IEEE Antennas and Propagation & Microwave Theory and Techniques Societies present a workshop on:

Advanced Antennas for Satellites, Aircraft and Remote Sensing Applications

Professional development credit hours available

See page 2 for details

Workshop Day:
Saturday
September 13, 2014

Location:
Motorola Mobility
222 W Merchandise Mart Plaza,
Chicago, Illinois

*Everyone is **required** to sign the Motorola NDA*
Check in at the Motorola Security Desk on the first floor

Pricing:
$150 – Non Members
$100 – Members
$40 – Students

Please make checks payable to "IEEE Chicago Section"

Website:
http://erricolo.engr.uic.edu/antenna-workshop/

Workshop Schedule:

7:30 am – 8:30 am Registration and Breakfast

8:30 am – 9:45 am **Dr. Brian Kent, AFRL**
Electromagnetic Interference Attenuation Test of the Space Shuttle Discovery using the Air Force Research Laboratory Mobile Diagnostic Laboratory

9:45 am – 10:00 am Coffee break

10:00 am – 12:00 pm **Dr. C.J. Reddy, Applied EM**
Advanced Computational Tools for Antenna Design and Placement Studies

12:00 pm – 1:00 pm Lunch

1:00 pm – 3:00 pm **Dr. Sudhakar Rao, Northrop Grumman**
Advanced Antenna Systems for Satellite Communication Payloads

3:00 pm – 3:15 pm Coffee Break

3:15 pm – 5:00 pm **Dr. Goutam Chattopadhyay, JPL/NASA**
Terahertz Radar for Stand-Off Imaging

5:00 pm Adjournment

Event Sponsored by: MOTOROLA MOBILITY

Registration

To register for this event, please go to:
http://erricolo.engr.uic.edu/antenna-workshop/

where you will find:

1. a link to the registration form, which includes menu selection and the required Motorola Non-Disclosure Agreement form,
2. a link to the IEEE VTools website for the payment https://meetings.vtools.ieee.org/m/27815

Please note that all attendees are required to sign the Motorola Non-Disclosure Agreement form

---

Hotel Accommodation

Anyone in need of a hotel accommodation, may consider the Holiday Inn Mart, which offers a rate of $170 + tax to anyone visiting Motorola Mobility offices (the location of the workshop). In such a case, when making a reservation, please request for the "Mobility rate." The hotel website is http://www.martplaza.com

---

Optional possibility to receive a certificate for professional development hours.

A certificate for six (6) professional development hours for attending this workshop may be received upon request. Two options are available:
1) receive a certificate issued by the IEEE Chicago Section, which is recognized by the State of Illinois and does not require any additional cost or,
2) receive a certificate issued by IEEE Headquarters, which is valid for national registration, but will cost an additional fee of $20.

If paying by check, please make your check payable to "IEEE Chicago Section" and mail it to:

IEEE Chicago c/o
Robert Burke
6372 Hampshire Ct,
Lisle, IL 60532

Parking is not included in the price of admission. Parking is available in public lots around the Merchandise Mart.

Any questions about the event should be addressed to:

Danilo Erricolo
Chair, IEEE AP/MTT Chapter
email: derric1@uic.edu

Antennas and Propagation Society Officers

Tapan K. Sarkar, President
Roberto D. Graglia, President-Elect
Zhongxiang Shen, Secretary
Don McPherson, Treasurer

Microwave Theory and Techniques Officers

Robert Weigel, President
Tim Lee, President-Elect
Arne Jacob, Secretary
Mark Gouker, Treasurer

IEEE Chicago Section

Vickie Peters, Chair
David Richardson, Vice Chair
Bob Hofmann, Treasurer
Sharan Kalwani, Secretary

IEEE Chicago Chapter of AP/MTT

Danilo Erricolo, Chair
Konrad Kaczmarski, Secretary

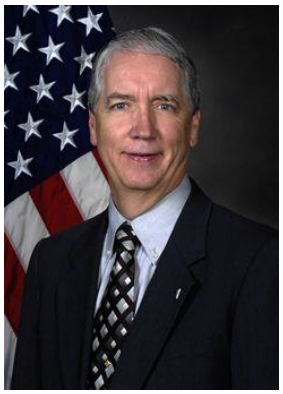
Electromagnetic Interference Attenuation Test of the Space Shuttle Discovery using the Air Force Research Laboratory Mobile Diagnostic Laboratory

Dr. Brian M Kent, Fellow IEEE, AMTA, AFRL
IEEE APS Distinguished Lecturer

ABSTRACT

As NASA prepared the Space Shuttle for its first return to flight mission (STS-114) in July of 2005, a number of new visual and radar sensors were used during the critical ascent phase of the flight to assess if unintentional debris was liberated from the Shuttle as it raced into orbit. New high-resolution C-Band and X-Band radars were used to help ascertain the location and speed of released debris. We also used both radars to monitor debris generated by routine flight events such as Solid Rocket Booster (SRB) separation. To assure these new radars did not interfere with flight-critical engine subsystems, an Electromagnetic Interference (EMI) measurement was performed on the Shuttle Orbiter "Discovery" in January 2005, using the Air Force Research Laboratory's Mobile Diagnostic Laboratory (MDL). This portable EM Measurement system performed a large number of attenuation measurements the night of January 17-18, 2005. This paper describes how the attenuation data was acquired, and the methodology used to reduce the data to predict average attenuation of the radar energy from the outside world to the inside of the aft engine bay of the Orbiter. This data was combined with a separate NASA-performed avionics EMI analysis to demonstrate that the new C and X-Band Debris Radars could be operated without adversely interfering with the Orbiter aft bay Avionics systems. After a through description of the AFRL aft bay EMI experiment, the talk will close with a brief overview and presentation of results from the separate NIST/NASA EMI experiment performed on Endeavour.

BIOGRAPHY



Dr. Brian M. Kent is an adjunct Professor at Michigan State University, and recently retired as the Chief Scientist, Sensors Directorate, Air Force Research Laboratory, Wright-Patterson Air Force Base, Ohio after serving for 37 years as a USAF Civilian. He is currently a part time engineering consultant supporting government, academic, and industrial partners related to the aerospace industry.

During his tenure as Chief Scientist, he served as the directorate's principal scientific and technical adviser and primary authority for the technical content of the science and technology portfolio. He identified research gaps and analyzed advancements in a broad variety of scientific fields to advise on their impact on laboratory programs and objectives. He served as an internationally recognized scientific expert, and provided authoritarian counsel and advice to AFRL management and the professional staff as well as to other

government organizations. He collaborated on numerous interdisciplinary research problems that encompass multiple AFRL directorates, customers from other DOD components, as well as the manned space program managed by NASA.

Dr. Kent joined the Air Force Avionics Laboratory in 1976 as cooperative engineering student through Michigan State University. He began his career performing research in avionics, digital flight displays and radar signature measurements. Through a career broadening engineering assignment with the Directorate of Engineering, Aeronautical Systems Division, he modeled a number of foreign threat missile systems and performed offensive and defensive electronic combat systems assessments. He received a National Science Foundation Fellowship in 1979, working at both the Air Force Wright Aeronautical Laboratories and the Ohio State University Electroscience Laboratory until the completion of his doctorate. Dr. Kent spent two years in the Passive Observables Branch of the Avionics Laboratory, later transferring to the AFWAL Signature Technology Office. From 1985 to 1992, Dr. Kent was involved with classified research efforts, managed through the Air Force Wright Laboratory, now the AFRL. During his tenure with AFRL and its predecessor organizations, Dr. Kent held a variety of positions. He has made pioneering and lasting contributions to the areas of signature measurement technology, and successfully established international standards for performing radar signature testing.

Dr. Kent became an adjunct professor in 1998 at Michigan State University, and has served the department on the Visiting Curriculum Committee, ABET accreditation, ECE Chair Search Committee, Deans Search Committee, and Dean's Advisory Committee. He has also participated in reforming the Senior Design Project classes, and has served for many years as a judge at the Spring and Fall Engineering "design day".

Dr. Kent has authored and co-authored more than 85 archival articles and technical reports and has written key sections of classified textbooks and design manuals. He has delivered more than 200 lectures, and developed a special DOD Low Observables Short Course that has been taught to more than 2,000 scientists and engineers since its inception in 1989. Dr. Kent has provided technical advice and counsel to a wide range of federal agencies, including the Department of Transportation, the Department of Justice and NASA's Space Shuttle Program. He is also an international technical adviser for the DOD and has provided basic research guidance to leading academic institutions.

Advanced Computational Tools for Antenna Design and Placement Studies

Dr. C. J. Reddy
President, Applied EM, Inc.
VP – Business Development – Electromagnetics, Americas, Altair

ABSTRACT

Recent advances in computational electromagnetic tools have made antenna design possible design and integration of antennas on various ground, sea and air platforms. Numerical computations can be performed to evaluate the effects of antenna design, placement, radiation hazard, EMC/EMI, etc. The typical numerical approaches include full wave techniques such as Method of Moments (MoM), Multilevel Fast Multipole Method (MLFMM) and asymptotic techniques such as Physical Optics (PO) and Uniform Theory of Diffraction (UTD). For many practical applications, sometimes it is necessary to study the electromagnetic behavior on a specific structure over a broad frequency band. In this talk, an overview various advance numerical techniques that are useful for antenna designs and placement studies. Talk will also include introduction to Characteristic Mode Analysis (CMA) and its use in antenna design and placement analysis.

BIOGRAPHY

C. J. Reddy received the B.Tech. degree in Electronics and Communications Engineering from Regional Engineering College (now National Institute of Technology), Warangal, India. He received his M.Tech. degree in Microwave and Optical Communication Engineering and Ph.D. degree in Electrical Engineering, both from Indian Institute of Technology, Kharagpur, India. From 1987 to 1991, he worked as a Scientific Officer at SAMEER (India) and participated in radar system design and development. In 1991, he was awarded NSERC Visiting Fellowship to conduct research at Communications Research Center, Ottawa, Canada. Later in 1993, he was awarded a National Research Council (USA)'s Research Associateship to conduct research in computational electromagnetics at NASA Langley Research Center, Hampton, Virginia. Dr. Reddy worked as a Research Professor at Hampton University from 1995 to 2000, while conducting research at NASA Langley Research Center. During this time, he developed various FEM codes for electromagnetics. He also worked on design and simulation of antennas for automobiles and aircraft structures. Particularly development of his hybrid Finite Element Method/Method of Moments/Geometrical Theory of Diffraction code for cavity backed aperture antenna analysis received Certificate of Recognition from NASA.

Currently, Dr. Reddy is the President and Chief Technical Officer of Applied EM Inc (www.appliedem.com), a small company specializing in computational electromagnetics, antenna design and development. At Applied EM, Dr. Reddy successfully led many Small Business Innovative Research (SBIR) projects from the US Department of Defense (DoD). Some of the technologies developed under these projects are being considered for transition to the DoD. Dr. Reddy also serves as the Vice President, Business Development-Electromagnetics at Altair Engineering, Inc.(www.altair.com). At Altair, he is leading the marketing and support of commercial 3D electromagnetic software, FEKO (www.feko.info) in Americas.

Dr. Reddy is a Senior Member of Institute of Electrical and Electronics Engineers (IEEE) and also a Senior Member of Antenna Measurement Techniques Association (AMTA). He has been elected Fellow of the Applied Computational Electromagnetic Society (ACES) in 2012 and served on ACES Board of Directors from 2006 to 2012. He published 35 journal papers, 54 conference papers and 17 NASA Technical Reports to date. Dr. Reddy is a co-author of the book, "Antenna Analysis and Design Using FEKO Electromagnetic Simulation Software," published in June 2014 by SciTech Publishing. Dr. Reddy was the General Chair of ACES 2011 Conference held in Williamsburg, VA during March 27-31, 2011. And also ACES 2013 conference, Monterey CA (March 24-28, 2013). He was the Co-General Chair of 2014 IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting held during July 6-11, 2014 in Memphis, TN. Dr. Reddy is the General Co-Chair for ACES 2015 conference (http://www.aces-society.org/conference/2015/) to be held in Williamsburg, Virginia during March 22-26, 2015.

Advanced Antenna Systems for Satellite Communication Payloads

Dr. Sudhakar Rao, IEEE APS Distinguished Lecturer
Northrop Grumman Aerospace Systems

ABSTRACT

Recent developments in the areas of antenna systems for FSS, BSS, PCS, & MSS satellite communications will be discussed. System requirements that drive the antenna designs will be presented initially. Advanced antenna system designs for contoured beams, multiple beams, and reconfigurable beams will be presented. Shaped reflector antenna designs, multi-aperture reflector antennas for multiple beams, multi-band reflector antennas, reconfigurable antennas, phased array systems, and lens antennas will be discussed in detail. Design examples of direct broadcast satellites (DBS) covering national and local channels will be given. Topics such as antenna designs for high capacity satellites, advanced reflector antennas, feed systems, large deployable mesh reflector designs, low PIM designs, and power handling issues will be included. High power test methods for the satellite payloads will be addressed. Future trends in the satellite antennas will be discussed. At the end of this talk, engineers will be exposed to typical requirements, designs, hardware, and test methods for various satellite antenna designs.

BIOGRAPHY

Sudhakar Rao is working as a Technical Fellow at Northrop Grumman Aerospace Systems and has the technical responsibility for all spacecraft and aircraft antenna systems. He worked as Technical Fellow at Lockheed Martin during 2003-2010, and as Chief Scientist at Boeing Satellite Systems during 1996-2003, and Spar Aerospace Systems in Canada as a staff scientist during 1982-1996. Dr. Rao developed antenna payloads for more than 65 satellites including first mobile satellite M-Sat and pioneered development of first Direct Broadcast Satellite with local channels. His work on development of radiation templates for complex radiation patterns of satellite antennas for interference analysis was adopted and recommended by the International Telecommunication Union (ITU)/CCIR in 1992 as the world-wide standard for satellite manufacturers and operators. He authored over 160 technical papers and has 41 U.S patents. He authored and co-edited three text book volumes on “Handbook of Reflector Antennas and Feed Systems” that are published in June 2013 by the Artech House.

Dr. Rao became an IEEE Fellow in 2006 and a Fellow of IETE in 2009. He received several awards and recognitions that include 2002 Boeing’s Special Invention Award for series of patents on satellite antenna payloads, 2003 Boeings’ technical achievement award, Lockheed Martin’s Inventor of Technology award in 2005 & 2007, IEEE Benjamin Franklin Key Award in 2006, Delaware Valley Engineer of the Year in 2008, and Asian American Engineer of the year award in 2008. He received IEEE Judith

Resnik Technical Field Award in 2009 for pioneering work in aerospace engineering. Dr. Rao is appointed as the Distinguished Lecturer by the IEEE APS for a three year period (2014-2016). He is the Chair for the IEEE APS “Industry Initiatives Committee” with 12 international members, associate editor for the IEEE Antennas & Propagation Magazine’s “Antenna Applications Corner”, Special Session Organizer/Chair and TPC member for the IEEE APS/URSI Symposia.

Terahertz Radar for Stand-Off Imaging

Dr. Goutam Chattopadhyay, IEEE MTT Distinguished Lecturer
Jet Propulsion Laboratory, California Institute of Technology

ABSTRACT

Demand for new surveillance capabilities for usage in airport screenings and battlefield security check-points has led to the development of terahertz imagers and sensors. There are several advantages of imaging at terahertz frequencies compared to microwave or infrared: the wavelengths in this regime are short enough to provide high resolution with modest apertures, yet long enough to penetrate clothing. Moreover, unlike in infrared, the terahertz frequencies are not affected by dust, fog, and rain.

Several groups around the world are working on the development of terahertz imagers for various applications. One option is to use passive imaging techniques, which were very successful at millimeter-wave frequencies, by scaling in frequencies to terahertz range. However, the background sky is much warmer at terahertz frequencies due to high atmospheric absorption. Since passive imagers detect small differences in temperatures from the radiating object against the sky background, at these frequencies passive imagers do not provide enough scene contrast for short integration times. On the other hand, in an active imager, the object is illuminated with a terahertz source and the resulting reflected/scattered radiation is detected to make an image. However, the glint from the background clutter in an active terahertz imager makes it hard to provide high fidelity images without a fortunate alignment between the imaging system and the target.

We have developed an ultra wideband radar based terahertz imaging system that addresses many of these issues and produces high resolution through-clothes images at stand-off distances. The system uses a 675 GHz solid-state transmit/receive system in a frequency modulated continuous wave (FMCW) radar mode working at room temperature. The imager has sub-centimeter range resolution by utilizing a 30 GHz bandwidth. It has comparable cross-range resolution at a 25m stand-off distance with a 1m aperture mirror. A fast rotating small secondary mirror rapidly steers the projected beam over a 50 x 50 cm target at range to produce images at frame rates exceeding 1 Hz.

In this talk we will explain in detail the design and implementation of the terahertz imaging radar system. We will show how by using a time delay multiplexing of two beams, we achieved a two-pixel imaging system using a single transmit/receive pair. Moreover, we will also show how we improved the signal to noise of the radar system by a factor of 4 by using a novel polarizing wire grid and grating reflector.

The research described herein was carried out at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA, under contract with National Aeronautics and Space Administration.

BIOGRAPHY

Goutam Chattopadhyay (S'93-M'99-SM'01-F'11) is a Principal Engineer/Scientist at the NASA's Jet Propulsion Laboratory, California Institute of Technology, and a Visiting Associate at the Division of Physics, Mathematics, and Astronomy at the California Institute of Technology, Pasadena, USA. He received the B.E. degree in electronics and telecommunication engineering from the Bengal Engineering College, Calcutta University, Calcutta, India, in 1987, the M.S. degree in electrical engineering from the University of Virginia, Charlottesville, in 1994, and the Ph.D. degree in electrical engineering from the California Institute of Technology (Caltech), Pasadena, in 1999. From 1987 until 1992, he was a Design Engineer with the Tata Institute of Fundamental Research (TIFR), Pune, India.

His research interests include microwave, millimeter-, and submillimeter- wave heterodyne and direct detector receivers, frequency sources and mixers in the terahertz region, antennas, SIS mixer technology, direct detector bolometer instruments; InP HEMT amplifiers, mixers, and multipliers; high frequency radars, and applications of nanotechnology at terahertz frequencies. He has more than 200 publications in international journals and conferences and holds several patents. Among various awards and honors, he was the recipient of the Best Undergraduate Student Award from the University of Calcutta in 1987, the Jawaharlal Nehru Fellowship Award from the Government of India in 1992, and the IEEE MTT-S Graduate Fellowship Award in 1997. He was the recipient of the best journal paper award in 2013 by IEEE Transactions on Terahertz Science and Technology. He also received more than 30 NASA technical achievement and new technology invention awards. He is a Fellow of IEEE and IEEE Distinguished Lecturer.