Performance Comparison of Uniform EBG and Broadband Progressive EBG Inside a Back Cavity of a Spiral Antenna</b>	816
<i>Sandeep Palreddy, Amir I. Zaghloul, Rudolf Cheung</i>	
<b>E-shaped Patch Antenna with Reconfigurable Circular Polarization for Wireless Applications</b>	821
<i>Ahmed Khidre, Kai-Fong Lee, Fan Yang, Atef Elsherbeni</i>	
<b>Bandwidth Enhancement of Circularly Polarized Patch Antenna using Lumped LC Matching Circuit</b>	826
<i>Qian Qiao, Fan Yang, Atef Z. Elsherbeni</i>	
<b>Numerical Analysis of the Impact of Dynamic RF Spectrum Assignments on Resonating Cavities Using Standardized Data Comparison Techniques</b>	832
<i>Irina Kasperovich, Andrew L. Drozd, Adrienne A. Croneiser</i>	
<b>Design of a High Directivity Dual Tapered Slotline Antenna</b>	838
<i>Shadrach A. Elechi, Brian A. Lail</i>	
<b>Robust Localization Techniques for Wireless Sensor Networks Using Adaptive Beamforming Algorithms</b>	842
<i>A. R. Kulaib, R. M. Shubair, M. A. Al-Qutayri, Jason W.P. Ng</i>	

## **SPACE APPLICATIONS**

*Session Organizers: James Stanley and Dawn Trout - Session Chairs: James Stanley and Dawn Trout*

<b>Evaluation of Lightning Induced Effects in a Graphite Composite Fairing Structure (Part 1)</b>	848
<i>Dawn H. Trout, James E. Stanley, Parveen F. Wahid</i>	
<b>Evaluation of Lightning Induced Effects in a Graphite Composite Fairing Structure (Part 2)</b>	854
<i>Dawn H. Trout, James E. Stanley, Parveen F. Wahid</i>	
<b>Modeling Electrostatic Fields Generated by Internal Charging of Materials in Space Radiation Environments</b>	860
<i>Joseph I. Minow</i>	
<b>Modeling the Transmission of Ku-Band Communication Signals Through Rocket Plumes</b>	866
<i>Barrel van der Veen, Rudy F. Bun, Daniel R. Kirk, Hector Gutierrez, James E. Stanley, Ronald W. Brewer, Dawn Trout</i>	
<b>NASA Applications for Computational Electromagnetic Analysis</b>	872
<i>Catherine Lewis, Dawn H. Trout, Mark E. Krome, Thomas A. Perry</i>	

## **ANTENNA ENHANCEMENT AND ASSESSMENT TECHNIQUES**

*Session Chairs: Douglas H. Werner and Erik Vedeler*

<b>Study on Different Types of AMCs and Its Application to HIS Ground Planes with Wire Antenna</b>	878
<i>Seungwoo Lee, Nam Kim, Seung-Yeup Rhee</i>	
<b>Assessment of Feature Selective Validation (FSV) Method for Comparing Modeled Antenna Patterns Against Measurements</b>	884
<i>Alex Hastings, Kedar Tamhankar, George Palafox</i>	
<b>Q Limits for Arbitrary-Shaped Multi-Mode Antennas Using Characteristic Modes</b>	890
<i>Jeffrey Chalas, Kubilay Sertel, John L. Volakis</i>	

## **PARALLEL AND HARDWARE ACCELERATION FOR COMPUTATIONAL ELECTROMAGNETICS**

*Session Organizers: Poman So and Ozlem Kilic - Session Chairs: Ozlem Kilic and Matthew Inman*

<b>Accelerating the Finite Difference Time Domain (FDTD) Method with CUDA</b>	896
<i>James F. Stack Jr.</i>	
<b>A Novel Hardware Acceleration Technique for High Performance Parallel Conformal FDTD Method</b>	902
<i>Wenhua Yu, Xiaoling Yang, Yongjun Liu, Raj Mittra</i>	
<b>Three-Dimensional Electromagnetic Inversion Code with Gauss-Newton Method Parallelization</b>	908
<i>Guangdong Pan, Jianguo Liu, Aria Abubakar, Tarek Habashy</i>	
<b>GPU-Accelerated Thin Wire Computations Coupled to DGFEM Electromagnetic Field Formulations</b>	912
<i>N. Godel, T. Warburton, M. Clemens</i>	
<b>Accelerating Phase-Only Reflectarray Antenna Synthesis by GPUs</b>	918
<i>A. Capozzoli, C. Curcio, A. Lisenko, M. Migliorelli, G. Toso</i>	
<b>Interferometric Imaging through Random Media using GPU</b>	924
<i>Ozlem Kilic, Andrew Smith, Esam El-Araby, Vinh Dang</i>	
<b>Optimizing Multiple GPU FDTD Simulations in CUDA</b>	930
<i>Matthew J. Inman, Atef Z. Elsherbeni</i>	

## **ADVANCES IN FDTD METHOD AND APPLICATIONS**

*Session Organizer: Atef Elsherbeni - Session Chairs: Mohammed Hadi and Mesut Gokten*

<b>Closed-Form Optimization of CPML Absorbing Boundary Conditions</b>	934
<i>Mohammed F. Hadi</i>	
<b>Scattering From Three Dimensional Gyrotropic Bodies Using FDFD Method</b>	939
<i>Ahmet F. Yagli, Mesut Gokten, Sehabettin T. Imeci, Lokman Kuzu</i>	
<b>Design and Analysis of Reconfigurable Frequency Selective Surfaces using FDTD</b>	945
<i>Khaled ElMahgoub, Fan Yang, Atef Elsherbeni</i>	
<b>Resolution Study for Detection Algorithm Based on Self-adjoint Sensitivity Analysis with Microwave Responses</b>	950
<i>Yifan Zhang, Li Liu, Natalia K. Nikolova</i>	
<b>Electromagnetic-Thermal Analysis of an RF Rectangular Resonant Cavity Applicator for Hyperthermia Targeting Deep-Seated Tumor and Using Thermal Modulation</b>	956
<i>Yutaka Tange, Yasushi Kanai</i>	

<b>Nanoplasmonics FDTD Simulations Using a General Dispersive Material Model .....</b>	962
<i>Ludmila J. Prokopeva, Alexander V. Kildishev, Jieran Fang, Joshua Borneman, Mark D. Thoreson, Vladimir M. Shalaev, Vladimir P. Drachev</i>	
<b>Improving CPML Implementation using Piecewise Linear Recursive Convolution Technique.....</b>	968
<i>Gyusub Kim, Veysel Demir, Ercument Arvas</i>	
<b><u>NUMERICAL TECHNIQUES FOR ELECTROMAGNETIC APPLICATIONS</u></b>	
<i>Session Chairs: Christopher Trueman and Sami Barmada</i>	
<b>Voltage and Current Analysis for Arcing Detection on AC Overhead Electrified Railways .....</b>	974
<i>S. Barmada, A. Musolino, M. Tucci</i>	
<b>Ricean and Rayleigh Distribution Functions for Estimating Field Distributions in Indoor Propagation.....</b>	979
<i>Mehdi Ardavan, Christopher W. Trueman, Ketra Schmitt</i>	
<b>Modeling of Implantable Passive LC Sensors for Biomedical Applications .....</b>	985
<i>Hao Jiang, Di Lan, Shiyu Zhou, Ken Goldman, Neel Shah, Mozziyar Etemadi, Hamid Shahnasser, Shuvo Roy</i>	
<b>Non-Linear Modeling of Active or Passive Optical Lamellar Nanostructures .....</b>	991
<i>A. Kildishev, X. Ni, L. Prokopeva, T. Knyazyan, H. Baghdasaryan</i>	
<b>Low-Frequency Response of a Sphere Embedded in Water .....</b>	997
<i>Juan Pablo Fernández, Benjamin E. Barrowes, Alex Bijamov, Tomasz Grzegorczyk, Kevin O'Neill, Irma Shamatava, Fridon Shubitidze</i>	
<b>Layered <math>\mathcal{H}</math>-Matrix Based LU Factorization of Significantly Reduced Complexity for Direct Finite-Element-Based Computation of Large-Scale Electromagnetic Problems .....</b>	1003
<i>Haixin Liu, Dan Jiao</i>	
<b>A Fast <math>\mathcal{H}</math>-Matrix Based Direct Integral Equation Solver for the Analysis of Large-Scale Dielectric Scatterers.....</b>	1009
<i>Wenwen Chai, Dan Jiao</i>	
<b>Power Containment of Hybrid Electromagnetic Modes of Cylindrical Dielectric Waveguide .....</b>	1015
<i>A. Maalik, M. Kamran, I. E. Rana, S. Ikram</i>	
<b>Hemispherical Dielectric Resonator Antenna Mounted on or Embedded in Spherical Ground Plane with a Superstrate.....</b>	1021
<i>S. H. Zainud-Deen, Noha A. El-Shalaby, K. H. Awadalla</i>	
<b>High-Directive Dielectric Resonator Antenna over Curved Ground Plane Using Metamaterials.....</b>	1027
<i>S. H. Zainud-Deen, Mourad S. Ibrahim, A. Z. Botros</i>	
<b>Author Index</b>	