2015 ICCEM

2015 IEEE International Conference on Computational Electromagnetics

Final Program and Book of Abstracts

February 2-5, 2015, City University of Hong Kong, Hong Kong

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February 2-5,2015~Hong Kong

http://www.ee.cityu.edu.hk/~sklmmw/iccem2015/index.php

General Co-Chairs' Message

Welcome to the 1st IEEE International Conference on Computational Electromagnetics (ICCEM 2015) to be held February 2-5, 2015 in Hong Kong. ICCEM 2015 is the first IEEE Antennas and Propagation Society Topical Meeting on Computational Electromagnetics. It is financially sponsored by the Antennas and Propagation Society with the State Key Laboratory of Millimeter Waves, Partner Laboratory in the City University of Hong Kong, its patron. It brings together researchers and practitioners for sharing their latest advances in numerical algorithms, modeling methods, optimization and animation tools, and computing platforms for applications across the whole electromagnetic spectrum. In additional to contributing papers, a special session with particular focus will be organized under the able leadership of the Technical Program Committee Chairs.

The conference will be held on City University of Hong Kong campus. City University of Hong Kong is a young university and it is celebrating its 30th anniversary in 2014. The university is uniquely placed in the population center of Hong Kong in Kowloon Tong. Three new buildings have been erected in the past few years, including the Run Run Shaw Creative Media Centre designed by the world renowned architect Daniel Libeskind and the Academic 3, the site of the conference. Through an underground walkway, the campus is connected to Festival Walk, a shopping mall of over 200 retail stores, including some of the world's renowned retail names and reputable companies. Festival Walk has many restaurants offering a wide selection of cuisines ranging from Cantonese to Vietnamese to Italian and it also has one of the largest ice rinks in Hong Kong.

Hong Kong, a metropolis of 7 million people, is one of the most popular tourist destinations. It offers cultural diversity, natural beauty and incredible skylines. February is a very pleasant time to visit Hong Kong and the conference banquet will be on a dinner cruise, sightseeing in Victoria Harbor. The Organizing Committee looks forward to meeting you and making your visit a memorable and delightful one. See you in Hong Kong in February 2015!

Sincerely,
Chi Hou Chan and Jin-Fa Lee
Conference General Co-Chairs

Organizing Committee

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（Partner Laboratory in City University of Hong Kong）

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2015 IEEE International Conference on Computational Electromagnetics

About ICCEM

The IEEE International Conference on Computational Electromagnetics (ICCEM 2015) is the 1st IEEE Antennas and Propagation Society (AP-S) Topical Meeting on Computational Electromagnetics. It brings together researchers and practitioners for sharing their latest advances in numerical algorithms, modeling methods, optimization and animation tools, and computing platforms for applications across the whole electromagnetic spectrum.

IEEE ICCEM 2015 is financially sponsored by the IEEE AP-S with the State Key Laboratory of Millimeter Waves, Partner Laboratory in the City University of Hong Kong, its patron.

General Information

Venues

The conference venues are located in Academic 3, City University of Hong Kong. It is only 45 minutes by rail from China as well as the Hong Kong International Airport.

The City University of Hong Kong required a new teaching and administration building in campus to accommodate its expanding intake of students in light of the new 3+3+4 education structure of HKSAR. Academic 3 is built up by Ronald Lu and Partners at the end of 2012. It is a 20-storey compound built in the centre of campus, edged by Tat Chee Avenue at east; providing classrooms, university offices, and various student amenities of total floor area 37,300 m^2. The State Key Laboratory of Millimeter Waves, Partner Laboratory in the City University of Hong Kong is located on floor 15, Academic 3.

Weather

Typical temperature in early February is around 15^{o}C, little rain and not humid.

Currency

The local currency in Hong Kong is the Hong Kong dollar (HK$), which is one of the most traded currencies in the world. The value of the Hong Kong dollar has been pegged at HK$7.8 to the US dollar, and consequent rates of exchange to other currencies. However, the market rate exchange to the US dollar fluctuates marginally.

Bank notes are issued by HSBC and Standard Chartered Bank have denominations of HK$10, HK$20, HK$50, HK$100, HK$500, and HK$1,000. The Bank of China issues all of the above denominations except HK$10. Coins are bronze-coloured for 10 cents, 20 cents and 50 cents, silver-coloured for HK$1, HK$2, and HK$5; nickel and bronze for HK$10. All coins are issued by the government.

Major credit cards are accepted in most hotels, shops and restaurants.
Traveller cheques and foreign currency can be exchanged at hotels or banks.

Octopus card

The Octopus card is a stored value electronic card widely used in Hong Kong for public transport, purchases in convenience stores, fast food shops, supermarkets, cake shops and vending machines, etc. You simply place the Octopus card over a reader, and the correct amount is deducted automatically from the stored value. With an Octopus card, you no longer need coins.

MTR Customer Service Centres:	All station (expect Racecourse station)
Light Rail Customer Service Centres:	Ferry Pier Terminus, Leung King, Town Centre, Yuen Long Terminus, Tin Yat, Siu Hong and Tin Shui Wai stations
KMB Customer Service Centres:	Sha Tin Central Bus Terminus
New World First Ferry Customer Service Centres:	Piers of Cheung Chau, Mui Wo, Peng Chau, Central Piers 5 &6
New World First Bus Customer Service Centres:	Admiralty (East) Bus Terminus

Transportation

Hong Kong is geographically compact and boasts one of the world's most efficient, safe, affordable and frequent public transport systems. Whether by taxi, ferry, rail, bus or tram, you can get around easily and catch wonderful glimpses of the city along the way.

For convenience, use the Octopus Card, an electronic stored-value card that is accepted on most public transport.

Tax and Tipping

Hong Kong is free of sales tax. The only tax you may be charged is 5% government tax on hotel rates. Most upscale hotels add this to a 10% service charge, making for a total surcharge of 15%. Tipping is optional. Some restaurants have 10% service charge.

Telephone

Country Code: 852
City Code: not required
Emergency: 999

Time Zone

GMT/UTC +8 (no daylight savings time)

Power Supply

220-Volt / 50-Hz system

Smoking

Smoking is forbidden by law in public transportation and in all closed public areas.

Travel and about Hong Kong

Hong Kong is a charming city and she is frequently described as a place where "East meets West", reflecting the culture's mix of the territory's Chinese roots with influences from its time as a British colony. Hong Kong balances a modernised way of life with traditional Chinese practices. The fusion of east and west also characterises Hong Kong's cuisine, where dim sum, hot pot, and fast food restaurants coexist with haute cuisine. She is also famous of the beautiful victory harbour view and over several thousands of skyscrapers.

Hong Kong has many kinds of theme parks. The most famous one should be the Hong Kong Disneyland. Some theme parks are for educational purpose, including the Hong Kong Ocean Park, the Hong Kong Wetland Park and Noah's Art.

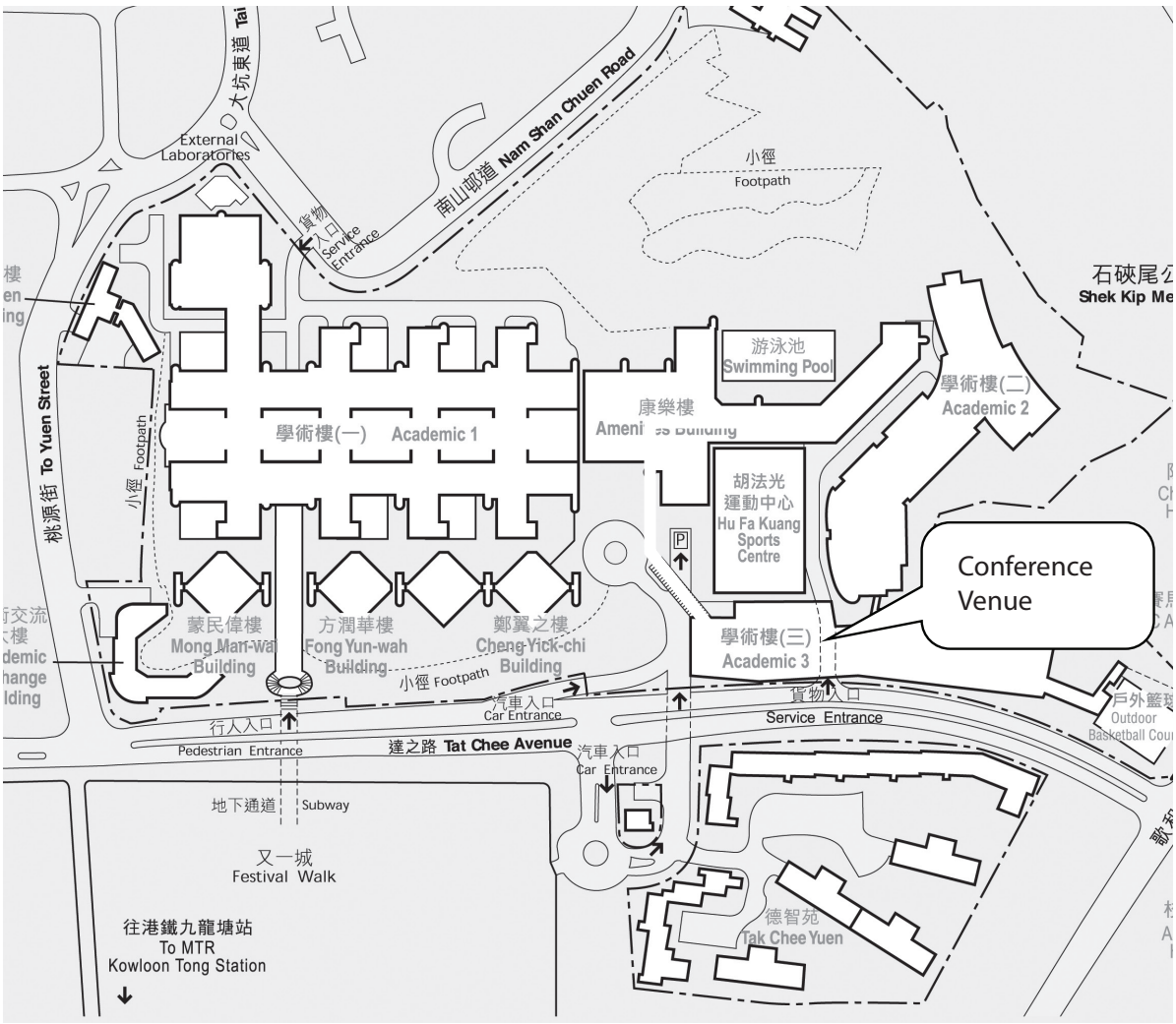
Shopping

Most shops open 10:00 to 22:00, Monday to Sunday.

Shopping districts: Mong Kok, Causeway Bay, Wan Chai, and Tsim Sha Tsui and Sham Shui Po.

Shopping Malls: IFC Mall, Times Square, ELEMENTS, Harbour City, Festival Walk, APM, Sogo, Wing On and Citygate Outlets.

Walking Route to Conference Venue



Arrived by public transport

1. (MTR-Kwun Tong Line or MTR-East Rail Line)
   When you get off the MTR, look for Festival Walk exit.
   In Festival Walk, on Level LG1, there is a Pedestrian Subway which will lead you to CityU campus.

2. After walking through the Pedestrian Subway, go down the staircase on your right and follow the directional signs, you will find yourself walking under a covered corridor alongside the garden which will lead you to the University Circle.

3. Go along the covered walkway and follow the directional signs which will lead you to Academic 3.

Arrived by taxi or by car

1. When you drop off at the University Circle, go along the covered walkway and follow the directional signs which will lead you to Academic 3.

Conference Information

Registration

Date	Opening Hours	Venue
2 February 2015 (Monday)	0830-1600	5/F, Outside area of Wong Cheung Lo Hui Yuet Hall, Academic 3, City University of Hong Kong
3 February 2015 (Tuesday)	0830-1500	Room 8-220, 8/F, Academic 3, City University of Hong Kong
4 February 2015 (Wednesday)	0830-1600	
5 February 2015 (Thursday)	0830-1100	
Payment	- Cash (HKD) - Credit card (Visa, Master or UnionPay)	

All participants could make registration and collect program package or any additional purchase at the registration desk as per the information provided as above. Printed receipts will be provided once payment is received.

Plenary Session

Date	2 February 2015 (Monday)
Time	0915-1710
Venue	Wong Cheung Lo Hui Yuet Hall, 5/F Academic 3, City University of Hong Kong

Invited and Regular Sessions

Date	3-5 February 2015 (Tuesday to Thursday)
Time	0820-1530 (3 February, Tuesday) 0820-1810 (4 February, Wednesday) 0900-1040 (5 February, Thursday)
Venue	Room 6-208 (6/F), Room 8-210, 8-230 (8/F), Academic 3, City University of Hong Kong

Presentation Instruction

Speakers are required to download and test their presentation files in a computer provided at the conference venue. An authorized assistant will copy the files to the computer. Please save your files in a USB memory stick in MS-Power Point or Adobe PDF format and arrive the venue at least 15 minutes in advance before your session starts.

As reminder that all speakers cannot use their personal computers for presentation.

Please make sure the files are compatible to Windows software (XP / Vista / 7) and check for the appropriate video codecs, before starting your session.

Conference Lunches and Welcoming Reception

3 day lunches (12:00 – 13:30 on 2 – 4 February) and a welcoming reception (2 February night) will be held on 19/F, Academic 3, City University of Hong Kong, which is the top of the building and has excellent view of Kowloon and Hong Kong Island. During the lunches and a welcoming reception, western meal will be served to all participants.

Banquet

The banquet will be held at 3 February night at Harbour Cruise – Bauhinia. The cruise offers a wonderful venue for sightseeing through the unparalleled Victoria Harbour and leads you to all the famous architectures in Hong Kong. You may interact with the inspiring and energetic city of Hong Kong in 360 degrees to light up your day.

The embarkation point of the banquet is at North Point (East) Passenger Ferry Pier, Hong Kong Island, HKSAR. A round transportation will be provided from conference venue to the pier. The departure time of the shutter bus is at 16:30 and the cruise is at 1800. Please take attention to the announcement.

Extra banquet tickets (not included in the registration fee), at the price of HKD 1000, can be purchased at the registration desk, subject to availability.

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	Keynote Speech 1
09:15-10:15	Computational Electromagnetics: Past, Present, and Future

Professor Weng Cho Chew
University of Illinois, Urbana-Champaign, USA

Abstract

Electromagnetics and Maxwell's equations have been instrumental in the conception of many electrical engineering technologies. It the beginning, it was telegraphy, and rotating machineries. Over the years, electromagnetics has given rise to numerous technologies like wireless communications, antennas, radar, and masers. On the optics side, simplified ray optics theory was used to design lenses and focusing systems.

As many optical systems can be described by ray optics approximations, the first area that requires the full solution of Maxwell's equations is in microwave engineering, antenna design, and remote and subsurface sensing. Hence, there were pressing needs to design better antenna systems for communication, radar for target identification, and radio waves for remote sensing. While closed form solutions offered some physics insight, approximate solutions were invoked to further expand the insight of designers and engineers. When approximation solutions were exhausted, numerical methods or computational electromagnetics (CEM) were developed to further aid designers and engineers.

As demand for numerical methods looms, fast and efficient methods of solving Maxwell's equations become a popular topic of research. There are essentially two classes of solvers for Maxwell's equations: differential equation solvers and integral equation solvers. While differential equation solvers use more unknowns than integral equation solvers, they are easy to implement and to maintain.

Integral equation solvers, on the other hand, use fewer unknowns, but are more difficult to implement. They also yield dense matrix systems that are expensive to solve and store. However, the advent of fast solvers has greatly expedited their solution efficiency. As of this point, dense matrix systems with over three billion unknowns have been solved using fast solvers. Also, the path to large scale computing requires the use of iterative solvers.

Over time, as the demand for CEM solvers grows, more complex structures with a disproportionate number of unknowns need to be solved. They give rise to ill-conditioned matrix systems. Hence, preconditioners or domain decomposition methods are designed to reduce the ill conditioning of matrix system. The preconditioners will greatly expedite iterative solutions to these problems.

Maxwell's equations are also intimately related to mathematical geometry and to quantum physics. Differential geometry concepts can be invoked to help in the selection of basis and testing functions in finding the matrix representations of Maxwell operators. Furthermore, even when quantum theory is invoked in the quantization of electromagnetic fields, the fields are still governed by Maxwell's equations. Therefore, solutions of Maxwell's equations are needed even in the quantum regime. Since photons play an important role in the manipulation of quantum information, the solutions of Maxwell's equations will be instrumental even in quantum optics or quantum electromagnetics. They will play an important role in the area of quantum computers and quantum information.

Biography

Weng Cho Chew received the B.S.E.E., M.S.E.E. and Engineer's degrees and Ph.D.E.E. degree in 1976, 1978, and 1980, respectively, from MIT. He joined the U of Illinois in 1985.

He served as the Dean of Engineering at Hong Kong U (2007-2011). Before 1985, he was a department manager and a program leader at Schlumberger-Doll Research (1981-1985). He served on the IEEE Adcom for AP Society as well as GRS Society. He is active with various journals and societies.

His research interests are in wave physics and mathematics of inhomogeneous media for sensing applications, IC, and antenna applications, as well as fast algorithms for scattering and radiation problems. He originated several fast algorithms for electromagnetics scattering and inverse problems. His research group solved dense matrices with tens of millions of unknowns first ever for scattering problems. His recent interest is in multi-physics phenomena in nano-eletronics and N/MEMS.

He authored and co-authored books entitled Waves and Fields in Inhomogeneous Media, Fast and Efficient Methods in Computational Electromagnetics, and Integral Equation Methods for Electromagnetic and Elastic Waves, and over 350 journal publications, 400 conference publications and ten book chapters.

He is a Fellow of IEEE, OSA, IOP, EMA, HKIE, and was an NSF Presidential Young Investigator (USA). He received the Schelkunoff Best Paper Award for AP Transaction, IEEE Graduate Teaching Award, UIUC Campus Wide Teaching Award, and IBM Faculty Awards. He was a Founder Professor of the College of Engineering (2000-2005), and the First Y.T. Lo Chair Professor (2005-2009), and an IEEE Distinguished Lecturer (2005-2007), Cheng Tsang Man Visiting Professor at NTU in Singapore (2006). In 2002, ISI Citation elected him to be among the Most Highly Cited Authors. He received the AP-Society Chen-To Tai Distinguished Educator Award (2008), and was on the BoD of Applied Science Technology Research Institute, Hong Kong. He is currently the Editor-in-Chief of PIER journals, and the Chair of the IEEE Joint Chapter on AP Society, GRS Society, and Photonic Society, which hosts a seminar series. Recently, he has been elected to the US National Academy of Engineering.

	Keynote Speech 2
10:35-11:35	Combining Computational Electromagnetics with Signal Processing Algorithms to Enhance the Performance of Imaging Devices and Antennas

Professor Raj Mittra
EMC Lab, Penn State University and the University of Central Florida, USA

Abstract

Computational Electromagnetics (CEM) has made great strides over the years and has enabled us to solve very large and complex problems that were well beyond our reach only a few year ago. This has been made possible because of steady increases in computing speeds--thanks to Moor's Law--and the advent of parallelization as well as development of iterative and domain decomposition techniques. The quest as well as progress toward the solution of very large and complex problems remain unabated--CEM problems involving "billions and billions" of unknowns are being routinely solved today--and this trend is likely to continue for a long time to come.

The focus of this presentation is not on proposing yet another algorithm which would help us solve even larger problems than we can handle today, but on discussing alternate ways by which we can enhance the performance of microwave devices--such as imaging systems and lenses--by combining signal processing algorithms with CEM.

The paper will discuss several examples of performance enhancement including sub-wavelength imaging of objects that are not located in the near fields of lenses, and improving the accuracy of direction finding antenna systems with size constraints that limit their limitation if conventional DF techniques are used. Our strategy is to first use available CEM techniques to solve the forward problems efficiently and then to use these solutions in Signal Processing algorithms for the purpose of performance enhancement of microwave devices of the type mentioned above.

Biography

Raj Mittra is a Professor in the Electrical Engineering department of the Pennsylvania State University, where he is the Director of the Electromagnetic Communication Laboratory. Prior to joining Penn State he was a Professor in the Electrical and Computer Engineering at the University of Illinois in Urbana Champaign from 1957 through 1996, when he moved to his present position at the Penn State University. Currently, he is also a Professor at the University of Central Florida in Orlando, FL.

He is a Life Fellow of the IEEE, a Past-President of AP-S, and he has served as the Editor of the Transactions of the Antennas and Propagation Society. He won the Guggenheim Fellowship Award in 1965, the IEEE Centennial Medal in 1984, and the IEEE Millennium medal in 2000. Other honors include the IEEE/AP-S Distinguished Achievement Award in 2002, the Chen-To Tai Education Award in 2004 and the IEEE Electromagnetics Award in 2006, and the IEEE James H. Mulligan Award in 2011.
He has been a Visiting Professor at Oxford University, Oxford, England and at the Technical University of Denmark, Lyngby, Denmark. Until recently, he served as the North America editor of the Journal AEU. He was recently appointed a Distinguished Professor (Adjunct) at the Yun Tze University in Taiwan, and also at the Harbin Engineering University in Harbin, PRC.

Dr. Mittra specializes in the design of electromagnetic systems such as radars, satellite antennas, communication systems, microwave and millimeter wave integrated circuits and instruments for remote sensing and geophysical prospecting. His role in the design of these systems is primarily in the development of special-purpose computer programs and algorithms that are capable of solving problems that are well beyond the reach of commercially available computer codes. The Electromagnetic Communication laboratory, of which Dr. Mittra is the Director, is engaged in a number of different areas of research under the general umbrella of Electromagnetics and Communication.

He has published over 1000 technical papers and more than 30 books or book chapters on various topics related to Electromagnetics, Antennas, Microwaves and Electronic Packaging. He is one of the top highly-cited researchers in Electromagnetics, as evidenced by the Citation index compiled by Thomson Scientific, Google and others.

He has advised more than 110 Ph.D. and an equal number of M.S. thesis students over the years, and has mentored more than 60 postdocs. He also has three patents on Communication Antennas to his credit. For the last 15 years he has directed, as well as lectured in, numerous short-course on Computational Electromagnetics, Electronic packaging, Wireless Antennas, RFID, Metamaterials, etc., both nationally and internationally. He has also served on a number of government panels on antenna designs and evaluation of Computational Electromagnetics codes. Further information may be found at the website:
http://www.personal.psu.edu/rxm53/.
Dr. Mittra is a Principal Scientist and President of RM Associates, a consulting company founded in 1980, which provides services to industrial and governmental organizations, both in the U.S. and abroad.

Technical Program

	February 2, 2015 (Monday)
0830-1600	Registration (5/F, Academic 3, CityU)
Wong Cheng Lo Hui Yuet Hall, 5/F, Academic 3, CityU	
0900-0915	Opening Ceremony
0915-1015	Plenary Session: Keynote Speech 1
	(Prof. Weng Cho Chew)
1015-1035	Tea Break
1035-1135	Plenary Session: Keynote Speech 2
	(Prof. Raj Mittra)
1200-1330	Lunch
Plenary Session: Engineering Applications of Electromagnetics and Computation Techniques (Delivered by IEEE Antennas and Propagation Society Administrative Committee Members)	
1330-1350	PS-1
1350-1410	PS-2
1410-1430	PS-3
1430-1450	PS-4
1450-1510	PS-5
1510-1530	PS-6
1530-1550	Tea Break
1550-1610	PS-7
1610-1630	PS-8
1630-1650	PS-9
1650-1710	PS-10
1800-2200	Welcoming Reception

	February 3, 2015 (Tuesday)		
0830-1500	Registration (8/F, Academic 3, CityU)		
	Room: 8-210, 8/F, Academic 3, CityU	Room: 8-230, 8/F, Academic 3, CityU	Room: 6-208, 8/F, Academic 3, CityU
	Invited Session 1: EM Simulation of Periodic Structures	Antenna Arrays	Imaging and Spurious Mode Suppression
0820-0840	IS1-1	A01-1	I01-1
0840-0900	IS1-2	A01-2	I01-2
0900-0920	IS1-3	A01-3	I01-3
0920-0940	IS1-4	A01-4	I01-4
0940-1000	IS1-5	A01-5	I01-5
1000-1020	Tea Break		
	Metamaterial and Artifical Materials	TDIE & FDTD	Invited Session 2: Recent Progress in Integral Equation Methods (Part I)
1020-1040	M01-1	T01-1	IS2-1
1040-1100	M01-2	T01-2	IS2-2
1100-1120	M01-3	T01-3	IS2-3
1120-1140	M01-4	T01-4	IS2-4
1140-1200	M01-5	T01-5	IS2-5
1200-1330	Lunch		
	Invited Session 3: On-/In-Body Antennas and Body Channel Modelling	Antenna Applications I	Circuit and Waveguide Characterization
1330-1350	IS3-1	A02-1	C01-1
1350-1410	IS3-2	A02-2	C01-2
1410-1430	IS3-3	A02-3	C01-3
1430-1450	IS3-4	A02-4	C01-4
1450-1510	IS3-5	A02-5	C01-5
1510-1530	IS3-6	A02-6	C01-6
1530-1550	Tea Break		

Transportation: From CityU Campus to Cruise

1800-2230	Banquet

	February 4, 2015 (Wednesday)		
0830-1600	Registration (8/F, Academic 3, CityU)		
	Room: 8-210, 8/F, Academic 3, CityU	Room: 8-230, 8/F, Academic 3, CityU	Room: 6-208, 8/F, Academic 3, CityU
	Invited Session 4: Recent Progress in Integral Equation Methods (Part II)	Antenna Applications II	Domain Decomposition and Interpolation Methods
0820-0840	IS4-1	A03-1	D01-1
0840-0900	IS4-2	A03-2	D01-2
0900-0920	IS4-3	A03-3	D01-3
0920-0940	IS4-4	A03-4	D01-4
0940-1000	IS4-5	A03-5	D01-5
1000-1020	Tea Break		
	Invited Session 4: Recent Progress in Integral Equation Methods (Part II)	EMC/EMI	Large-scale Simulations for Complex Structure
1020-1040	IS4-6	E01-1	L01-1
1040-1100	IS4-7	E01-2	L01-2
1100-1120	IS4-8	E01-3	L01-3
1120-1140	IS4-9	E01-4	L01-4
1140-1200	IS4-10	E01-5	L01-5
1200-1330	Lunch		
	Invited Session 5: High Frequency ScatteringWave	Analysis and Simulation of EM Scattering	FDTD & FVTD
1330-1350	IS5-1	A04-1	F01-1
1350-1410	IS5-2	A04-2	F01-2
1410-1430	IS5-3	A04-3	F01-3
1430-1450	IS5-4	A04-4	F01-4
1450-1510	IS5-5	A04-5	F01-5
1510-1530		A04-6	
1530-1550	Tea Break		
	Invited Session 6: Computational Photonics	Invited Session 7: Antenna Design	Mesh Refinements and Finite-element Formulation
1550-1610	IS6-1	IS7-1	M02-1
1610-1630	IS6-2	IS7-2	M02-2
1630-1650	IS6-3	IS7-3	M02-3
1650-1710	IS6-4	IS7-4	M02-4
1710-1730	IS6-5	IS7-5	M02-5
1730-1750	IS6-6	IS7-6	M02-6
1750-1810	IS6-7		M02-7

	February 5, 2015 (Thursday)	
0830-1100	Registration (8/F, Academic 3, CityU)	
	Room: 8-210, 8/F, Academic 3, CityU	Room: 8-230, 8/F, Academic 3, CityU
	Invited Session 8: Antennas for Wireless Communication	Integral Equation and Hybrid Methods
0900-0920	IS8-1	I02-1
0920-0940	IS8-2	I02-2
0940-1000	IS8-3	I02-3
1000-1020	IS8-4	I02-4
1020-1040	IS8-5	
1040-1100	Tea Break	

	February 2, 2015 (Monday), Day 1-4
09:00-17:10	Wong Cheng Lo Hui Yuet Hall, 5/F, Academic 3, City University of Hong Kong
Plenary Session:	**Session Chair: Chi Hou Chan**
09:15-10:15	Computational Electromagnetics: Past, Present, and Future (Keynote Speech 1)
Plenary Session:	**Session Chair: Chi Hou Chan**
10:35-11:35	Combining Computational Electromagnetics with Signal Processing Algorithms to Enhance the Performance of Imaging Devices and Antennas (Keynote Speech 2)
Plenary Session:	**Session Chair: Chi Hou Chan**
	Engineering Applications of Electromagnetics and Computation Techniques (Delivered by IEEE Antennas and Propagation Society Administrative Committee Members)
	PS-1:
13:30-13:50	The Random Auxiliary Sources Method: A Simple, Fast, and Efficient Electromagnetic Scattering
	PS-2:
13:50-14:10	Characteristic Modes – An Intuitive Approach for Antenna Design
	PS-3:
14:10-14:30	HOFEM: A Higher Order Finite Element Method Electromagnetic Simulator
	PS-4:
14:30-14:50	Electromagnetic Modeling and Simulation
	PS-5:
14:50-15:10	Electromagnetic Space, Time and Space-Time Processing for MMW and THz Technology
	PS-6:
15:10-15:30	Computational Models for Bandwidth Enhancement of Electromagnetic Bandgap (EBG) Resonator Antennas and Their Limitations
	PS-7:
15:50-16:10	Numerical Techniques for Evaluating Electromagnetic Field Propagators
	PS-8:
16:10-16:30	A Summary of the Major Global 3-D FDTD Modeling Capabilities To-Date
	PS-9:
16:30-16:50	Hierarchical and Singular Bases for Finite Methods
	PS-10:
16:50-17:10	Solution of Helmholtz Equation Starting with the Frequency Independent Laplace's Equation

	February 2, 2015 (Monday), Day 1-4
09:00-17:10	Wong Cheng Lo Hui Yuet Hall, 5/F, Academic 3, City University of Hong Kong

09:00-09:15	Opening Ceremony

Plenary Session:	Session Chair: Chi Hou Chan
09:15-10:15	Computational Electromagnetics: Past, Present, and Future (Keynote Speech 1)

Professor Weng Cho Chew
University of Illinois, Urbana-Champaign, United States

10:15-10:35	**Tea Break**

Plenary Session:	Session Chair: Chi Hou Chan
10:35-11:35	Combining Computational Electromagnetics with Signal Processing Algorithms to Enhance the Performance of Imaging Devices and Antennas (Keynote Speech 2)

Professor Raj Mittra
Penn State University and the University of Central Florida, United States

12:00-13:30	**Lunch**

Plenary Session:	Session Chair: Chi Hou Chan
	Engineering Applications of Electromagnetics and Computation Techniques (Delivered by IEEE Antennas and Propagation Society Administrative Committee Members)

	PS-1:
13:30-13:50	The Random Auxiliary Sources Method: A Simple, Fast, and Efficient Electromagnetic Scattering

Mohamed A. Moharram and Ahmed A. Kishk
Concordia University, Canada

A simple, fast, and efficient approach to solve the electromagnetic (EM) scattering problem from arbitrary object is offered by the Random Auxiliary Sources (RAS) method. Based on direct application of the boundary conditions and projection of radiating modes with infinitesimal sources, the method is able to accurately solve problems with much less execution time than other comparable methods. The method is verified and compared to the Method of Moments (MoM) for 2D and 3D problems for accuracy and speed.

	PS-2:
13:50-14:10	Characteristic Modes – An Intuitive Approach for Antenna Design

Dirk Manteuffel
University of Kiel, Germany

The decomposition of the current distribution on an antenna into its so-called Characteristic Modes can offer some intuitive insight into the antenna concept. In this paper a new software currently under development at Kiel university is presented. It includes some parameters derived from the characteristic mode analysis that have proven to be very useful for the design of antennas for smartphones as well as antennas for automotive applications.

	PS-3:
14:10-14:30	HOFEM: A Higher Order Finite Element Method Electromagnetic Simulator

Daniel Garcia-Doñoro, Ignacio Martinez-Fernandez, Luis Emilio Garcia-Castillo, and Magdalena Salazar-Palma
Universidad Carlos III de Madrid, Spain

This document presents a new electromagnetic in-house parallel EM simulator named HOFEM (Higher Order Finite Element Method). The simulator makes use of some of the research developments on the area made within the Group of Radiofrequency, Electromagnetism, Microwaves and Antennas (GREMA) of the Universidad Carlos III de Madrid to which the authors belong to. HOFEM makes use of a weak formulation based on double curl vector wave equation discretized with the higher-order isoparametric curl-conforming tetrahedral (and prisms) finite element rigorous implementations of Nédélec's first family of elements. A non-standard mesh truncation technique, FE-IIEE (Finite Element - Iterative Integral Equation Evaluation) for open region problems provides an arbitrarily exact absorbing boundary condition while retaining the original sparse structure of the FEM matrices. The simulator provides a multi-platform (Linux & Windows) user friendly graphical user interface. Remote job submission to HPC clusters is supported by integrating an in-house software tool developed for this purpose.

	PS-4:
14:30-14:50	Electromagnetic Modeling and Simulation

Levent Sevgi
Okan University, Turkey

Modeling and simulation in electromagnetics is reviewed. Fundamental terms and concepts are revisited. Examples are presented.

	PS-5:
14:50-15:10	Electromagnetic Space, Time and Space-Time Processing for MMW and THz Technology

Christophe Caloz [1, 2]
[1] *Polytechnique Montréal, Canada*
[2] *King Abdulaziz University, Kingdom of Saudi Arabia*

The paper will present the author's vision for space, time and space-time processing as a potential solution for tomorrow's millimeter-wave (mmw) and terahertz (THz) technology. In each case, it will present fundamental concepts, novel electromagnetic devices and potential applications.

	PS-6:
15:10-15:30	Computational Models for Bandwidth Enhancement of Electromagnetic Bandgap (EBG) Resonator Antennas and Their Limitations

Basit A. Zeb, Karu P. Esselle, and Raheel M. Hashmi
Macquarie University, Australia

Since the pioneering work of Von Trentini in 1956, significant improvements in the performance of electromagnetic band gap resonator antennas (ERA) have been made. The focus of this paper is on the computational models and computational efficiency related to the enhancement of 3-dB directivity bandwidth of such antennas. We explore to what extent the two unit-cell numerical electromagnetic models, Superstructure Model and Defect-Cavity Model, can be efficiently used to reduce the computation burden of the design process to achieve the best antenna bandwidth. It was found that they are very useful for antennas with medium or large superstructure areas but for smaller antennas that have much wider bandwidths numerical analysis of the whole antenna is required to achieve the best directivity bandwidth.

15:30-15:50	**Tea Break**

	PS-7:
15:50-16:10	Numerical Techniques for Evaluating Electromagnetic Field Propagators

H. T. Abbas, J. Shin, and Robert D. Nevels
Texas A&M University, United States

We review a series of electromagnetic field propagator expressions and their numerical solutions. These include propagators arising from a spectral-frequency domain scalar Helmholtz equation solution evaluated by a Fast Fourier transform numerical method, a full wave vector spectral-spatial domain expression solved by an implicit Fourier transform method, and a full wave time domain tensor field expression solved by an explicit integration technique. It is shown that the tensor field explicit integration method has some computational and accuracy advantages over differential equation finite difference methods.

	PS-8:
16:10-16:30	A Summary of the Major Global 3-D FDTD Modeling Capabilities To-Date

Jamesina J. Simpson
University of Utah, United States

Global three-dimensional finite-difference time-domain (FDTD) models of the Earth-ionosphere waveguide first appeared in the literature a decade ago. Over the past 10+ years, many advances have expanded the capabilities of these models and broadened their applicability. The capabilities are summarized in this Paper.

	PS-9:
16:30-16:50	Hierarchical and Singular Bases for Finite Methods

Roberto D. Graglia[1], **A. F. Peterson**[2], **P. Petrini**[1], **and L. Matekovits**[1]
[1] *Politecnico Di Torino, Italy*
[2] *Georgia Institute of Technology, United States*

Hierarchical basis function families that incorporate singular behavior to model fields with corner singularities are reviewed. These families are of the additive kind, and combine a traditional polynomial-complete representation with additional singular terms that incorporate general exponents that may be adjusted for the specific wedge angle of interest. A few results are reported to validate the benefits of using such bases when dealing with two-dimensional structures with corners meshed with triangular cells.

	PS-10:
16:50-17:10	Solution of Helmholtz Equation Starting with the Frequency Independent Laplace's Equation

T. K. Sarkar[1] **and M. Salazar Palma**[2]
[1] *Syracuse University, United States*
[2] *Universidad Carlos III de Madrid, Spain*

A new boundary integral method for solving the general Helmholtz equation has been developed starting from the frequency independent Laplace's equation. The new formulation is based on the Method of Moments solution of Laplace's equation. The main feature of this new formulation is that the boundary conditions are satisfied independent of the region node discretizations. The numerical solution of the present method is compared with finite difference and finite element solutions.

18:00-22:00	**Welcoming Reception**

	February 3, 2015 (Tuesday), Day 2-4
08:20-10:00	Room: 210, 8/F, Academic 3, City University of Hong Kong Session: IS1
	Session Chair: Wei Hong
	Electromagnetic Simulation of Periodic Structures
	IS1-1:
08:20-08:40	Low-Profile Broadband Antennas Using Metamaterial- Mushroom Structures
	IS1-2:
08:40-09:00	A Fast and Efficie Design of Circuit Analog Absorbers Consisting of Resistive Square Loop Arrays
	IS1-3:
09:00-09:20	Quasiconformal Maps in Transformation Optics and Their Electrostatic Analogs
	IS1-4:
09:20-09:40	Full Wave Analysis of Millimeter Wave Quasi-Periodical Structure for Antenna Applications by Method of Moments and Its Conjugate Gradient Solution on GPU/CPU Platform
	IS1-5:
09:40-10:00	Some Efficient Methods for the Electromagnetic Simulation of Periodic Structures

	February 3, 2015 (Tuesday), Day 2-4
08:20-10:00	Room: 210, 8/F, Academic 3, City University of Hong Kong Session: IS1

	Session Chair: Wei Hong
	Electromagnetic Simulation of Periodic Structures

	IS1-1:
08:20-08:40	Low-Profile Broadband Antennas Using Metamaterial- Mushroom Structures

Wei Liu[1], **Zhi Ning Chen**[1, 2], **and Xianming Qing**[2]
[1] *National University of Singapore, Singapore*
[2] *Institute for Infocomm Research, Singapore*

A type of metamaterial-based center-fed mushroom antenna is proposed for low-profile broadband antenna design. The mushroom structure is used as the radiating element and aperture coupled beneath the radiators. Unique dual resonant modes are simultaneously excited for broadside radiation. The proposed antenna design methodology has been successfully applied in antenna and array designs for 5-GHz WLAN and 60-GHz WPAN applications.

	IS1-2:
08:40-09:00	A Fast and Efficie Design of Circuit Analog Absorbers Consisting of Resistive Square Loop Arrays

Wenquan Che[1], **Han Ye**[1], **Ying Xiong**[1], **Yumei Chang**[1], **and Christos Christopoulos**[2]
[1] *Nanjing University of Science and Technology, China*
[2] *University of Nottingham, United Kingdom*

This paper proposes new precise equivalent circuit models (ECMs) for circuit analog absorbers consisting of resistors-loaded square loop arrays. Furthermore, a genetic algorithm (GA) is employed to optimize the geometrical parameters and the corresponding impedance properties to achieve different design requirements. For demonstration, two absorbers consisting of single and double square loop arrays are designed by using the combined methods of ECM and generic algorithm. The agreement between the simulated and measured reflection coefficients indicates the validity of the presented method.

	IS1-3:
09:00-09:20	Quasiconformal Maps in Transformation Optics and Their Electrostatic Analogs

Fu Liu [1], Pengjiang Wei[2], Z. Chang[3], Gengkai Hu[3], and Jensen Li1[4]

[1] *University of Birmingham, United Kingdom*

[2] *City University of Hong Kong, Hong Kong*

[3] *Beijing Institute of Technology, China*

[4] *City University of Hong Kong, Shenzhen, China*

Quasiconformal maps have been utilized for generating transformation optical devices with a range of applications including invisibility cloaks, waveguide benders, couplers, surface-conformal lenses and antennas. Here, we discuss their generation by numerically solving the Poisson's equation where the analytic solution of a typical electrostatic problem in the virtual space acts as a seed in numerically generating a quasiconformal map with a transformed shape of boundary. Two examples about capacitor under external voltage and a point charge in a cavity are given.

	IS1-4:
09:20-09:40	Full Wave Analysis of Millimeter Wave Quasi-Periodical Structure for Antenna Applications by Method of Moments and Its Conjugate Gradient Solution on GPU/CPU Platform

Zhe Song, Yan Zhang, Hou-Xing Zhou, and Wei Hong

Southeast University, China

In this paper, an accurate and efficient full wave analysis for millimeter wave quasi-periodical structure for antenna applications is realized. By extracting all the surface wave poles of the spectral domain multilayered Green's functions, the discrete complex image method (DCIM) can be adopted to fast evaluate their counter parts in spatial domain, and the mixed potential integral equation (MPIE) for method of moments (MoM) can be constructed. With the Jerusalem cross as a patch element on a dielectric layer, a quasi-periodical structure can be organized as the geometries gradually varied. By illuminate this kind of structure with an incident plane wave, the distribution of electric current on the metal surface can be obtained by solving the MoM equation and the forward scattering cross section can be fast calculated. A layered structure with a 17×17 Jerusalem crosses at 30GHz was calculated and very good agreements have been found between the proposed method and commercial EM simulator (CST), while an improvement on efficiency is realized.

	IS1-5:
09:40-10:00	Some Efficient Methods for the Electromagnetic Simulation of Periodic Structures

Wei Hong, Feng Xu, Zhiqing Lv, Xiang An, Weidong Li, Zhe Song, Li Yan, and Houxin Zhou

State Key Laboratory of Millimeter Waves, China

In this talk, some efficient methods for the electromagnetic (EM) simulation of periodic structures are reviewed, including the Method of Lines (MoL) and the Finite Difference Frequency Domain (FDFD) method for the propagation characteristic simulation of substrate integrated waveguide (SIW), and the Partial Basic Solution Vector (PBSV) method for the scattering and propagation simulation of various periodic structures etc.

10:00-10:20	**Tea Break**

	February 3, 2015 (Tuesday), Day 2-4
10:20-12:00	Room: 210, 8/F, Academic 3, City University of Hong Kong Session: M01
	Session Chair: Long Li
	Metamaterial and Artificial Materials
	M01-1:
10:20-10:40	Metamaterial-Inspired Wideband Low-Profile Circularly Polarized Antenna
	M01-2:
10:40-11:00	Three Dimensional Electromagnetic Invisibility Cloak With Arbitrary Shapes
	M01-3:
11:00-11:20	Dispersion Analysis of a Fishnet Metamaterial Based on the Rotated TLM Method
	M01-4:
11:20-11:40	Fast Analysis of Electrically Large Plasmonic Arrays with Aperiodic Spiral Order
	M01-5:
11:40-12:00	Ultra-Wide Bandstop Frequency Selective Structive Using a Cascaded Array of Vertically Stacked Parallel Strip Lines

	February 3, 2015 (Tuesday), Day 2-4
10:20-12:00	Room: 210, 8/F, Academic 3, City University of Hong Kong Session: M01

	Session Chair: Long Li
	Metamaterial and Artificial Materials

	M01-1:
10:20-10:40	Metamaterial-Inspired Wideband Low-Profile Circularly Polarized Antenna

Zhao Wu, Haixia Liu, Yan Shi, and Long Li
Xidian University, China

A wideband and low-profile circularly polarized antenna using metasurface for WLAN or satellite communication applications is proposed. The proposed antenna consists of a planar slot coupling antenna with an array of metallic rectangular patches which can be viewed as a metasurface. The metasurface is utilized to adjust axial ratio (AR) for circularly polarized radiation and the slot is angled at 42^0 with respect to the feed-line. Furthermore, the proposed metamaterial-inspired antenna has a compact structure with a low-profile of $0.07\lambda_0$ (λ_0 stands for the free space wavelength at 5.25 GHz). Simulated results show that the -10 dB impedance bandwidth for the proposed antenna is 32.5% from 4.25 to 5.9 GHz, and 3-dB AR bandwidth is 18.5% from 4.9 to 5.9 GHz.

	M01-2:
10:40-11:00	Three Dimensional Electromagnetic Invisibility Cloak With Arbitrary Shapes

Wei Tang, Yan Shi, and Long Li
Xidian University, China

Based on metamaterials and transformation optics theory, we develops a method to design 3D invisibility cloak with arbitrary shapes. The proposed electromagnetic invisibility cloak can perfectly hide the target object with arbitrary shapes and materials. Full-wave simulation results demonstrate that 3D electromagnetic invisibility cloaks designed by the proposed method have good performance for hiding objects.

	M01-3:
11:00-11:20	Dispersion Analysis of a Fishnet Metamaterial Based on the Rotated TLM Method

Ying Xiong[1, 2], Johannes A. Russer[2], Wenquan Che[1], Guangxu Shen[1, 2], and Peter Russer[2]
[1] *Nanjing University of Science and Technology, China*
[2] *Technical University of Munich, Germany*

A novel three-dimensional LC-based metamaterial topology to model traditional fishnet structure is proposed. Rotated Transmission-Line Matrix (RTLM) unit as one independent half cell from the typical Transmission-Line Matrix (TLM) unit with each incident polarization rotated by 45°, is supposed to save the computation time and decrease the processing data when a structure is analyzed, especially when some specific components of the structure are dealt with. Here a RTLM unit is used to construct a lumped fishnet structure circuit model. The dispersion relation and Bloch impedance are given and compared with the simulation to validate the feasibility of our proposed circuit model.

	M01-4:
11:20-11:40	Fast Analysis of Electrically Large Plasmonic Arrays with Aperiodic Spiral Order

Muhammad Zubair[1], Matteo Alessandro Francavilla[2], Marco Righero[2], Giuseppe Vecchi[1], and Luca Dal Negro[3]
[1] *Politecnico Di Torino, Italy*
[2] *Istituto Superiore Mario Boella, Italy*
[3] *Boston University, United States*

This work presents a fast analysis of electromagnetic scattering from arrays of metallic nano-particles with aperiodic spiral order. The reported method extends the integral equation fast Fourier transform (IE-FFT) algorithm to the method of moments solution of PMCHWT integral equation for aperiodic homogenous dielectric arrays. The algorithm relies on the interpolation of Greens function by Lagrangian polynomials on a uniform Cartesian grid. Hence, the matrix-vector product in the iterative solver can be computed via the fast Fourier transform. The memory requirement and the computational complexity of the algorithm tend to stay close to O(N) and O(NlogN), respectively, where N is the number of unknowns. Some numerical examples are included, which illustrate the accuracy and capability of the present method.

	M01-5:
11:40-12:00	Ultra-Wide Bandstop Frequency Selective Structive Using a Cascaded Array of Vertically Stacked Parallel Strip Lines

Ali Qasim and Zhongxiang Shen
Nanyang Technological University, Singapore

A novel three-dimensional frequency-selective structure with an ultra-wide bandstop response is proposed using a cascaded configuration of a two-dimensional array of vertically stacked parallel strip lines. The structure is designed to achieve a combined rejection response of two independently designed parallel strips etched on the same substrate material. The bandwidth and the position of the rejection band are configurable by controlling the lengths of the two cascaded parallel strips. An example design is presented with its measured result, achieving a -10 dB fractional bandwidth of 100%. The structure demonstrates a stable angular response under fairly large oblique incident angles given the wide bandwidth. The operating principles and design procedures are briefly explained.

12:00-13:30	**Lunch**

	February 3, 2015 (Tuesday), Day 2-4
13:30-15:30	Room: 210, 8/F, Academic 3, City University of Hong Kong Session: IS3
	Session Chair: Yong Xin Guo
	On-/In-Body Antennas and Body Channel Modelling
	IS3-1:
13:30-13:50	Antenna Design Considerations for Far Field and Near Field Wireless Body-Centric Systems
	IS3-2:
13:50-14:10	Antennas Design for Implantable Medical Devices
	IS3-3:
14:10-14:30	Modeling and Design of Wireless Data Telemetry and Power Transfer for Biomedical Implants
	IS3-4:
14:30-14:50	2GHz Near-Field In-head Path-loss Model for Stroke Detection
	IS3-5:
14:50-15:10	Ground Plane Effects on SAR for Human Head Model Exposed to a Dual-Band PIFA
	IS3-6:
15:10-15:30	MRI-based Electrical Property Mapping for Human Body

	February 3, 2015 (Tuesday), Day 2-4
13:30-15:30	Room: 210, 8/F, Academic 3, City University of Hong Kong Session: IS3

	Session Chair: Yong Xin Guo
	On-/In-Body Antennas and Body Channel Modelling

	IS3-1:
13:30-13:50	Antenna Design Considerations for Far Field and Near Field Wireless Body-Centric Systems

Elham Moradi[1], Karoliina Koski[1], Masoumeh Hasani[1], Yahya Rahmat-Samii[2], and Leena Ukkonen[1]
[1] *Tampere University of Technology, Finland*
[2] *University of California, Los Angeles, United States*

In this paper we analyze the design and realization of wearable and implantable antennas meant for wireless bodycentric systems. Studied wearable antennas exploit electrotextiles, including embroidered textiles and conductive fabrics, for the light-weight and transparent integration with daily clothing. We also present mm-sized implantable loop antennas that are capable of providing electromagnetic power to implant devices from an external on-body loop antenna through near field inductive link.

	IS3-2:
13:50-14:10	Antennas Design for Implantable Medical Devices

Shaoqiu Xiao and Rongqiang Li
University of Electronic Science and Technology of China, China

The purpose of this paper is to design antennas for implantable medical devices. A miniature semicircular implantable planar inverted-F antenna (PIFA) is designed and experimentally demonstrated for medical communications services (MICS) band (402-405 MHz). By embedding three arc-shaped slots in a semicircular patch, the proposed antenna can obtain effective size reduction at a fixed frequency operation. The total volume of the proposed antenna including substrate and superstrate is about 151 mm^3 ($9.52\times1\pi/2$ mm3+$0.5\times9.5\times2\times1$ mm^3). In addition, a compact dual-band implantable antenna consisting of a spiral radiating stripe and a U-shaped radiating stripe is proposed for MICS and industrial, scientific, and medical (ISM) (2.4-2.48 GHz) applications.

	IS3-3:
14:10-14:30	Modeling and Design of Wireless Data Telemetry and Power Transfer for Biomedical Implants

Kush Agarwal[1, 2], Rangarajan, Jegadeesan[2], Yong-Xin Guo[1, 3], and Nitish V. Thakor[1, 2]
[1] *National University of Singapore, Singapore*
[2] *Singapore Institute for Neurotechnology, Singapore*
[3] *National University of Singapore Suzhou Research Institute, China*

This paper briefly discusses the modeling and design processes of various implantable miniaturized antennas and coils proposed by our research group for wireless data telemetry and power transfer for implants. Methods to overcome practical design issues in implants are proposed whilst adhering to the standard safety regulations.

	IS3-4:
14:30-14:50	2GHz Near-Field In-head Path-loss Model for Stroke Detection

Hong-Li Peng[1], Zheng Tang[1], and Bai-Qing Zong[2]
[1] *Shanghai Jiao Tong University, China*
[2] *ZTE Corporation, China*

A realistic 2GHz human in-head near-field path-loss (NF-PL) modeling approach is presented in this paper. Due to the facts that the EM near-field interactions and in-head NF-PL characteristic are fully reflected in the simulation system, which consists of a verified UWB antenna and a well-known head-phantom, the NF-PL parameters can then be extracted in terms of this rigorous simulated results. The results will provide an invaluable insight into signal's transmission in head as well as be used for head stroke detection.

	IS3-5:
14:50-15:10	Ground Plane Effects on SAR for Human Head Model Exposed to a Dual-Band PIFA

Jun Wang, Yue Wang, Gen Chen, and Lei Zhao
Jiangsu Normal University, China

Effects of ground plane on the Specific absorption rate (SAR) in SAM head model exposed PIFA antenna is investigated in this paper. The dual-band PIFA working at 900M and 1800M is designed to operate with a ground plane, and the ground plane is an integral part of the antenna assembly. To investigate systematic biases on SAR in SAM head model resulting from shape effect of the ground, both the average SAR over a mass of 1g and l0g in the head models exposed to a dual band PIFA were determined. These results are very useful in the design of a PIFA for applications requiring a small ground plane.

	IS3-6:
15:10-15:30	MRI-based Electrical Property Mapping for Human Body

Elizaveta Motovilova, Jiasheng Su, and Shao Ying Huang
Singapore University of Technology and Design, Singapore

This article presents and compares analytical and numerical methods for electrical property retrievals that are developed recently in our research group. The methods create electrical property maps of human body only on the basis of typical data from magnetic resonance imaging (MRI) (without using any additional devises or data). Derivations and results are included. Analysis and comparison of the methods are presented.

15:30-15:50	**Tea Break**

18:00-22:30	**Banquet**

	February 3, 2015 (Tuesday), Day 2-4
08:20-10:00	Room: 230, 8/F, Academic 3, City University of Hong Kong Session: A01
	Session Chair: Yilong Lu
	Antenna Arrays
	A01-1:
08:20-08:40	A Printed Antenna Array Fed by Balanced Schiffman Shifter Used for UWB Location System
	A01-2:
08:40-09:00	Adaptive Beamforming for Arbitrary Array by Particle Swarm Optimization
	A01-3:
09:00-09:20	A Planar Antenna Array with Wide Pattern Coverage for 2.4GHz Zig-bee Wireless Sensor Network
	A01-4:
09:20-09:40	Preliminary Investigations on MIMO OTA Testing in Small Anechoic Chambers
	A01-5:
09:40-10:00	Types and Comparison of Low Cost Radar Beamforming Arrays

	February 3, 2015 (Tuesday), Day 2-4	
08:20-10:00	Room: 230, 8/F, Academic 3, City University of Hong Kong	Session: A01

	Session Chair: Yilong Lu
	Antenna Arrays

	A01-1:
08:20-08:40	A Printed Antenna Array Fed by Balanced Schiffman Shifter Used for UWB Location System

Yuanshan Cui, Deqiang Yang, Huiling Zeng, Meng Zou, and Jin Pan
University of Electronic Science and Technology of China, China

A double-sided printed bow-tie antenna array fed by balanced Schiffman phase shifter, which used as a reader antenna in ultra-wideband (UWB) location system, is proposed in this paper. The presented antenna has a impedance bandwidth of 3.4–4.4 GHz and a high gain of more than 5dB within the whole bandwidth. Good omnidirectional radiation pattern is obtained in the plane of $\theta = 15^{o}$. Good simulation results are achieved by HFSS.

	A01-2:
08:40-09:00	Adaptive Beamforming for Arbitrary Array by Particle Swarm Optimization

Wei Cui and Yilong Lu
Nanyang Technological University, Singapore

Adaptive beamforming is critical in high performance radar and wireless communications applications. This paper presents a study of adaptive beamforming for arbitrary array by applying the powerful and versatile particle swarm optimization (PSO). Numerical experiments for sidelobe suppression, nulling, null steering and array failure correction have demonstrated that the presented PSO approach is effective for adaptive beamforming.

	A01-3:
09:00-09:20	A Planar Antenna Array with Wide Pattern Coverage for 2.4GHz Zig-bee Wireless Sensor Network

Liang Zhou and Cheng Liao
Southwest Jiao-Tong University, China

The performance of a multi-element patch array are studied and compared to determine their suitability in Zigbee sensor relay for placement on rotating platforms. Each antenna operates in the 2.175 GHz frequency band and occupies a maximum area of 40 by 60 mm. It is demonstrated that using the multi-element patch in place of the single-element patch, 5dB gain enhancement and superior radiation pattern coverage can be obtained.

	A01-4:
09:20-09:40	Preliminary Investigations on MIMO OTA Testing in Small Anechoic Chambers

Wei Fan, Ondrej Franek, Samantha Caporal Del Barrio, and Gert F. Pedersen
Aalborg University, Denmark

The multi-probe anechoic chamber method, which is a promising candidate in over the air (OTA) testing of multiple-input multiple-output (MIMO) capable terminals, has attracted great research attention recently. The objective of the paper is to investigate the feasibility of using a small anechoic chamber (e.g. size of several wavelengths) for OTA testing, where the main focus is on investigating the impact of system nonidealities (e.g. probe scattering, wall reflections) in small anechoic chambers and plane wave synthesis in small anechoic chambers.

	A01-5:
09:40-10:00	Types and Comparison of Low Cost Radar Beamforming Arrays

Shan Xing and Yilong Lu
Nanyang Technological University, Singapore

This paper presents a study of various types of radar array architectures for low cost radar antennas with digital beamforming (BDF) capabilities. In addition to popular oneway and twoway beamforming, the emerging synthetic array radar (SAR)-like DBF and multiple-input-multiple-output (MIMO) DBF are examined with beamforming equations. New simple approximation formulae about half-power beamwidth (HPBW) estimation for SAR-like array and MIMO array are proposed for easier design reference. The comparison study shows that the SAR-like DBF or MIMO DBF can achieve much better angular higher resolution than the conventional oneway or twoway beamforming techniques.

10:00-10:20	**Tea Break**

	February 3, 2015 (Tuesday), Day 2-4
10:20-12:00	Room: 230, 8/F, Academic 3, City University of Hong Kong Session: T01
	Session Chair: Ali E. Yilmaz
	TDIE & FDTD
	T01-1:
10:20-10:40	A Parallel Out-of-Core Algorithm for Time-Domain Adaptive Integral Method
	T01-2:
10:40-11:00	Analysis of Triangular Shape Dielectric Resonator Antenna Using FDTD Method
	T01-3:
11:00-11:20	FDTD Simulation of ELF Surface Responses for Underground Resource Detection
	T01-4:
11:20-11:40	Nyström Method Solution for Time-Domain Electric Field Integral Equations
	T01-5:
11:40-12:00	An Explicit MOT-TDVIE Scheme for Analyzing Electromagnetic Field Interactions on Nonlinear Scatterers

	February 3, 2015 (Tuesday), Day 2-4
10:20-12:00	Room: 230, 8/F, Academic 3, City University of Hong Kong Session: T01

	Session Chair: Ali E. Yilmaz
	TDIE & FDTD

	T01-1:
10:20-10:40	A Parallel Out-of-Core Algorithm for Time-Domain Adaptive Integral Method

Guneet Kaur and Ali E. Yilmaz
The University of Texas at Austin, United States

A parallel multi-level out-of-core algorithm is presented to mitigate the high memory requirement of the time-domain adaptive integral method. Numerical results demonstrate the performance of the method for large-scale simulations where terabytes of data are transferred to/from a distributed storage system.

	T01-2:
10:40-11:00	Analysis of Triangular Shape Dielectric Resonator Antenna Using FDTD Method

Anshul Gupta[1, 2] **and Ravi Kumar Gangwar**[2]
[1] *National Institute of Technology Raipur, India*
[2] *Indian School of Mines, India*

Analysis of strip excited triangular shape dielectric resonator antenna (TDRA) using Finite Difference Time Domain (FDTD) numerical technique is presented. The calculated values of resonant frequencies using FDTD method have been compared with predicted resonant frequencies values using Dielectric Waveguide Method. The numerical and theoretical results are found in good agreement, which validate this analysis using FDTD numerical technique.

	T01-3:
11:00-11:20	FDTD Simulation of ELF Surface Responses for Underground Resource Detection

Yi Wang[1, 2] **and Qunsheng Cao**[1]
[1] *Nanjing University of Aeronautics and Astronautics, China*
[2] *Nanjing University of Information Science and Technology, China*

The geodesic FDTD method is applied to simulate surface responses caused by extremely low frequency (ELF) electromagnetic (EM) wave propagation for potential underground (UG) resource detection applications. The simulation space extends from 100km above the Earth's surface to 100km below it. Object with specific dielectric values are buried to simulate possible UG resource. A model is establish for possible UG resource detection using ELF waves. Using these settings, surface responses are simulated and analyzed. Finally, potential application of inverse study using the simulation results are discussed.

	T01-4:
11:20-11:40	Nyström Method Solution for Time-Domain Electric Field Integral Equations

Gui Zhu Yin, Jie Zhang, Wen Jie Chen and Mei Song Tong
Tongji University, China

The interaction of transient electromagnetic (EM) wave with objects can be formulated by the integral equation approach in time domain. For conducting objects or homogeneous penetrable objects, the time-domain surface integral equations (TDSIEs) can be applied. Traditionally, the TDSIEs are solved by the method of moments (MoM) in spatial domain and a marchon in time (MOT) scheme in temporal domain. In this work, we propose a hybrid scheme in which the Nyström method is used in spatial domain while the MoM with Laguerre function as a basis function in the time domain is employed. The numerical example for EM scattering by a conducting sphere is presented to demonstrate the scheme and its merits can be observed.

	T01-5:
11:40-12:00	An Explicit MOT-TDVIE Scheme for Analyzing Electromagnetic Field Interactions on Nonlinear Scatterers

H. Arda Ülkü[1, 2]**, Sadeed Bin Sayed**[1]**, and Hakan Bağci**[1]
[1] *King Abdullah University of Science and Technology, Saudi Arabia*
[2] *Gebze Institute of Technology, Turkey*

An explicit marching on-in-time (MOT) based time domain electric field volume integral equation (TDVIE) solver for characterizing electromagnetic wave interactions on scatterers with nonlinear material properties is proposed. Discretization of the unknown electric field intensity and flux density is carried out by half and full Schaubert-Wilton-Glisson basis functions, respectively. Coupled system of spatially discretized TDVIE and the nonlinear constitutive relation between the field intensity and the flux density is integrated in time to compute the samples of the unknowns. An explicit $PE(CE)^m$ scheme is used for this purpose. Explicitness allows for "easy" incorporation of the nonlinearity as a function only to be evaluated on the right hand side of the coupled system of equations. A numerical example that demonstrates the applicability of the proposed MOT scheme to analyzing electromagnetic interactions on Kerr-nonlinear scatterers is presented.

12:00-13:30	**Lunch**

	February 3, 2015 (Tuesday), Day 2-4
13:30-15:30	Room: 230, 8/F, Academic 3, City University of Hong Kong Session: A02
	Session Chair: Wenquan Che
	Antenna Applications I
	A02-1:
13:30-13:50	CPW fed UWB Strip Antenna with Extended Ground
	A02-2:
1350-14:10	Design of a Pneumatically Controlled Frequency Switchable Patch Antenna
	A02-3:
14:10-14:30	An Omnidirectional Microstrip Antenna with Enhanced Bandwidth for UWB Wireless Systems
	A02-4:
14:30-14:50	Compact Dipole Antenna with Multiple Radiation Pattern Reconfigurations
	A02-5:
14:50-15:10	Design for Multiband Relay Antenna with Parasitic Monopoles
	A02-6:
15:10-15:30	Parasitic Antenna with Interdigital Structure for TV Broadcast Energy Harvesting

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	February 3, 2015 (Tuesday), Day 2-4	
13:30-15:30	Room: 230, 8/F, Academic 3, City University of Hong Kong	Session: A02

	Session Chair: Wenquan Che
	Antenna Applications I

	A02-1:
13:30-13:50	CPW fed UWB Strip Antenna with Extended Ground

Ayman S.Al-Zayed and Shameena V. A
Kuwait University, Kuwait

A compact coplanar waveguide (CPW) fed ultrawideband (UWB) monopole antenna is presented in this paper. The antenna consists of a CPW fed monopole with a rectangle embedded on it. Also two symmetrical open-circuit stubs extended from the CPW's ground plane are introduced to implement an ultra wideband radiation. The antenna having a size of 17.7 mm x26 mm x 1.6 mm gives a -10dB bandwidth ranging from 3.1 to 10.6 GHz. Investigation of the frequency domain characteristics reveal that antenna exhibits ultra wide bandwidth, omni directional radiation pattern and stable gain.

	A02-2:
1350-14:10	Design of a Pneumatically Controlled Frequency Switchable Patch Antenna

Billy Wu, Michal Okoniewski, and Chris Hayden
University of Calgary, Canada

A pneumatically controlled patch antenna with resonant frequency that can be switched to either 3.05 GHz or 5 GHz is introduced. The resonant frequency of the device is determined by the dimension of the patch that is excited. To select a particular frequency, a pneumatically-operated copper-plated swinging arm is moved to cover one of two orthogonal slots on the ground plane. The uncovered slot allows energy to be coupled from the microstrip feedline to the corresponding dimension of the patch. Simulated results from HFSS are provided.

	A02-3:
14:10-14:30	An Omnidirectional Microstrip Antenna with Enhanced Bandwidth for UWB Wireless Systems

Nasser Ojaroudi
Islamic Azad University, Iran

This study introduces a new design of low profile, multi-resonance and omni-directional monopole antenna for ultra-wideband (UWB) applications. The proposed antenna configuration consists of an ordinary square radiating patch and a ground plane with pairs of inverted fork-shaped slits and inverted Γ-shaped parasitic structures, which provides a wide usable fractional bandwidth of more than 135%. The proposed antenna has symmetrical structure with an ordinary square radiating patch, therefore displays a good omni-directional radiation patterns even at the higher frequencies. The antenna radiation efficiency is greater than 87% across the entire radiating band. The measured results show that the proposed antenna can achieve the voltage standing wave ratio (VSWR) requirement of less than 2.0 in frequency range from 2.83 to 14.87GHz which is suitable for UWB systems.

	A02-4:
14:30-14:50	Compact Dipole Antenna with Multiple Radiation Pattern Reconfigurations

Y. Juan[1], Wenquan Che[1], Wanchen Yang[1], and ZhiNing Chen[2]
[1] *Nanjing University of Science and Technology, China*
[2] *National University of Singapore, Singapore*

An antenna with four sets of PIN diodes-loaded parasitic strips and reflectors is designed to realize multiple reconfigurable radiation pattern. Parasitic strips are placed between the dipole and reflectors to change impedance of the dipole, thus reducing the distance between the dipole and the reflector. The size of the whole antenna is only $0.1\lambda_0 \times 0.1\lambda_0$. Moreover, by switching and controlling the PIN diode, the parasitic strip and reflector can perform as a director or a reflector, a Yagi-Uda antenna. As a result, the antenna can provide three modes with nine fundamental radiation patterns. Two modes can realize an eight-beam scanning in the azimuth plane with a 45°-angle-interval at the frequency of 1.575GHz. The peak gain more than 7dBi of all the beams are achieved at the elevation angle of 60°. Another mode can generate an approximate conical radiation pattern. The maximum gain is 5.1 dBi, achieved at the elevation angle of 50°.

	A02-5:
14:50-15:10	Design for Multiband Relay Antenna with Parasitic Monopoles

Sung-min Kim[1], Kyeong-sik Min[1], and Seong-yong Gang[2]
[1] *Korea Maritime and Ocean University, Korea*
[2] *Microwave and RF Leader Technology Co. Ltd, Korea*

This paper presents a multiband antenna composed of one main monopole and four parasitic poles for the in-building mobile relay system including a firefighting radio band. A main center pole is resonated at 450 MHz of the firefighting band, parasitic poles are considered for the multi-resonance and the beam direction control. The measured results such as the reflection coefficients and the radiation patterns of a fabricated antenna are shown reasonable agreement with the prediction.

	A02-6:
15:10-15:30	Parasitic Antenna with Interdigital Structure for TV Broadcast Energy Harvesting

Minjing Zhang[1], Xueguan Liu[1], Huiping Guo[1], Xinmi Yang[1, 2], and Danpeng Xie[1]
[1] *Soochow University, China*
[2] *State Key Laboratory of Millimeter Waves, China*

This paper presents a novel parasitic antenna for RF energy harvesting. The antenna consists of a planar driven dipole and a planar parasitic dipole which are printed on the bottom and top surfaces of a substrate, respectively. For each dipole, meander lines are used for size reduction and transferring the RF power. Moreover, by loading these two dipoles with interdigital structures, the antenna impedance and the radiation directivity can be tuned. A slot-modified reflector is also applied for the purpose of unifying the current direction and improving the radiation directivity and efficiency. The measured -10dB bandwidth is from 508 to 521MHz and the simulated peak gain is 3.26dBi at 515MHz. A rectifier based on HSMS2862 diode is presented. The proposed antenna is employed by the rectifier the received dc voltage is up to 536 mV. The proposed antenna has advantages such as high efficiency, high directivity and electrically small structure, which is suitable for energy harvesting in TV broadcast bands.

15:30-15:50	**Tea Break**

18:00-22:30	**Banquet**

	February 3, 2015 (Tuesday), Day 2-4
08:20-10:00	Room: 208, 6/F, Academic 3, City University of Hong Kong Session: I01
	Session Chair : Petros Allilomes
	Imaging and Spurious Mode Suppression
	I01-1:
08:20-08:40	Analysis and Design of Millimeter Wave Beam Scanning Antennas with 2.5-Dimensional Electrically-Large Structure
	I01-2:
08:40-09:00	Microwave Imaging with Random Sparse Array and Compressed Sensing for Target Detection
	I01-3:
09:00-09:20	SAR Imaging with Time-Domain Full-Wave Scattering Calculations
	I01-4:
09:20-09:40	Eigenanalysis of Photonic Structures Based on Finite Element with Efficient Suppression of Spurious Modes
	I01-5:
09:40-10:00	Eigenanalysis of Open-Radiating Microwave Structures with Efficient Suppression of Spurious Modes

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	February 3, 2015 (Tuesday), Day 2-4
08:20-10:00	Room: 208, 6/F, Academic 3, City University of Hong Kong Session: I01

	Session Chair : Petros Allilomes
	Imaging and Spurious Mode Suppression

	I01-1:
08:20-08:40	Analysis and Design of Millimeter Wave Beam Scanning Antennas with 2.5-Dimensional Electrically-Large Structure

Chao Li and GuangYou Fang
Institute of Electronics, Chinese Academy of Sciences, China

In this paper, a special kind of beam scanning antenna with 2.5-dimensional electrically-large structure was proposed in millimeter wave band. A numerical method with high efficiency was developed to deal with the electromagnetic analysis and design problems of the proposed antenna. Experiment in 200GHz was performed to verify the proposed numerical approach.

	I01-2:
08:40-09:00	Microwave Imaging with Random Sparse Array and Compressed Sensing for Target Detection

Ling Huang and Yilong Lu
Nanyang Technological University, Singapore

This paper presents a study of Synthetic Aperture Radar (SAR) imaging based on random sparse array (RSA) and compressed sensing (CS) for target detection. Extensive numerical experiments based on real RSA measurement data are carried out and statistical analysis is performed to compare the performances of the CS technique and back-projection (BP) method using RSA. Performance analysis of the results show that RSA-CS method has better performance than the RSA-BP method and can achieve acceptable performance with much smaller data amount than full SAR imaging.

	I01-3:
09:00-09:20	SAR Imaging with Time-Domain Full-Wave Scattering Calculations

Yupei Feng, Dongying Li, Wenxian Yu, and Min Zhang
Shanghai Jiao Tong University, China

This paper introduces a methodology of synthetic aperture radar imaging by utilizing scattering coefficients of targets obtained from time-domain full-wave simulations. Compared with conventional point-reflector assumption in synthetic radar imaging as well as shooting and bouncing rays technology, such a method is able to achieve a higher resolution in range, and is especially useful in imaging complex and electrically-large targets.

	I01-4:
09:20-09:40	Eigenanalysis of Photonic Structures Based on Finite Element with Efficient Suppression of Spurious Modes

Constantinos Zekios, Peter Allilomes, and George Kyriacou
Democritus University of Thrace, Greece

The establishment of finite element based eigenanalysis as a numerical tool for the indepth understanding and revealing the characteristics of Terahertz and photonic structures, constitute the scope of this work. A tree-cotree splitting formulation method is used for the removal of imaginary and dc spurious modes. The Ritz vectors are appropriately restricted during the linearization technique of the polynomial eigenproblem. The capabilities of the method is demonstrated presenting certain microdisk and microrings whispering gallery modes eigenvalues and eigenvectors.

	I01-5:
09:40-10:00	Eigenanalysis of Open-Radiating Microwave Structures with Efficient Suppression of Spurious Modes

Constantinos Zekios, Peter Allilomes, and George Kyriacou
Democritus University of Thrace, Greece

Recently we have proposed a finite element based eigenanalysis for lossy and unbounded microwave structures. Our present effort aims at the validation of this technique for the study of complex radiating structures like the cavity backed type. The typical Absorbing Boundary Condition (ABC) of 1st kind is employed for the truncation of the unbounded domain, while finite conductivity is introduced at the metallic parts of the studied structure. The spurious modes that occur due to the discretization of the solution domain are being suppressed by the enforcement of "divergence-free" constraint equations in the whole domain. It is proved in the current work that the nonphysical modes restriction of the solution domain is achieved only by the projection of the seeding vector in the null space of the irrotational field, during the linearization procedure.

10:00-10:20	**Tea Break**

	February 3, 2015 (Tuesday), Day 2-4
10:20-12:00	Room: 208, 6/F, Academic 3, City University of Hong Kong Session: IS2
	Session Chairs : Jun Hu and Zhen Peng
	Recent Progress in Integral Equation Methods (Part I)
	IS2-1:
10:20-10:40	Accuracy Enhancement of the Equivalence Principle Algorithm Based on the Meshless Spherical Surface
	IS2-2:
10:40-11:00	A Kernel-Independent Wideband Nested Equivalent Source Approximation
	IS2-3:
11:00-11:20	A Domain Decomposition Method for Electromagnetic Radiation of Large-Scale Arrays
	IS2-4:
11:20-11:40	Fast Wideband Scattering Analysis Based on Taylor Expansion and Higher Order Hierarchical Vector Basis Functions
	IS2-5:
11:40-12:00	An Efficient Numerical Method for Simplified Plasma Limiter Simulation

	February 3, 2015 (Tuesday), Day 2-4
10:20-12:00	Room: 208, 6/F, Academic 3, City University of Hong Kong Session: IS2

	Session Chairs : Jun Hu and Zhen Peng
	Recent Progress in Integral Equation Methods (Part I)

	IS2-1:
10:20-10:40	Accuracy Enhancement of the Equivalence Principle Algorithm Based on the Meshless Spherical Surface

Xin Fu, Lijun Jiang, and Zuhui Ma
The University of Hong Kong, Hong Kong

Conventional equivalence principle algorithm (EPA) employs cubical boxes to support equivalence sources. However, it introduces strong discontinuities. In this work, a spherical surface is employed as the equivalence surface in EPA to avoid singularities from non-smooth surfaces. Further to achieve high order accuracy, meshless samples are used for the integrals on the spherical surface to avoid the equivalence surface mesh discretization. Theoretically the accuracy of EPA can be significantly improved, which was further benchmarked though numerical examples. Various meshless schemes are also discussed to achieve the optimal solution based on the spherical equivalence surface.

	IS2-2:
10:40-11:00	A Kernel-Independent Wideband Nested Equivalent Source Approximation

Mengmeng Li[1], Rushan Chen[1], Matteo Alessandro Francavilla[2], and Giuseppe Vecchi[3]
[1] *Nanjing University of Science and Technology, China*
[2] *Istituto Superiore Mario Boella, Italy*
[3] *Politecnico di Torino, Italy*

We introduce a kernel-independent wideband nested equivalent source approximation method. The nested equivalent source approximation (NESA), proposed by these authors to solve low frequency problems with linear complexity, is extended here to electrically large multiscale structures. The low frequency algorithm is directly employed at the bottom levels of an Octree clustering; in the high frequency regime, the directional low rank property is exploited, yielding a nested directional algorithm (Wideband NESA - WNESA) with *O(N log N)* complexity. Numerical results demonstrate the validity of the proposed solver.

	IS2-3:
11:00-11:20	A Domain Decomposition Method for Electromagnetic Radiation of Large-Scale Arrays

Pengfei Gu, Ting Su, Zhen Hong Fan, and Rushan Chen
Nanjing University of Science and Technology, China

A domain decomposition method based on equivalence principle algorithm is used for analyzing and calculating radiation problems of large-scale arrays. The adaptive cross approximation method is introduced to accelerate computing the translate operator, and the repeatability of the array is removed. Numerical results demonstrate that the time consumption and the memory usage are all reduced.

	IS2-4:
11:20-11:40	Fast Wideband Scattering Analysis Based on Taylor Expansion and Higher Order Hierarchical Vector Basis Functions

Huanhuan Zhang, Dazhi Ding, Zhen Hong Fan, and Rushan Chen
Nanjing University of Science and Technology, China

A fast wideband electromagnetic scattering analysis method based on Taylor expansion and higher order hierarchical vector basis functions is proposed. By extracting a phase term from the green function, the remaining exponent term can be approximated by its truncated Taylor expansion. After that, some computationally intensive matrices related to the geometry of the object can be computed in advance. During the frequency sweeping process, the impedance matrix is generated efficiently by combining the pre-computed matrices and some frequency dependent terms. By using higher order hierarchical vector basis functions, only one coarse mesh corresponding to the lowest frequency of the given frequency band is generated. The order of the basis functions increases with the rising of frequency. Moreover, only the pre-computed matrices corresponding to the highest order basis need to be computed. All impedance matrices at different frequencies can be generated by these pre-computed matrices due to the hierarchical property of the basis functions. Numerical results show that the proposed method can greatly accelerate the wide-band scattering analysis.

	IS2-5:
11:40-12:00	An Efficient Numerical Method for Simplified Plasma Limiter Simulation

Cheng Qian, Dazhi Ding, and Rushan Chen
Nanjing University of Science and Technology, China

In this paper, a simplified plasma limiter is modeled and simulated based on spectral-element time-domain (SETD) method. Maxwell Equations coupled to fluid model are proposed to describe the physics procession of the gas discharge and the mechanism of the plasma limiter. In order to solve the proposed PDEs, the Galekin's method is employed for the space discretization and the central difference scheme is used for time stepping. Numerical examples demonstrate the ability and effectiveness of the SETD method for the design and analysis of these structures.

12:00-13:30	**Lunch**

	February 3, 2015 (Tuesday), Day 2-4
13:30-15:30	Room: 208, 6/F, Academic 3, City University of Hong Kong Session: C01
	Session Chair : Lei Zhu
	Circuit and Waveguide Characterization
	C01-1:
13:30-13:50	A Review on Numerical Calibration and De-Embedding Techniques in Fullwave Algorithms
	C01-2:
13:50-14:10	Discussion of Conversion Theory between Mixed-Mode S-Parameters and T-Parameters for Differential Circuit with and without Common-Mode Suppression
	C01-3:
14:10-14:30	Equivalent Circuit Models of a Lossy MIM Multiple Teeth-Shape Filter
	C01-4:
14:30-14:50	Mode-Matching Analysis for Double-Layered Substrate Integrated and Rectangular Waveguide Filter Technology
	C01-5:
14:50-15:10	Broadband Dual Polarized End-Launched Coaxial Transition for Dielectric-Filled Square Waveguide
	C01-6:
15:10-15:30	Electrostatic mode-matching solution for CTEM cell

	February 3, 2015 (Tuesday), Day 2-4	
13:30-15:30	Room: 208, 6/F, Academic 3, City University of Hong Kong	Session: C01

	Session Chair : Lei Zhu
	Circuit and Waveguide Characterization

	C01-1:
13:30-13:50	A Review on Numerical Calibration and De-Embedding Techniques in Fullwave Algorithms

Lei Zhu[1] **and Sheng Sun**[2]
[1] *University of Macau, Macao*
[2] *The University of Hong Kong, Hong Kong*

This paper presents a brief review on the development of numerical calibration and de-embeddingtechniques. The earlier proposed short-open-calibration (SOC) technique was first implemented in the integral-equation basedmethod of moments and extensively studied for computer-aided design of different microwave circuit structures. Unlike other deembedding techniques, the SOC technique has no need to predefine the port discontinuities and feed network, but only consider them as a unified error box. Recent progress in this research will be discussed and clarified.

	C01-2:
13:50-14:10	Discussion of Conversion Theory between Mixed-Mode S-Parameters and T-Parameters for Differential Circuit with and without Common-Mode Suppression

Jie Yang, Wai-Wa Choi, and Kam-Weng Tam
University of Macau, Macao

Recently, mixed-mode S-parameters are becoming more and more important due to the widely used of differential circuits in the RF and microwave area. In the single-end network, designing process based on the S-parameters is one of the most common and convenient approaches, and the Chain Scattering parameters allows the ease of design for the cascade topology. A parameter conversion theory was reported for the transformation between mixed-mode scattering parameters (S-matrix) and chain scattering parameters (T-matrix) for the differential two-port networks. In this paper, measurement results of a practical differential UWB bandpass filter with Common-mode suppression is applied to the said conversion theory and it is found that the reported method is not applicable to the differential circuit with well common-mode rejection.

	C01-3:
14:10-14:30	Equivalent Circuit Models of a Lossy MIM Multiple Teeth-Shape Filter

Dongying Li[1], Er-Ping Li[2], Min Zhang[1], and Wenxian Yu[1]
[1] *Shanghai Jiao Tong University, China*
[2] *Zhejiang University, China*

A brief introduction of transmission line models of three-dimensional metal-insulator-metal plasmonic waveguides is given, along with which is the parasitic circuit model for plasmonic waveguide T junctions. With these analytical means, an equivalent circuit model of a teeth-shape filter is given, and its accuracy is validated by comparison to the result of full-wave solvers.

	C01-4:
14:30-14:50	Mode-Matching Analysis for Double-Layered Substrate Integrated and Rectangular Waveguide Filter Technology

Jan Schorer and Jens Bornemann
University of Victoria, Canada

The adaption of Mode Matching Techniques (MMTs) for an E-plane double-layer discontinuity is presented. The bottom layer is realized in substrate integrated waveguide (SIW) and the top layer in conventional waveguide technology. The calculations are validated by comparison with data from commercial field solvers. The verification shows a good match and qualifies the MMT routine as a suitable method to prototype magnetically coupled, double layer, mixed technology filters.

	C01-5:
14:50-15:10	Broadband Dual Polarized End-Launched Coaxial Transition for Dielectric-Filled Square Waveguide

Kwok Kee Chan
Chan Technologies Inc., Canada

A modal analysis method and a design approach for a compact broadband dual polarized end-launched coaxial transition into a dielectric-filled square waveguide are presented in this paper.

	C01-6:
15:10-15:30	Electrostatic mode-matching solution for CTEM cell

Hyunsoo Kim and Hyo J. Eom
KAIST, Korea

An electrostatic mode-matching solution for a circular transverse electromagnetic cell (CTEM cell) is obtained. Laplace's equation for the electrostatic potential across the cross section of CTEM cell is solved. Computations illustrate that the mode-matching solution is viable and efficient for the analysis of CTEM cell.

15:30-15:50	**Tea Break**
18:00-22:30	**Banquet**

	February 4, 2015 (Wednesday), Day 3-4
08:20-12:00	Room: 210, 8/F, Academic 3, City University of Hong Kong Session: IS4
	Session Chairs : Jun Hu and Zhen Peng
	Recent Progress in Integral Equation Methods (Part II)
	IS4-1:
08:20-08:40	Tunability Analysis of a Miniaturized Patch Antenna with Self-Biased Magnetic Film
	IS4-2:
08:40-09:00	A Hybrid Unconditionally/ Conditionally Stable Parallel Spectral-Element Time-Domain Algorithm for Multi-Scale Computation
	IS4-3:
09:00-09:20	A Non-Conformal Domain Decomposition Algorithm of FE-BI-MLFMA for 3-D Electromagnetic Scattering/Radiation Problems
	IS4-4:
09:20-09:40	Surface Integral Equation Based Discontinuous Galerkin Method for Impedance Surface Objects
	IS4-5:
09:40-10:00	Domain Decomposition Method for Scattering From Multiple Bodies of Revolution
	IS4-6:
10:20-10:40	Adaptive, Scalable Domain Decomposition Methods for Surface Integral Equations
	IS4-7:
10:40-11:00	Analysis of Electromagnetic Scattering from Combination Target of BoR and Arbitrary Structure Using Non-Conformal IE-DDM
	IS4-8:
11:00-11:20	Analysis of Substrate Integrated Waveguide Structures Using Contour Integral Equation
	IS4-9:
11:20-11:40	A Concise and Practical Domain Decomposition Method Using Phase Extracted Basis Functions
	IS4-10:
11:40-12:00	A New Sampling Algorithm used in MultiLevel UV Factorization method for Scattering from Random Rough Surface

	February 4, 2015 (Wednesday), Day 3-4
08:20-12:00	Room: 210, 8/F, Academic 3, City University of Hong Kong Session: IS4

	Session Chairs : Jun Hu and Zhen Peng
	Recent Progress in Integral Equation Methods (Part II)

	IS4-1:
08:20-08:40	Tunability Analysis of a Miniaturized Patch Antenna with Self-Biased Magnetic Film

Xiao Wen Zhang, Jia Shi, Jie Zhang, and Mei Song Tong
Tongji University, China

Tunability analysis based on electromagnetic modeling and simulation is performed for a miniaturized patch antenna loaded with self-biased magnetic films. The antenna includes a lossy dielectric substrate and layered thin-ferrite-film superstrate above microstrip. The structure is of multiscale and multimaterial feature and the system matrix may not be well-conditioned if the problem is described by surface integral equations (SIEs) in the integral equation approach. We use volume-surface integral equations (VSIEs) to formulate the problem and the VSIEs are solved by the method of moments (MoM) with a different implementation scheme. A numerical example is presented to illustrate the approach.

	IS4-2:
08:40-09:00	A Hybrid Unconditionally/ Conditionally Stable Parallel Spectral-Element Time-Domain Algorithm for Multi-Scale Computation

Hao Xu and Rushan Chen
Nanjing University of Science and Technology, China

This paper proposes a hybrid unconditionally/conditionally stable parallel spectral-element time-domain algorithm for the analysis of multi-scale electromagnetic problems. Usually multi-scale simulation will lead to very small cells and thus making the time step size extremely small. However, when using this method, the time step size is no longer constrained by the CFL condition and it will greatly reduce the computation time. The Newmark-Beta scheme is employed for the small cells with MUMPS solver and central difference is for the large cells with direct solution procedure. Consequently, a relatively large time step size can be adopted. Parallel technique is also applied to achieve a satisfied efficiency with MPI. Finally, numerical results demonstrate the accuracy and effectiveness of the proposed method.

	IS4-3:
09:00-09:20	A Non-Conformal Domain Decomposition Algorithm of FE-BI-MLFMA for 3-D Electromagnetic Scattering/Radiation Problems

Hong-Wei Gao, Ming-Lin Yang, Gao-Huizi Guo, and Xin-Qing Sheng
Beijing Institute of Technology, China

A non-conformal domain decomposition algorithm (DDA) of the hybrid finite element-boundary integral-multilevel fast multipole algorithm (FE-BI-MLFMA) is presented for computing electromagnetic scattering/radiation problems. The numerical performance of the presented non-conformal DDAFE-BI-MLFMA is investigated for scattering/radiation problems comparing with its conformal version. Furthermore, a preconditioner is constructed to further accelerate convergence speed of this non-conformal DDA.

	IS4-4:
09:20-09:40	Surface Integral Equation Based Discontinuous Galerkin Method for Impedance Surface Objects

Ming Jiang, Jun Hu, Ran Zhao, and Zaiping Nie
University of Electronic Science and Technology of China, China

This paper investigates the discontinuous Galerkin method based on surface integral equations for the simulation of the electromagnetic scattering problem from objects with impedance boundary condition (IBC). The new surface integral equation is formulated by a proper dual paring to form a reaction integral, which is able to easily simulate scattering from objects with different IBCs even from the perfect electric conductors (PEC) and the perfect magnetic conductors (PMC). Due to the discontinuous Galerkin scheme, it is possible to employ non-conformal surface discretization of the objects. In addition, the multilevel fast multipole algorithm (MLFMA) is implemented to reduce the computational complexity. Numerical examples are presented to demonstrate the performance of the proposed formulations.

	IS4-5:
09:40-10:00	Domain Decomposition Method for Scattering From Multiple Bodies of Revolution

Yuke Li, Jun Hu, and Zaiping Nie
University of Electronic Science and Technology of China, China

In this paper, a domain decomposition method is developed for scattering from multiple conducting bodies of revolution (BoR). The BoR basis functions are utilized to solve the single BoR problem and multilevel fast multipole algorithm (MLFMA) is used to take into account the interaction between multiple BoRs. Because the MLFMA cannot be applied for entire domain basis functions directly, a basis function mapping technique (BFMT) developed by us is used to transform the BoR basis functions into RWG basis functions to overcome this difficulty. Numerical results prove the validity and efficiency of the present method.

10:00-10:20	**Tea Break**

	IS4-6:
10:20-10:40	Adaptive, Scalable Domain Decomposition Methods for Surface Integral Equations

Zhen Peng and Brian Mackie-Mason
University of New Mexico, United States

The objective of this work is to investigate scalable, high performance surface integral equation solvers for large multi-scale electromagnetic problems. The key ideas of the proposed work include: (1) adaptive discontinuous Galerkin boundary element discretizations, which permit the use of nonconformal surface discretizations, allow mixing different types of elements, and dramatically facilitate the mesh generation for high-definition objects; (2) a new geometry-aware SIE domain decomposition method to conquer the geometric complexity of physical domain, by which an arbitrarily complicated surface model can be decomposed into a collection of components, the socalled sub-domains; and (3) parallel and scalable computational algorithms to reduce the time complexity via high performance computing architectures. The proposed work can be viewed as an effective preconditioning scheme that reduces the condition number of very large systems of equations. Furthermore, the mathematical advancements through this work result in highperformance simulation software with superior parallel efficiency and scalability.

	IS4-7:
10:40-11:00	Analysis of Electromagnetic Scattering from Combination Target of BoR and Arbitrary Structure Using Non-Conformal IE-DDM

Mi Tian, Xiang Wei, Jun Hu, and Zaiping Nie
University of Electronic Science and Technology of China, China

Electromagnetic scattering from conducting combination target of body of revolution (BoR) and arbitrary structure is analyzed using the integral equation domain decomposition method (IE-DDM). In non-conformal IE-DDM framework, the target is divided into the BoR sub-domain and non-BoR sub-domain according to geometrical feature, where the BoR and RWG basis functions are used respectively. To realize fast computation of interaction between two sub-domains, the basis function mapping technique is used to transform the BoR basis functions into the RWG basis functions. Results obtained by the proposed approach are given to demonstrate the accuracy and efficiency of this method.

	IS4-8:
11:00-11:20	Analysis of Substrate Integrated Waveguide Structures Using Contour Integral Equation

Huapeng Zhao[1], Zhongxiang Shen[2], Cheng Jin[3], and Er-Ping Li[1]
[1] *Institute of High Performance Computing, Singapore*
[2] *Nanyang Technological University, Singapore*
[3] *Beijing Institute of Technology, China*

This paper presents analysis of substrate integrated waveguide (SIW) structures using contour integral equation method. By ignoring the field variation in vertical direction, the SIW structure is decomposed into internal and external problems. The internal electromagnetic (EM) fields are governed by the contour integral equation, while the external EM fields are computed from the equivalent magnetic currents along the periphery of SIW. Different from most existing SIW analysis methods, the proposed method is able to calculate the radiation from the periphery of SIW, and it is applicable to the analysis of SIW antennas. The proposed method is validated against alternative methods, and its advantages are demonstrated by comparison with commercial software.

	IS4-9:
11:20-11:40	A Concise and Practical Domain Decomposition Method Using Phase Extracted Basis Functions

Kui Han and Zaiping Nie
University of Electronic Science and Technology of China, China

A domain decomposition method (DDM) using phase extracted basis functions with very few overlapped buffer regions is investigated to solve electromagnetic scattering problems of electrically large PEC objects. The concept of "Non-scattering surface" is employed in this DDM and combined field integral equation (CFIE) is used in the numerical solution of each subdomain in corresponding local model which can be seen as a closed object. Instead of employing a certain number of basis functions as buffer regions, this method just uses the patches adjacent to artificial boundaries to ensure the normal continuity of the currents across the artificial regional edges. The multilevel fast multipole algorithm (MLFMA) is applied to accelerate the computation of matrix-vector multiplication. Numerical results show that with buffer regions mentioned above, using phase extracted basis functions defined on large patches has better convergence rate than RWG or CRWG basis functions.

	IS4-10:
11:40-12:00	A New Sampling Algorithm used in MultiLevel UV Factorization method for Scattering from Random Rough Surface

Zherui Yu[1], **Haogang Wang**[1], **and Jiancheng Shi**[2]
[1] *Zhejiang University, China*
[2] *Institute of Remote Sensing Applications, China*

In this paper, we propose a new sampling algorithm combined with multilevel UV(MLUV) factorization method to calculate the scattering from Gaussian random rough surface with exponential correlation function. The new sampling algorithm is based on the steepness of patch pairs which support the basis functions. The numerical analyses in this paper show that the proposed algorithm significantly improves the accuracy of the UV approximation of matrix Z_K.

12:00-13:30	**Lunch**

	February 4, 2015 (Wednesday), Day 3-4
13:30-15:10	Room: 210, 8/F, Academic 3, City University of Hong Kong Session: IS5
	Session Chair : Yu Mao Wu
	High Frequency Scattering Wave
	IS5-1:
13:30-13:50	Application of GTM Method Combined with Local-PO Algorithm
	IS5-2:
13:50-14:10	The Fast Solver for Calculating the High Frequency Scattered Field from the Fock Current on the Surface of the 3-D Convex Scatterer
	IS5-3:
14:10-14:30	Range Profile Analysis of Complex Targets Based on Ray Clustering
	IS5-4:
14:30-14:50	Surface-Ray Tracing Based on the Property of Geodesic on Arbitrary NURBS Surfaces
	IS5-5:
14:50-15:10	Practical Shadowing Test for PO Integral on Trimmed NURBS Surfaces

	February 4, 2015 (Wednesday), Day 3-4
13:30-15:10	Room: 210, 8/F, Academic 3, City University of Hong Kong Session: IS5

	Session Chair : Yu Mao Wu
	High Frequency Scattering Wave

	IS5-1:
13:30-13:50	Application of GTM Method Combined with Local-PO Algorithm

Shang Xiang[1], Canping Zhu[1], Jinpeng Fang[2], Gaobiao Xiao[1], and Junfa Mao[1]
[1] *Shanghai Jiao Tong University, China*
[2] *Shanghai Key Laboratory of Electromagnetic Environmental Effects for Aerospace Vehicle, China*

In this paper, a hybrid method of generalized transition matrix (GTM) and local physical optics (PO) is proposed. The GTM of a scatterer is defined uniquely to describe the relationship between the out-going fields and the incident fields on a specified reference surface. The PO algorithm is applied to obtain current distribution on the electrically large platform. Due to the locality principle, Fresnel zone is determined to reduce the unknowns on the platform analyzed by PO method. The computational efficiency can be improved comparing with conventional method. Numerical examples will be shown to demonstrate the feasibility of the hybrid method.

	IS5-2:
13:50-14:10	The Fast Solver for Calculating the High Frequency Scattered Field from the Fock Current on the Surface of the 3-D Convex Scatterer

Yu Mao Wu[1], Weng Cho Chew[2], and Li Jun Jiang[3]
[1] *Fudan University, China*
[2] *University of Illinois, Urbana- Champaign, United States*
[3] *The University of Hong Kong, Hong Kong*

In this paper, we first consider the Fock current from the 3-D convex cylinder. Next, on invoking the incremental length diffraction technique (ILDC), the resultant high frequency scattered fields are expressed in terms of the Fock current. We propose the NSDP method to calculate these scattered fields. Numerical examples illustrate that the proposed NSDP method for calculating the high frequency scattered fields could achieve the frequency independent computational workload and error controllable accuracy.

	IS5-3:
14:10-14:30	Range Profile Analysis of Complex Targets Based on Ray Clustering

Yang He, Guo-Qiang Zhu, Si-Yuan He, and Yun-hua Zhang
Wuhan University, China

This work presents a new technique based on ray tracing to extract and analyze scattering centers from complex targets, which is called ray clustering. The input of this method is the target CAD model and the output is the dominant scattering centers. This method can separate the echoes from different components by clustering rays owning the different paths and establish relationship between target components and the scattering source, thus it can provide an effective approach to analyze the target characteristics. After introducing the implementation procedure of the extracting method, we present an example to demonstrate its application in characteristic analysis.

	IS5-4:
14:30-14:50	Surface-Ray Tracing Based on the Property of Geodesic on Arbitrary NURBS Surfaces

Song Fu, Yun-Hua Zhang, Si-Yuan He, and Guo-Qiang Zhu
Wuhan University, China

An accurate and efficient numerical algorithm is presented for creeping ray tracing on the arbitrarily shaped surfaces modeled by the Non-Uniform Rational B-spline (NURBS) surfaces. The main problem in calculating the UTD surface diffracted fields on NURBS surfaces is due to the difficulty in determining the geodesic paths which the creeping rays propagate along. In this paper, an efficient method is developed based on the property of geodesic to compute geodesic paths on NURBS surfaces. And the algorithm can extend the applicability of UTD for practical engineering. The validity and efficiency of the algorithm is verified by numerical results.

	IS5-5:
14:50-15:10	Practical Shadowing Test for PO Integral on Trimmed NURBS Surfaces

Jun Yan, Jun Hu, and Zaiping Nie
University of Electronic Science and Technology of China, China

A practical shadowing test technique for the trimmed NURBS surface (TNS) is presented in this work. By employing an efficient Bezier patch classification algorithm, a two-level hierarchical space partitioning volume (HSPV) is built for the TNS, where the leaves of the HSPV that contains trimmed off part of the original surface are marked out, making sure the shadowing test occurs on the effective part of the original surface. The numerical example demonstrates the effectiveness of the proposed method.

15:30-15:50	**Tea Break**

	February 4, 2015 (Wednesday), Day 3-4
15:50-18:10	Room: 210, 8/F, Academic 3, City University of Hong Kong Session: IS6
	Session Chair : Ya Yan Lu
	Computational Photonics
	IS6-1:
15:50-16:10	Efficient Analysis of Plasmonic Discontinuities
	IS6-2:
16:10-16:30	Rigorous Numerical Study of Symmetry Breaking in a Pair of Nonlinear Cylinders
	IS6-3:
16:30-16:50	Compact 2D Stencils for Inhomogeneous Helmholtz Equation Based on Method of Connected Local Fields
	IS6-4:
16:50-17:10	Analyzing Photonic Crystal Heterostructure Mode-Gap Cavities by Dirichlet-to-Neumann Maps
	IS6-5:
17:10-17:30	Vertical Mode Expansion Method for Scattering of Light by Cylindrical Objects of Arbitrary Cross Sections
	IS6-6:
17:30-17:50	Accurate Analysis of a Rib Waveguide by Pseudospectral Modal Method
	IS6-7:
17:50-18:10	Light Extraction Modeling from Organic Light-Emitting Devices with Microlens Arrays

	February 4, 2015 (Wednesday), Day 3-4	
15:50-18:10	Room: 210, 8/F, Academic 3, City University of Hong Kong	Session: IS6

	Session Chair : Ya Yan Lu
	Computational Photonics

	IS6-1:
15:50-16:10	Efficient Analysis of Plasmonic Discontinuities

Afaf M. A. Said and S. S. Obayya
Zewail City of Science and Technology, Egypt

Blocked Schur finite-element bidirectional beam propagation method (BS-FE-BiBPM) is introduced for highindex contrast plasmonic waveguides with multiple-longitudinal discontinuities. The square root of the characteristic matrix appearing at the discontinuity section is accurately computed using the newly Blocked Schur algorithm which could save, by serial implementation only, about 60% of the execution time comparing with Schur algorithm. The suggested BS-FE-BiBPM overcomes the stability and accuracy problems of the conventional BiBPMs based on the commonly used Padé approximation in dealing with plasmonic devices thanks to a physically treatment of evanescent and surface waves.

	IS6-2:
16:10-16:30	Rigorous Numerical Study of Symmetry Breaking in a Pair of Nonlinear Cylinders

Lijun Yuan
College of Mathematics and Statistics, Chongqing Technology and Business University, China

Symmetry breaking refers to the existence of solutions that break the original symmetries of the underlying nonlinear system. In nonlinear optics with Kerr nonlinearity, symmetry breaking has been studied in serval complex structures by some approximate semi-analytical methods. In this paper, we develop an efficient numerical method to rigorously analyze symmetry breaking in a simple system of two circular cylinders with Kerr nonlinearity. The rigorous numerical studies and detailed analysis can lead to better understanding and practical applications of symmetry breaking.

	IS6-3:
16:30-16:50	Compact 2D Stencils for Inhomogeneous Helmholtz Equation Based on Method of Connected Local Fields

Hung-Wen Chang and Sin-Yuan Mu
National Sun Yat-Sen University, Taiwan

We extend the numerical theory of the method of connected local fields (CLFs) for obtaining semi-analytical solutions of Helmholtz equation with dielectric discontinuities. Using two sets of local plane waves we match the tangential fields along the dielectric interface. We are able to obtain 2D compact FD-like stencil for CLF cell with a straight interface. The results are then compared with other high-accuracy frequency-domain finite-difference (FD-FD) methods with ours. At five points per wavelength spatial sampling, compact CLF-LPW derived coefficients achieve less than .01% relative local error near a planar interface subjecting to an arbitrary incident plane wave.

	IS6-4:
16:50-17:10	Analyzing Photonic Crystal Heterostructure Mode-Gap Cavities by Dirichlet-to-Neumann Maps

Zhen Hu
Hohai University, China

Photonic crystal heterostructure mode-gap cavities, constructed by connecting two kinds of photonic crystal waveguides with different lattice constants, are important photonic devices. In this paper, we extend the Dirichlet-to-Neumann map method to analyze mode-gap cavities in two-dimensional photonic crystal heterostructures. The efficiency of our method is illustrated by numerical simulations.

	IS6-5:
17:10-17:30	Vertical Mode Expansion Method for Scattering of Light by Cylindrical Objects of Arbitrary Cross Sections

Hualiang Shi
City University of Hong Kong, Hong Kong

Two applications of a vertical mode expansion method with horizontal boundary integral equations, are presented for the study of transmission of light through a subwavelength cylindrical hole in a metallic film and scattering of light by a silicon cylinder, where both the hole and the cylinder have arbitrary smooth boundaries. Numerical examples indicate that the method performs accurately and efficiently.

	IS6-6:
17:30-17:50	Accurate Analysis of a Rib Waveguide by Pseudospectral Modal Method

Dawei Song
Nanjing University of Aeronautics and Astronautics, China

For optical waveguides with high index-contrast and sharp corners, the mode matching method can be used when the interfaces are only in vertical and horizontal directions. As an efficient alternative to the classical mode matching method, the pseudospectral modal method (PSMM) for diffraction gratings has recently been reformulated as a full-vectorial waveguide mode solver. In this paper, we apply the PSMM mode solver to a classical rib waveguide benchmark problem. The results show that the PSMM can give extremely high accuracy.

	IS6-7:
17:50-18:10	Light Extraction Modeling from Organic Light-Emitting Devices with Microlens Arrays

Wen-Lan Yeh and Yih-Peng Chiou
National Taiwan University, Taiwan

Microlens arrays attached on organic light-emitting diodes (OLEDs) substrate have been developed for the outcoupling enhancement in general illumination applications. Although microlens arrays work well to overcome light trapping, it is still challenging to determine the various optimization parameters due to heavy computational burden. In this work, we develop an efficient method combing transfer matrix method and ray-tracing technique for simulating layer structure with microlens arrays. Using a point source model, based on raytracing and round-trip calculation, the light outcoupling with the same microlens geometry is discussed in different color sources.

	February 4, 2015 (Wednesday), Day 3-4
08:20-10:00	Room: 230, 8/F, Academic 3, City University of Hong Kong Session: A03
	Session Chair : Ikmo Park
	Antenna Applications II
	A03-1:
08:20-08:40	On a Wideband Circularly Polarized Dielectric Resonator Antenna Using a Higher-Order Mode
	A03-2:
08:40-09:00	Single-Feed four-Arm Curl Antenna for Circularly Polarized Radiation
	A03-3:
09:00-09:20	Gain Enhanced Omnidirectional Rectangular Dielectric Resonator Antenna
	A03-4:
09:20-09:40	Effective Magnetic Loop Array Antenna with Enhanced Bandwidth
	A03-5:
09:40-10:00	Generation of OAM Millimeter Waves using Traveling-Wave Circular Slot Antenna Based on Ring Resonant Cavity

	February 4, 2015 (Wednesday), Day 3-4	
08:20-10:00	Room: 230, 8/F, Academic 3, City University of Hong Kong	Session: A03

	Session Chair : Ikmo Park
	Antenna Applications II

	A03-1:
08:20-08:40	On a Wideband Circularly Polarized Dielectric Resonator Antenna Using a Higher-Order Mode

Xiao Sheng Fang, Ka Ki Ng, and Kwok Wa Leung
City University of Hong Kong, Hong Kong

A strip-fed wideband circularly polarized (CP) dielectric resonator antenna (DRA) is investigated in this paper. The wideband design makes use of the quasi-TE_{111} and -TE_{113} modes of the rectangular DRA. To generate CP fields, two opposite corners of the rectangular DRA are truncated at 45^{o}. A groove and two parasitic strips are introduced to tune the axial ratio (AR) of the antenna. Measured results show that a wide AR bandwidth of 16.3 % can be achieved. The reflection coefficient, AR, radiation pattern, and antenna gain of the DRA are studied using ANSYS HFSS. Reasonable agreement between the measured and simulated results is observed.

	A03-2:
08:40-09:00	Single-Feed four-Arm Curl Antenna for Circularly Polarized Radiation

Son Xuat Ta and Ikmo Park
Ajou University, Korea

A circularly polarized single-feed four-arm curl antenna is presented in this paper. We demonstrate that a four-arm curl antenna can be fed by a single 50-Ω source without a matching network and can produce good circularly polarized (CP) radiation at the desired frequency. A curl antenna normally exhibits as a resonant antenna and its input impedance depends on the number of turns, the spacing between its turns, the width of its arm, and the dielectric substrate. In this paper, the CP radiation was obtained via the proper choice of the number of turns, i.e., the turn numbers for the curl arms were chosen such that the real part of their input admittances were equal and the angle of the input admittances differed by 90º.

	A03-3:
09:00-09:20	Gain Enhanced Omnidirectional Rectangular Dielectric Resonator Antenna

Li Ying Feng[1, 2] **and Kwok Wa Leung**[1]
[1] *City University of Hong Kong, Hong Kong*
[2] *Tianjin University of Technology and Education*

The omnidirectional rectangular dielectric resonator (DR) antenna (DRA) using its higher-order quasi-TM_{015} mode is proposed for the gain enhancement. It was designed, fabricated and measured for 5.8-GHz WLAN applications. Its measured bandwidth and antenna gain of the proposed DRA are 4.84% and 3.63 dBi, respectively.

	A03-4:
09:20-09:40	Effective Magnetic Loop Array Antenna with Enhanced Bandwidth

Quanwen Hou
Northwestern Polytechnical University, China

An effective magnetic loop array antenna with modified feeding structure is designed, fabricated and tested. This antenna works at 4.83 GHz - 5.04 GHz, and radiate omnidirectionally in the azimuth plane. Compared with the original effective magnetic loop array antenna, the bandwidth increases 3 times. The average gain is 5.65 dB, and the elevation angles at different frequencies are about 30 degrees. This antenna is low profile and of compact structure, which is easy to be conformal to other surfaces.

	A03-5:
09:40-10:00	Generation of OAM Millimeter Waves using Traveling-Wave Circular Slot Antenna Based on Ring Resonant Cavity

Shilie Zheng, Xiaonan Hui, Xiaofeng Jin, Hao Chi, and Xianmin Zhang
Zhejiang University, China

A novel traveling-wave circular slot antenna based on ring resonant cavity is proposed to generate orbital angular momentum beams at millimeter-wave frequency. To converge its radiation, a ring focus parabolic reflector is cleverly designed. All the antenna components are fabricated by 3D-print technique and the electro-less copper plating surface treatment process. The near-field and the far-field are measured with a 3D platform with open-end waveguide and a rotate platform with a standard antenna. 60GHz millimeter waves carrying OMA states of $l=\pm 3$ are obtained. The experimental results show that the antenna achieves proper performances with low reflection within the bandwidth and main lobe direction of less than 7°.

10:00-10:20	**Tea Break**

	February 4, 2015 (Wednesday), Day 3-4
10:20-12:00	Room: 230, 8/F, Academic 3, City University of Hong Kong Session: E01
	Session Chair : Er-Ping Li
	EMC/EMI
	E01-1:
10:20-10:40	An Iterative Source Reconstruction Based Method for Radiated Emissions Prediction from PCBs
	E01-2:
10:40-11:00	Singularity Study of Induced Cable Response Irradiated by Plane-wave
	E01-3:
11:00-11:20	Fast Prediction for Conducted EMI in Flyback Converters
	E01-4:
11:20-11:40	Power and Clock Distribution Networks for 3D-ICs: An Overview
	E01-5:
11:40-12:00	The Efficient Prediction Technique of SAR Based on a Modified FDTD Method

	February 4, 2015 (Wednesday), Day 3-4
10:20-12:00	Room: 230, 8/F, Academic 3, City University of Hong Kong Session: E01

	Session Chair : Er-Ping Li
	EMC/EMI

	E01-1:
10:20-10:40	An Iterative Source Reconstruction Based Method for Radiated Emissions Prediction from PCBs

Fang-Pin Xiang, Xing-Chang Wei and Er-Ping Li
Zhejiang University, China

In this paper, an equivalent magnetic dipole array assumed to reproduce the radiated emissions from PCBs, iterative source reconstruction method is employed to reconstruct the equivalent sources based on phaseless magnetic near field planar scanning with the initial phase provided by a novel repeated particle swarm optimization (RPSO) process. Once the equivalent sources are determined, radiated emissions from PCB can be obtained. Finally, numerical results are presented to illustrate the effectiveness of this approach.

	E01-2:
10:40-11:00	Singularity Study of Induced Cable Response Irradiated by Plane-wave

Min Zhang, Tianmin Zeng and Fei Su
Shanghai Jiao Tong University, China

This work presents a peculiar phenomenon which occurs in the response at a cable terminal exposed to an incident plane wave. There is no even-order resonance peak in the induced voltage if the entire cable is irradiated perpendicularly. Theoretical formulation predicts the phenomenon which is in turn validated by a full-wave electromagnetic simulation of the scenario.

	E01-3:
11:00-11:20	Fast Prediction for Conducted EMI in Flyback Converters

Jianwei Liu[1,2], Yi Wang[1,2], Dan Jiang[1], and Qunsheng Cao[1]
[1] *Nanjing University of Aeronautics and Astronautics, China*
[2] *Nanjing University of Information Science and Technology, China*

The flyback switched mode power supply often fails in electromagnetic compatibility (EMC) because of the easily aroused conducted electromagnetic interference (EMI). However, the measurement of conducted EMI during initial compliance tests requires strict test environments and expensive facilities, this makes the prediction of EMI important. This paper presents a time domain simulation method to predict the conducted EMI of a flyback converter before prototyping. The CST PCB Studio is utilized to extract parasitic parameters of a printed circuit board (PCB) based on 2D field solver and perform total circuit simulation. Experimental results validate that the presented modeling method is efficient and fast to predict EMI.

	E01-4:
11:20-11:40	Power and Clock Distribution Networks for 3D-ICs: An Overview

Khaled Salah
Mentor Graphics, Egypt

Power and clock distribution networks design for three-dimensional integrated circuits is a crucial task. In this paper, common structures of power distribution networks are discussed. Moreover, common structures of clock distribution networks are discussed. In addition, survey of novel methods to globally combine power distribution networks and clock distribution networks are presented.

	E01-5:
11:40-12:00	The Efficient Prediction Technique of SAR Based on a Modified FDTD Method

Jian Wang[1], Wenyan Yin[2], and Zhufei Chu[1]
[1] *Ningbo University, China*
[2] *Zhejiang University, China*

A high-order dielectric conformal technique based on the modified finite difference time domain (FDTD) method has been proposed in this paper to predict the specific absorption rate (SAR) distribution of a human body model illuminated by some typical radar sources on ship platforms. The conformal technique introduces an effective dielectric constant and a new conductivity derived by linear average of different dielectric regions in nine spatial discrete cells to modify the update equations of FDTD method. Furthermore, the effects of incident radar signals with different incident angles and polarizations on the SAR distribution are characterized in detail and the simulation results also show that our method has good accuracy and computing efficiency compared with the traditional methods.

12:00-13:30	**Lunch**

	February 4, 2015 (Wednesday), Day 3-4
13:30-15:30	Room: 230, 8/F, Academic 3, City University of Hong Kong Session: A04
	Session Chair : Xin-Qing Sheng
	Analysis and Simulation of Electromagnetics Scattering
	A04-1:
13:30-13:50	Fast Analysis of EM Scattering By Joint Use of the MLFMA and the FGG-FG-FFT
	A04-2:
13:50-14:10	Simulation of Scattering by a Rotating Hypersonic Object with Plasma Sheath
	A04-3:
14:10-14:30	SAR Imaging Simulation of Sea Surface with Breaking Wave at Low-Grazing-Angles
	A04-4:
14:30-14:50	Applications of Sliding Scattering Centers in Feature Extraction
	A04-5:
14:50-15:10	The Joint Influences of Wind Fetch and Water Depth on Doppler Spectrum of Dynamic Nonlinear Ocean Surfaces Ding Nie, Min Zhang, and Ning Li
	A04-6:
15:10-15:30	Accurate Solution of Volume Integral Equations for Electromagnetic Scattering by Lossy Conductors

	February 4, 2015 (Wednesday), Day 3-4	
13:30-15:30	Room: 230, 8/F, Academic 3, City University of Hong Kong	Session: A04

	Session Chair : Xin-Qing Sheng
	Analysis and Simulation of Electromagnetics Scattering

	A04-1:
13:30-13:50	Fast Analysis of EM Scattering By Joint Use of the MLFMA and the FGG-FG-FFT

Wei-Bin Kong, Hou-Xing Zhou, Shu-Wen Chen, and Wei Hong
Southeast University of China, China

In this paper, a hybrid algorithm of the MLFMA and the FGG-FG-FFT is proposed for fast analysis of multiscale EM scattering from electrically large PEC objects. For multiscale problems, both the MLFMA and the FGG-FG-FFT have their own disadvantages. However, the hybrid algorithm can more easily deal with multiscale problems, leading to higher efficiency than either of these two algorithms. Numerical examples are provided to demonstrate the validity and efficiency of the proposed method.

	A04-2:
13:50-14:10	Simulation of Scattering by a Rotating Hypersonic Object with Plasma Sheath

J. W. Qian, and M. Y. Xia
Peking University, China

An approximate approach to simulate the scattering by a rotating hypersonic object with plasma sheath is developed. Following geometric modeling, computational fluid dynamic tool is adopted to resolve the complex dielectric constant distribution of the plasma sheath. Then the Born approximate method is applied to evaluate the influences of the plasma sheath on the scattered field. Finally, Doppler and micro-Doppler parameters are extracted by using the coherent sampling and chirp filtering techniques.

	A04-3:
14:10-14:30	SAR Imaging Simulation of Sea Surface with Breaking Wave at Low-Grazing-Angles

Min Zhang, Gen Luo, Pengbo Wei, and D. M. Zhang
Xidian University, China

In this paper, the mesoscale breaking wave model is introduced to account for the contribution of breaking waves. At high frequency bands, the backscattering coefficient of the sea surface is calculated by the Two-Scale Method (TSM). Accounting for the coverage of breaking wave, the mesoscale breaking wave model is employed to modify the backscattering coefficient based on TSM. And also, the spatial distribution of the breaking waves is obtained by using the slope criterion. Based on these, the SAR images of sea surface at incident angle 80° with breaking wave are simulated. The simulated SAR images can indicate sea spikes and high polarization ratios, which is a typical event of sea spike.

	A04-4:
14:30-14:50	Applications of Sliding Scattering Centers in Feature Extraction

Quan-You Qu, Kun-Yi Guo, and Xin-Qing Sheng
Beijing Institute of Technology, China

The application of sliding scattering centers induced by reflected waves in feature extraction has been investigated. The scattering center change with the line of sight of radar (LOS) and show distinguished feature in the time-frequency representations (TFR). The time-frequency signatures of the scattering center have been utilized to deduce the geometry and motion parameters of two streamlined targets. Simulation shows that the parameters are estimated with high accuracy. The scattering data used in simulations are computed by the well validated full-wave numerical method (FE-BI-MLFMA), and processed by the reassigned spectrogram (RSP).

	A04-5:
14:50-15:10	The Joint Influences of Wind Fetch and Water Depth on Doppler Spectrum of Dynamic Nonlinear Ocean Surfaces Ding Nie, Min Zhang, and Ning Li

Ding Nie, Min Zhang, and Ning Li
Xidian University, China

The wind fetch and water depth will greatly impact the ocean waves from the perspective of their shape and statistical characteristics. In this paper, special focus is given to the joint influence of wind fetch and water depth upon Doppler spectrum of dynamic nonlinear ocean surfaces. The study is based on the simulation of two-dimensional fetch- and depth-changed sea surfaces via nonlinear revised choppy wave model (RCWM). Then the Doppler spectral characteristics of echoes from simulated surfaces are mainly analyzed in detail by applying second-order small slope approximation (SSA-2).

	A04-6:
15:10-15:30	Accurate Solution of Volume Integral Equations for Electromagnetic Scattering by Lossy Conductors

Jia Shi, Xiao Wen Zhang, Jie Zhang, and Mei Song Tong
Tongji University, China

Lossy conductors are not perfectly electric conductors and their finite conductivity needs to be carefully accounted for in the accurate solution of electromagnetic problems. Traditionally, surface integral equations (SIEs) are used to approximately describe the problems, but we use volume integral equations (VIEs) to exactly formulate the problems by treating the lossy conductors as dielectric-like objects. The VIEs are solved by a point-matching scheme which allows the use of JMformulation, yielding some desirable merits. Typical numerical examples are presented to demonstrate the scheme and its robustness has been verified.

15:30-15:50	**Tea Break**

	February 4, 2015 (Wednesday), Day 3-4
15:50-17:50	Room: 230, 8/F, Academic 3, City University of Hong Kong Session: IS7
	Session Chair : Yong Mei Pan
	Antenna Design
	IS7-1:
15:50-16:10	Wideband Dielectric Resonator Terahertz Reflectarray
	IS7-2:
16:10-16:30	A Miniaturized Differentially Fed Implantable Hilbert Curve Fractal Antenna at MICS Band
	IS7-3:
16:30-16:50	Compact Differentially-Fed Antenna with Filtering Response
	IS7-4:
16:50-17:10	Frequency Tuning of the Omnidirectional Circularly Polarized Dielectric Resonator Antenna Using Parasitic Patch
	IS7-5:
17:10-17:30	Reflectarray Elements with Clusters of Rectangular Ring-Based Patches
	IS7-6:
17:30-17:50	Wideband Two-Layer Transparent Cylindrical Dielectric Resonator Antenna Used as a Light Cover

	February 4, 2015 (Wednesday), Day 3-4	
15:50-17:50	Room: 230, 8/F, Academic 3, City University of Hong Kong	Session: IS7

	Session Chair : Yong Mei Pan
	Antenna Design

	IS7-1:
15:50-16:10	Wideband Dielectric Resonator Terahertz Reflectarray

Huan Yi[1], Shi-Wei Qu[1], and Chi Hou Chan[2]
[1] *University of Electronic Science and Technology of China, China*
[2] *City University of Hong Kong, Hong Kong*

Reflectarray is one of the most suitable options for terahertz (THz) frequency applications, because it can realize high gain with low feed loss. However, conventional metallic reflectarray suffer from significant energy dissipation in metals and dielectric losses in the THz frequency band. To overcome those limitations, a dielectric resonator reflectarray is proposed in this paper. The reflectarray is composed of rectangular columns element with high-resistivity silicon. A multi-frequency phase-matching method is employed in the design, and the simulated results show that the reflectarray has high aperture efficiency and a wide 1-dB gain bandwidth.

	IS7-2:
16:10-16:30	A Miniaturized Differentially Fed Implantable Hilbert Curve Fractal Antenna at MICS Band

Hui Liu and Xiong-Ying Liu
South China University of Technology, China

A miniaturized differentially fed implantable Hilbert curve fractal antenna is investigated. The antenna operates at the center frequency of 405 MHz, which lies in the 402-405 MHz medical implant communication services (MICS) band, and has a bandwidth of 77 MHz (372-449 MHz) with differential reflection coefficient less than -10 dB. Differentially fed and fractal technologies are employed to suit the differential circuitries of radio frequency integrated circuits (RFICs) and miniaturize the size of proposed antenna, respectively. The dimensions of the antenna are $9.3 \times 9.3 \times 0.635$ mm^3. The Specific Absorption Rate (SAR), as one crucial factor for implantable antennas, is simulated in HFSS three layer phantom. The good performance guarantees the proposed antenna to be a candidate in biomedical applications.

	IS7-3:
16:30-16:50	Compact Differentially-Fed Antenna with Filtering Response

Wen Duan, Xiu Yin Zhang, and Yong Mei Pan
South China University of Technology, China

In this paper, a compact differentially-fed antenna with filtering response is proposed. The antenna is composed of two radiating patches and a differential feed circuit embedded with two u-shaped slots which generate two notches. The stacked patch is employed to further improve the impedance bandwidth to fit the LTE communication application. The proposed antenna achieves a 18% impedance bandwidth. The average gain within the bandwidth is 9.5 dBi with less than 0.5 dB variation. The cross polarization ratio is less than 30dB. Out of the operating band, the gain drops sharply, exhibiting a bandpass response.

	IS7-4:
16:50-17:10	Frequency Tuning of the Omnidirectional Circularly Polarized Dielectric Resonator Antenna Using Parasitic Patch

Yongmei Pan
South China University of Technology, China

An omnidirectional circularly polarized (CP) dielectric resonator antenna (DRA) with a parasitic patch loading on its top is investigated in this paper. It is found that the operating frequency of the antenna can be tuned by changing both the sizes of the patch and ground plane. The reflection coefficient, axial ratio (AR), radiation pattern and antenna gain of the proposed CP DRA are studied, and reasonable agreement between the measured and simulated results is observed.

	IS7-5:
17:10-17:30	Reflectarray Elements with Clusters of Rectangular Ring-Based Patches

Y. X. Tan, E. H. Lim, and F. L. Lo
Universiti Tunku Abdul Rahman, Malaysia

Three microstrip rectangular patches of different sizes are cascaded close to each other to form a reflectarray element. It is found that the patch lengths can be used as the phase-shifting elements to achieve a reflection phase range of greater than 700^{o}. In this case, the lengths of the patches are varied simultaneously following a pegged ratio. By replacing each of the patches by a cluster of concentric microstrip rings, it is found that the reflection phase range can be further extended up to 1000^{o}. This element structure is a very attractive as very broad phase range can be easily obtained with only a single layer of unit element.

	IS7-6:
17:30-17:50	Wideband Two-Layer Transparent Cylindrical Dielectric Resonator Antenna Used as a Light Cover

Yuxiang Sun, Xiaosheng Fang, and Kwok Wa Leung
City University of Hong Kong, Hong Kong

This paper investigates a wideband cylindrical transparent dielectric resonator antenna (DRA), working as a light cover. The antenna is made of transparent materials. To broaden its bandwidth, two layers of transparent materials with different dielectric constants are put together. The lower layer has a hollow region for the accommodation of an LED light source. The VSWR, radiation pattern, and antenna gain are simulated and measured. Results show that it can simultaneously work as an antenna and a light cover, with negligible effects of the LED light source on the antenna performance.

	February 4, 2015 (Wednesday), Day 3-4
08:20-10:00	Room: 208, 6/F, Academic 3, City University of Hong Kong Session: D01
	Session Chair : Hang Wong
	Domain Decomposition and Interpolation Methods
	D01-1:
08:20-08:40	On the Choice of Basis Functions for the Meshless Radial Point Interpolation Method with Small Local Support Domains
	D01-2:
08:40-09:00	Integral Equation Domain Decomposition Method for Scattering from Thin Coating Objects
	D01-3:
09:00-09:20	Volume Integral Equation Combined with ODDM for Analysis of EM Scattering from Inhomogeneous
	D01-4:
09:20-09:40	A Domain Decomposition Framework for the Solution of Multi-Scale Problems Using Integral Equation Formulations
	D01-5:
09:40-10:00	Fast Parameter Scanning Method for Printed Circuits Based on Matrix High-Dimensional Interpolation

	February 4, 2015 (Wednesday), Day 3-4
08:20-10:00	Room: 208, 6/F, Academic 3, City University of Hong Kong Session: D01

	Session Chair : Hang Wong
	Domain Decomposition and Interpolation Methods

	D01-1:
08:20-08:40	On the Choice of Basis Functions for the Meshless Radial Point Interpolation Method with Small Local Support Domains

Zahra Shaterian, Thomas Kaufmann and Christophe Fumeaux
The University of Adelaide, Australia

The behavior of two different types of basis functions for the meshless Radial Point Interpolation Method (RPIM) is investigated in this paper. A 2D test function is interpolated through Gaussian and Wendland basis functions and the approximation errors on the low-order derivatives of the test function are calculated. It is shown that the Gaussian basis function is more appropriate for the interpolation in small support domains whereas Wendland basis function is more accurate for larger support domains.

	D01-2:
08:40-09:00	Integral Equation Domain Decomposition Method for Scattering from Thin Coating Objects

Ran Zhao, Jun Hu, Ming Jiang, and Zai-ping Nie
University of Electronic Science and Technology of China, China

In this paper, a novel non-conformal non-overlapping integral equation domain decomposition method with impedance boundary condition (IE-DDM-IBC) is presented to simulate the EM scattering from thin coating objects. By using the Robin transmission condition, the original object can be decomposed into several non-overlapping closed sub-domains, and each sub-domain can be meshed independently. It also provides an effective preconditioner to realize fast convergence for thin coating objects with multi-scale property.

	D01-3:
09:00-09:20	Volume Integral Equation Combined with ODDM for Analysis of EM Scattering from Inhomogeneous

Shu-Wen Chen, Hou-Xing Zhou, Wei-Bin Kong, and Wei Hong
Southeast University of China, China

In this paper, the volume integral equation (VIE) combined with overlapping domain decomposition method (ODDM) is presented for analysis of electromagnetic (EM) scattering from inhomogeneous anisotropic nonmagnetic dielectric objects. Discretizing a volumetric domain of electrically large size by using tetrahedral usually produces too many unknowns for the traditional VIE-MoM to accommodate. However, the VIE combined with ODDM (VIEODDM) can overcome this difficulty. In the VIE-ODDM, at any time, only one subdomain problem needs to be stored in host memory, significantly reducing memory requirement. Numerical results are provided to demonstrate the validity and efficiency of the proposed method.

	D01-4:
09:20-09:40	A Domain Decomposition Framework for the Solution of Multi-Scale Problems Using Integral Equation Formulations

Mario Alberto Echeverri Bautista[1], **Francesca Vipiana**[1], **Matteo Alessandro Francavilla**[2], **and Giuseppe Vecchi**[1]
[1] *Politechnico di Torino, Italy*
[2] *Istituto Superiore Mario Boella, Italy*

A general framework for the analysis of perfect electric conductor structures is presented; the proposed strategy is based in the decomposition of single structure into non-connected domains, whose individual analysis are used as preconditioner, obtaining good convergence properties for the iterative solution of the entire structure. Transmission conditions between the sub-domains are imposed using discontinuous Galerkin, and then are enhanced by enlarging the sub-domains information.

	D01-5:
09:40-10:00	Fast Parameter Scanning Method for Printed Circuits Based on Matrix High-Dimensional Interpolation

Jun Hu[1, 2], **Tao Hua Wen**[1], **and Bo Wen He**[1]
1 Nanjing University of Science and Technology, China
2 Southeast University, China

In this paper, one fast method for analyzing printed circuits based on matrix high-dimensional interpolation schemes has been presented. By virtual of the bi-interpolation on the plane of the frequency direction and the dielectric constant direction, the proposed method can greatly reduce the global time consuming of matrix fillings, and it can greatly improve the efficiency of multi-parameter scanning. The numerical example provided suggests the accuracy and the efficiency of the proposed method.

10:00-10:20	**Tea Break**

	February 4, 2015 (Wednesday), Day 3-4
10:20-12:00	Room: 208, 6/F, Academic 3, City University of Hong Kong Session: L01
	Session Chair : Li-xin Guo
	Large-scale Simulations for Complex Structure
	L01-1:
10:20-10:40	Octree Based Backward SBR-PO Method for Electromagnetic Scattering of Electrically Large Target
	L01-2:
10:40-11:00	A New Efficient Hybrid SBR/MoM Technique for Scattering Analysis of Complex Large Structures
	L01-3:
11:00-11:20	ML-TDS Analysis of Scattering from Hypersonic Vehicles Covered with Plasma Sheath
	L01-4:
11:20-11:40	A Large-Scale Numerical Simulation of Indoor Radio Wave Propagation for a Wireless LAN System
	L01-5:
11:40-12:00	Enhancing the Efficiency of MLFMA-PO Hybrid Method for Analyzing Electrically Large Objects

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	February 4, 2015 (Wednesday), Day 3-4	
10:20-12:00	Room: 208, 6/F, Academic 3, City University of Hong Kong	Session: L01

	Session Chair : Li-xin Guo
	Large-scale Simulations for Complex Structure

	L01-1:
10:20-10:40	Octree Based Backward SBR-PO Method for Electromagnetic Scattering of Electrically Large Target

Li-xin Guo and Tian-qi Fan
Xidian University, China

The shooting and bouncing ray (SBR) method is highly effective for solving the electromagnetic scattering problems. This paper introduces the octree based SBR-PO method, due to the fact that traditional SBR method is not fast enough for scattering prediction for electrically large target. Using the octree structure to rebuild the target model and process ray tracing based on this technique can obtain great improvement. Simulation results obtained using this method are compared with the results from literature and those generated by commercial software. The good agreement and significant speedup achieved demonstrate that the newly developed code is capable of modeling a very large-size platform for practical rapid design.

	L01-2:
10:40-11:00	A New Efficient Hybrid SBR/MoM Technique for Scattering Analysis of Complex Large Structures

Xiaowei Mei, Yong Zhang, and Hai Lin
Zhejiang University, China

A new efficient hybrid technique is presented, which combines the method of moments (MoM) and the shooting and bouncing ray (SBR) for analyzing scattering of complex large structures. By applying the SBR method for the whole structures, a corrected incident field including not only the direct incident field but also the multi-bounce field from the SBR region contributes to the integral equation in the MoM region. For the SBR region, it also considers the interaction from MoM region and then a physical optics (PO) type integration is performed to calculate the scattered field. For complex electrically large electromagnetic problems, the proposed technique is more efficient and simpler to implement in a general-purpose computer code. Numerical results are presented to show the efficiency and accuracy of the method.

	L01-3:
11:00-11:20	ML-TDS Analysis of Scattering from Hypersonic Vehicles Covered with Plasma Sheath

Xue Niu, Zaiping Nie, Xiaofeng Que, and Shiquan He
University of Electronic Science and Technology of China, China

In this paper, scattering from hypersonic vehicles covered with the plasma sheath has been studied by the multilayer thin dielectric sheet (ML-TDS) approximation method. Single-layer model and multi-layer model are used to solve the scattering problem with the thinner and thicker plasma sheath, respectively. A few unknowns have been needed to model the hypersonic vehicles covered with the plasma sheath. A waverider-shaped vehicle model has been analyzed in the paper.

	L01-4:
11:20-11:40	A Large-Scale Numerical Simulation of Indoor Radio Wave Propagation for a Wireless LAN System

Hajime Otani, Shoichi Yamaguchi, Satoshi Yonezawa, and Manabu Omiya
Hokkaido University, Japan

Recently, a high-power wireless LAN access point (AP) based on IEEE802.11n/ac standard with a high-speed data transmission rate has been developed. Using this AP makes it possible to build easily wireless networks including a few floors in the adjacent as well as many rooms in a floor. This paper discusses indoor propagation characteristics including received signal strength indicators (RSSI) and propagation channel in a whole office floor based on a large-scale numerical electromagnetic simulations employing the FDTD technique. A precise numerical model with the spatial resolution of 5 mm is developed for the numerical simulation at the frequency of 5 GHz. The calculation are carried out by using the high-performance and high-capacity computer system, HITACHI SR16000 model M1. As a result, we confirm the validity of numerical simulation related to RSSI and channel modeling. The manner is useful to decide the number of access points as well as their locations for designing wireless networks.

	L01-5:
11:40-12:00	Enhancing the Efficiency of MLFMA-PO Hybrid Method for Analyzing Electrically Large Objects

Yong Zhang and Hai Lin
Zhejiang University, China

A hybrid technique combining the multi-level fast multipole algorithm (MLFMA) and the physical optics (PO) is presented for analyzing scattering and radiation by electrically large structures. Based on the previously proposed hybrid technique, an extra oct-tree structure is built for the MoM region to accelerate the solving process. What is more, an iteration scheme is proposed to further enhance the efficiency compared to the conventional hybrid method. Numerical results are given to demonstrate the reasonable accuracy and high capability of the proposed hybrid technique compared to the conventional MLFMA and MLFMA-PO method.

12:00-13:30	**Lunch**

	February 4, 2015 (Wednesday), Day 3-4
13:30-15:10	Room: 208, 6/F, Academic 3, City University of Hong Kong Session: F01
	Session Chair : Madhavan Swaminathan
	FDTD & FVTD
	F01-1:
13:30-13:50	FDTD Analysis of HF Heating Effect on Local Ionosphere
	F01-2:
13:50-14:10	Extension of the Unconditionally-Stable Four-Stages Split-Step FDTD Method to Debye Dispersive Media
	F01-3:
14:10-14:30	Optimized High-Order Finite-Difference Time-Domain (2, 4) Method
	F01-4:
14:30-14:50	Transient Non-Conformal Domain Decomposition Using the Laguerre-FDTD Method
	F01-5:
14:50-15:10	Fast Solution of Time Domain Maxwell's Equations Using Large Time Steps

	February 4, 2015 (Wednesday), Day 3-4
13:30-15:10	Room: 208, 6/F, Academic 3, City University of Hong Kong Session: F01

	Session Chair : Madhavan Swaminathan
	FDTD & FVTD

	F01-1:
13:30-13:50	FDTD Analysis of HF Heating Effect on Local Ionosphere

Ye Zhou[1], **Yi Wang**[1, 2], **and Qunsheng Cao**[1]
[1] *Nanjing University of Aeronautics and Astronautics, China*
[2] *Nanjing University of Information Science and Technology, China*

An auxiliary differential equation (ADE) finite-difference time-domain (FDTD) method is applied to analyze the effect of ionospheric high frequency (HF) heating on electromagnetic (EM) wave propagation. First ionosphere background parameters in East China generated from IRI are introduced in the study model and nonlinear phenomenon during ionospheric heating process at low altitude between 60 and 120km is simulated. Then vertical distribution of electron temperature in initial and saturation condition is used to simulate the EM wave propagation in the ionosphere. During the simulation, an ADE plasma model is employed to simulate the dispersive characteristics of the ionosphere. The simulation result shows that the ionospheric heating has a direct influence on the echo wave.

	F01-2:
13:50-14:10	Extension of the Unconditionally-Stable Four-Stages Split-Step FDTD Method to Debye Dispersive Media

Yong-Dan Kong[1, 2] **and Qing-Xin Chu**[1, 2]
[1]*South China University of Technology, China*
[2]*The State Key Laboratory of Millimeter Waves, China*

The unconditionally-stable four-stages split-step finite-difference time-domain (SS4-FDTD) method is extended to Debye dispersive media, which based on the auxiliary differential equation (ADE) formulation. Furthermore, numerical results are carried out for different Courant-Friedrichs-Lewy numbers in two-dimensional domains, which shown that the proposed method is unconditionally-stable.

	F01-3:
14:10-14:30	Optimized High-Order Finite-Difference Time-Domain (2, 4) Method

Min Zhu[1], Lei Zhao[2], and Qunsheng Cao[1]
[1] *Nanjing University of Aeronautics and Astronautics, China*
[2] *Nanjing Dodia Measure and Control Technology Co., Ltd, China*

In order to reduce the dispersion of the conventional HO-FDTD (2, 4) method, the axes-optimized method has been provided. This paper mainly discusses the optimization of the weight parameters based on the numerical dispersion equation. The numerical examples have been given to demonstrate the optimized HO-FDTD (2, 4) method. It has been found that the dispersion error can be eliminated in the axial direction and the optimized method has better dispersion error.

	F01-4:
14:30-14:50	Transient Non-Conformal Domain Decomposition Using the Laguerre-FDTD Method

Ming Yi and Madhavan Swaminathan
Georgia Institute of Technology, United States

In this paper, a transient non-conformal domain decomposition scheme is proposed based on the unconditionally stable Laguerre-FDTD method. Field continuity at the non-conformal domain interface is ensured by applying a mortarelement-like method. A time-derivative Lagrange multiplier is introduced at the domain interface which physically represents the interface current excitation. Simulation results have been presented to demonstrate the accuracy and efficiency of the proposed scheme.

	F01-5:
14:50-15:10	Fast Solution of Time Domain Maxwell's Equations Using Large Time Steps

Nikitabahen Makwana and Avijit Chatterjee
Indian Institute of Technology Bombay, India

A Large Time Step (LTS) method is used in the Finite Volume Time Domain (FVTD) framework for the solution of time domain Maxwell's equations. The LTS method [1] was originally proposed for the numerical solution of nonlinear hyperbolic conservation laws, as a generalization of the classical Godunov's approach which requires Riemann problems to be solved at individual cell faces in a finite volume framework. The LTS method allows the use of time steps much larger than that dictated by the Courant-Friedrich-Lewy (CFL) stability criterion for numerical solution of wave dominated problems. Long simulation times are a major concern in electromagnetic scattering problems involving large electrical sizes and re-entrant structures. The use of very large time steps in the propagation of EM waves both in freespace and multiple media is demonstrated in this work using a LTS based FVTD method.

15:30-15:50	**Tea Break**

	February 4, 2015 (Wednesday), Day 3-4
15:50-18:10	Room: 208, 6/F, Academic 3, City University of Hong Kong Session: M02
	Session Chair : Sheng Sun
	Mesh Refinements and Finite-element Formulation
	M02-1:
15:50-16:10	Automatic h-refinement through A-posteriori Error Estimation and Discontinous Galerkin
	M02-2:
16:10-16:30	Implicit *h* Type Finite-Element Error Estimator for the Vector Helmholtz Equation
	M02-3:
16:30-16:50	3D to 2D Surface Mesh Parameterization for Unstructured Transmission Line Method Simulations
	M02-4:
16:50-17:10	A Reduced Order Model for Electromagnetic Scattering using Multilevel Krylov Subspace Splitting
	M02-5:
17:10-17:30	A Low-Frequency Stable Finite-Element Formulation for Modal Waveguide Analysis
	M02-6:
17:30-17:50	Dispersion in the 2D Unstructured Transmission Line Modelling (UTLM) Method
	M02-7:
17:50-18:10	Vectorial Solution to Double Curl Equation with Generalized Coulomb Gauge for Magnetostatic Problems

	February 4, 2015 (Wednesday), Day 3-4	
15:50-18:10	Room: 208, 6/F, Academic 3, City University of Hong Kong	Session: M02

	Session Chair : Sheng Sun
	Mesh Refinements and Finite-element Formulation

	M02-1:
15:50-16:10	Automatic h-refinement through A-posteriori Error Estimation and Discontinous Galerkin

Jorge Alberto Tobon Vasquez[1], Matteo Alessandro Francavilla[1], Francesca Vipiana[2], Giuseppe Vecchi[2], Zhen Peng[3], and Jin-Fa Lee[4]
[1] *Istituto Superiore Mario Boella, Italy*
[2] *Politecnico Di Torino, Italy*
[3] *The University of New Mexico, United States*
[4] *The Ohio State University, Italy*

This work describes an automatic tool able to estimate the error in the Integral Equation solution in order to refine the mesh where the error is higher than the chosen threshold. The local refinement is performed through a hierarchical dyadic subdivision on the selected triangles to reach the desired error. As the resulting mesh is non-conformal, a Discontinous Galerkin scheme is applied.

	M02-2:
16:10-16:30	Implicit *h* Type Finite-Element Error Estimator for the Vector Helmholtz Equation

Markus Lösch, Ortwin Farle, Rolf Baltes, and Romanus Dyczij-Edlinger
Saarland University, Germany

A dual-corrected, goal-oriented error estimator is presented. While existing methods employ *p* hierarchical basis functions for enriching the FE space for the dual problem, the present method uses hierarchichal *h* refinement, based on a hanging-variables framework. The paper emphasizes the importance of enriching the gradient subspace. Numerical results demonstrate that the proposed method restores optimal rates of convergence even in presence of singularities.

	M02-3:
16:30-16:50	3D to 2D Surface Mesh Parameterization for Unstructured Transmission Line Method Simulations

Hayan Nasser, Steve Greedy, Trevor Benson, Ana Vukovic, and Phillip Sewell
University of Nottingham, United Kingdom

Advances in small scale fabrication processes have led to the advent of very thin flexible devices such as flexible RFID tags and smart clothing. In a geometrical sense, these present themselves as curved 2D open surfaces embedded in a 3D domain. When simulating EM behavior on these surfaces at low frequencies, a full 3D field model can become computationally expensive in terms of memory and run times. The objective of this paper is to present a method for applying a 2D unstructured Transmission Line Method (TLM) simulation to open, curved surfaces embedded in a 3D domain, by providing a one-to-one mapping of the geometry to a 2D flat plane. The simulation results are then mapped back to the original 3D geometry, negating the need for a full 3D simulation. Further, we demonstrate that if the surface material parameters are altered in the vicinity of high curvature, the proposed method is still effective.

	M02-4:
16:50-17:10	A Reduced Order Model for Electromagnetic Scattering using Multilevel Krylov Subspace Splitting

Neeraj Kumar, K. J. Vinoy, and S. Gopalakrishnan
Indian Institute of Science, India

Traditional moment matching (Taylor expansion) based reduced order modeling in electromagnetics is known to be narrowband due to ill-conditioned moment generation process. In recent years, multipoint well-conditioned broadband asymptotic waveform evaluation techniques have been introduced that use implicit orthogonalization. These techniques are inherently sequential and difficult to parallelize. This paper introduces an elegant subspace splitting technique that is parallelizable and easy to implement. The technique is shown to match moments and is thus accurate. A wideband scattering problem is used to demonstrate the technique.

	M02-5:
17:10-17:30	A Low-Frequency Stable Finite-Element Formulation for Modal Waveguide Analysis

Rolf Baltes, Joseph Al Ahmar, Ortwin Farle, and Romanus Dyczij-Edlinger
Saarland University, Germany

This paper presents a low-frequency stable finite element formulation in terms of the electric fiel and the magnetic flu density for the modal analysis of waveguides. In contrast to competing methods, the eigenvalues of the proposed formulation represent propagation coefficient rather than their squares, which allows to resolve solutions close to zero more accurately.

	M02-6:
17:30-17:50	Dispersion in the 2D Unstructured Transmission Line Modelling (UTLM) Method

Lamia Khashan[1, 2], **Ana Vukovic**[1], **Phillip Sewell**[1], **and Trevor M. Benson**[1]
University of Nottingham, United Kingdom
Misr International University, Egypt

In this paper the dispersion characteristics of the two-dimensional TLM method, based upon an unstructured triangular mesh, are investigated and compared against those of the TLM method based on structured rectangular mesh. This is done numerically on an example of plane wave propagation in an homogeneous free space. Phase errors of plane wave propagation are extracted for a variety of triangular meshes and compared to an equivalent conventional TLM mesh. The computational resources needed for TLM method based on triangular and rectangular grid to obtain the same numerical dispersion are also compared.

	M02-7:
17:50-18:10	Vectorial Solution to Double Curl Equation with Generalized Coulomb Gauge for Magnetostatic Problems

Yan Lin Li[1], **Sheng Sun**[1], **Qi I. Dai**[2], **and Weng Cho Chew**[2]
[1] *The University of Hong Kong, Hong Kong*
[2] *University of Illinois, Urbana-Champaign, United States*

In this paper, a solution to the double curl equation with generalized Coulomb gauge is proposed based on the vectorial representation of the magnetic vector potential. Coulomb gauge is applied to remove the null space of the curl operator and hence the uniqueness of the solution is guaranteed. However, as the divergence operator cannot act on the curl-conforming edge basis functions directly, the magnetic vector potential is used to be represented by nodal finite elements. Inspired by the mapping of Whitney forms by mathematical operators and Hodge operators, the divergence of the magnetic vector potential, as a whole, can be approximated by scalar basis functions. Hence, the magnetic vector potential can be expanded by vector basis functions, and the original equation can be rewritten in a generalized form and solved in a more natural and accurate way.

	February 5, 2015 (Thursday), Day 4-4
09:00-10:40	Room: 210, 8/F, Academic 3, City University of Hong Kong Session: IS8
	Session Chair : Bin Li
	Antennas for Wireless Communication
	IS8-1:
09:00-09:20	Millimeter-Wave Spiral Microstrip-Based Leaky-Wave Antenna for Circularly Polarized Radiation
	IS8-2:
09:20-09:40	A Novel Stacked Inverted-F Antenna for Implanted Bio-Devices in the MICS Band
	IS8-3:
09:40-10:00	Design of Terahertz Waveguide-Fed Antipodal Hyperbolic-Sine Tapered Slot Antenna Based on Silicon Micromachine
	IS8-4:
10:00-10:20	Polarization Tunable Dielectric Resonator Antenna with Quasi-Lumped Quadrature Coupler
	IS8-5:
10:20-10:40	Planar Two-Element UWB MIMO Antennas with High Isolations

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	February 5, 2015 (Thursday), Day 4-4	
09:00-10:40	Room: 210, 8/F, Academic 3, City University of Hong Kong	Session: IS8

	Session Chair : Bin Li
	Antennas for Wireless Communication

	IS8-1:
09:00-09:20	Millimeter-Wave Spiral Microstrip-Based Leaky-Wave Antenna for Circularly Polarized Radiation

Xue Bai[1], Shi-Wei Qu[1], Chi Hou Chan[2], and Kung Bo Ng[2]
[1] *University of Electronic Science and Technology of China, China*
[2] *City University of Hong Kong, Hong Kong*

In this paper a circularly polarized (CP) leaky-wave antenna is proposed for millimeter-wave communication. By the addition of metallic strip grating on a ground dielectric slab (GDS), the fundamental TM0-mode surface waves on the GDS is transformed into leak waves (LWs). Meanwhile, by tailoring the phases and magnitudes of the LWs, CP radiation can be achieved. Investigations show that the proposed antenna features characteristics of high gain and simple feeding structure.

	IS8-2:
09:20-09:40	A Novel Stacked Inverted-F Antenna for Implanted Bio-Devices in the MICS Band

Zetao Wu, Xiong Ying Liu, and Yun Hui Di
South China University of Technology, China

This work designs a compact implantable antenna for Bio-device in medical implant communication services band (MICS band: 402-405 MHz). The proposed antenna is a modifi-cation of Planar Inverted-F Antenna (PIFA), consisting of three layers, i.e., ground, lower patch, and upper patch. The stacked structure, with a thickness of 1.27 mm, extends the current path effectively, miniaturizing the antenna dimensions. To avoid injur-ing tissues in the human body, the antenna is made in the shape of coin with a radius of 4.5 mm. Considering real implantation cases, biocompatible film of parylene-C is employed to cover the implanted antenna isolated from the biological tissue. The anten-na is simulated in a three-layer human tissue model and shows a good resonant performance.

	IS8-3:
09:40-10:00	Design of Terahertz Waveguide-Fed Antipodal Hyperbolic-Sine Tapered Slot Antenna Based on Silicon Micromachine

Peng-Fei Zhao, Qing Li, Hong-Da Lu, Bin Li, Yong Liu, and Xin Lv
Beijing Institute of Technology, China

A THz antipodal hyperbolic-sine tapered slot antenna (AHSTSA) designed on silicon is proposed in this paper. The antenna is feed by WR2.2 waveguide and work at 480GHz to 500GHz. The antipodal curved slots and feeding waveguide are designed to be monolithically fabricated by deep reactive-ion etching (DRIE), then sputtering gold, with gold-gold thermo-compression bonding at last. The simulation result of VSWR is below 1.25 within 480GHz to 520GHz. The AHSTSA shows asymmetric beamwidths of ~20° in both E- and H-plane, with a maximum gain of 17.7dBi. The cross polarization and sidelobe levels are less than -20.7dBi and -10.6dBi, respectively. The proposed AHSTSA can be used in THz imaging and detection systems.

	IS8-4:
10:00-10:20	Polarization Tunable Dielectric Resonator Antenna with Quasi-Lumped Quadrature Coupler

Meng Zhang, Bin Li, Yong Liu, and Xin Lv
Beijing Institute of Technology, China

A full polarization reconfigurable dielectric resonator antenna (DRA) is proposed in this paper. Fed with a quasi-lumped quadrature coupler (QLQC), the DRA can achieve vertical linear, horizontal linear, left-handed circular and right-handed circular polarization simply by changing the mode and input port of the hybrid. A reconfigurable DRA operating at 3.5 GHz has been investigated. Due to the wideband characteristic of DRA, the impedance bandwidth (S11 < -10dB) of linear polarization (LP) is 12.6% with reasonable gain. The bandwidth of circular polarization is 15.1% with S11 lower than -10 dB and gain in the boresight direction over 5dBi.

	IS8-5:
10:20-10:40	Planar Two-Element UWB MIMO Antennas with High Isolations

Xue-Song Yang, Lin Zhang, Li-Ling Zhou, Rui-Qi Wang, and Xu-Jia Li
University of Electronic Science and Technology of China, China

Two compact planar UWB MIMO antennas for wireless communications are presented. The first antenna, which operates in the 2.3-12 GHz frequency band, has a size of 72 mm × 48 mm × 0.76 mm. High port-to-port isolation over the whole ultra-wideband is achieved by using an inverted-T stub between the elements. The second antenna has a size of 34 mm × 47 mm × 1.6 mm, and operates in the band from 3.8 to 11.8 GHz. Unlike other designs, the radiators are reversely parallel placed for achieving high isolation between two ports. Furthermore, an interdigital-like structure, which is composed of stubs and strips, has been employed to enhance both the isolation and the bandwidth. The current distributions, S parameters and radiation patterns of both antennas are given. The results show that, both antennas have high isolation of more than 20 dB over the ultra-wide operation bandwidth. The proposed antennas are suitable for some portable MIMO/diversity applications.

10:40-11:00	**Tea Break**

	February 5, 2015 (Thursday), Day 4-4
09:00-10:20	Room: 230, 8/F, Academic 3, City University of Hong Kong Session: I02
	Session Chair : Mingyao Xia
	Integral Equation and Hybrid Methods
	I02-1:
09:00-09:20	A New Approach Based on Compressive Sensing for Solving Monostatic Scattering from 3D Conducting Bodies Modeled by NURBS Surface
	I02-2:
09:20-09:40	A Comparative Study on Different Singularity Extraction Techniques of EFIE
	I02-3:
09:40-10:00	Fast Analysis of Scattering from PEC Objects above Halfspace over Wide Angular and Frequency Band
	I02-4:
10:00-10:20	Modeling of Magnetic Field Induced by Ship Wake

	February 5, 2015 (Thursday), Day 4-4	
09:00-10:20	Room: 230, 8/F, Academic 3, City University of Hong Kong	Session: I02

	Session Chair : Mingyao Xia
	Integral Equation and Hybrid Methods

	I02-1:
09:00-09:20	A New Approach Based on Compressive Sensing for Solving Monostatic Scattering from 3D Conducting Bodies Modeled by NURBS Surface

Shui-Rong Chai and Li-Xin Guo
Xidian University, China

A new approach conjugating the compressive sensing (CS) and the Method of Moments (MoM) is proposed and validated in this paper for fast analyzing the monostatic scattering problems. The nonuniform rational B-spline (NURBS) is introduced to MoM for the purpose of reducing the unknowns in the electric field integral equation (EFIE). Meanwhile, the CS theory is utilized to decrease the sampling rate of the incident angles in wide-angle scattering problems. The accuracy and efficiency of the proposed approach are shown by comparing with the traditional MoM using Rao-Wilton-Glisson (RWG) basis function.

	I02-2:
09:20-09:40	A Comparative Study on Different Singularity Extraction Techniques of EFIE

Chunbei Luo, Yong Zhang, and Hai Lin
Zhejiang University, China

A comparative study on different singularity extraction techniques of Electric Field Integral Equation (EFIE) is presented. Three types of methods which are the Duffy transform, projection integration and the analytic integration are implemented and compared. Numerical results show the differences in the efficiency, memory usage and the accuracy of three methods. Furthermore, the best choice of the different methods is recommended for dealing with singularity when mesh sizes are different.

	I02-3:
09:40-10:00	Fast Analysis of Scattering from PEC Objects above Halfspace over Wide Angular and Frequency Band

Yunqin Hu, Jian Zhu, Quanquan Wang, and Ting Wan
Nanjing University of Posts and Telecommunications, China

An efficient numerical approach is proposed for analyzing the scattering from PEC objects above a lossy half space over wide angular and frequency band. The spectral domain method of moment (MoM) and the multilevel fast multipole algorithm (MLFMA) based on half space green's functions are applied for the single frequency response. An adaptive cross approximation (ACA) based method is used for fast analysis of the scattered field with multiple incident angles. The geometric theory of diffraction (GTD) model based interpolation method is used for fast analysis of the scattered field over wide frequency band. Numerical examples show the valid and efficiency of the proposed approach.

	I02-4:
10:00-10:20	Modeling of Magnetic Field Induced by Ship Wake

Xiaojian Zhu[1], Changping Du[1], and Mingyao Xia[2]
[1] *University of Electronic Science and Technology of China, China*
[2] *Peking University, China*

Moving seawater through geomagnetic field can evoke a distribution of weak electric currents in the medium, which may generate a measurable magnetic field. The velocity vector of moving seawater can be resolved by using the ship wave theory, and the induced magnetic field can be evaluated by solving the Maxwell equations. Simulation results show that the induced magnetic field by the wake of a typical cruising vessel is on the order of a few hundred pico-Tesla near the sea surface.

10:40-11:00	**Tea Break**

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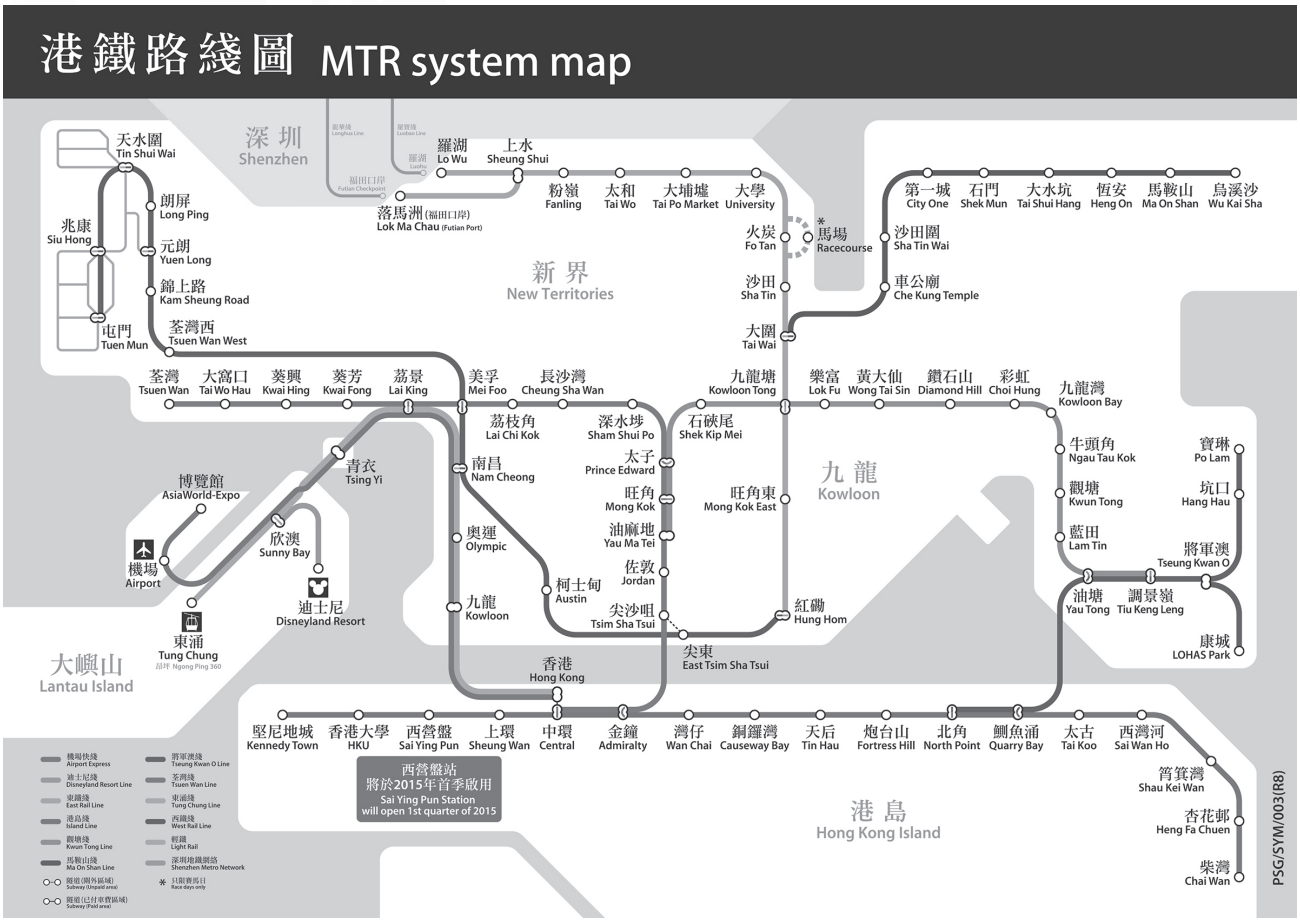
SUBWAY MAP


港鐵路綫圖 MTR system map
深圳 Shenzhen
新界 New Territories
九龍 Kowloon
港島 Hong Kong Island
大嶼山 Lantau Island
天水圍 Tin Shui Wai
朗屏 Long Ping
兆康 Siu Hong
元朗 Yuen Long
錦上路 Kam Sheung Road
屯門 Tuen Mun
荃灣西 Tsuen Wan West
羅湖 Lo Wu
上水 Sheung Shui
落馬洲 (福田口岸) Lok Ma Chau (Futian Port)
粉嶺 Fanling
太和 Tai Wo
大埔墟 Tai Po Market
大學 University
火炭 Fo Tan
馬場 Racecourse
第一城 City One
石門 Shek Mun
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油塘 Yau Tong
調景嶺 Tiu Keng Leng
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青衣 Tsing Yi
欣澳 Sunny Bay
迪士尼 Disneyland Resort
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