Australian Academy of Science

WARS 2010

Workshop on Applications of Radio Science

An initiative of the

National Committee for Radio Science

of the

Australian Academy of Science

PROGRAM AND ABSTRACTS BOOKLET

11 – 12 February 2010

The Shine Dome
Gordon Street
Canberra

The Australian Academy of Science through its National Committee for Radio Science is the Australian member of the Union Radio-Scientifique Internationale International Union of Radio Science

U.R.S.I.

CONTENTS

Formal WARS 2010 Proceedings will appear at http://www.unisa.edu.au/itee/WARS/default.asp following the Workshop.

WELCOME

On behalf of the Australian Academy of Science National Committee for Radio Science I am delighted to welcome you to the 2010 Workshop on Applications of Radio Science (WARS). WARS has been the Australian radio science community's national gathering since it was initiated in Canberra in 1995. This year it returns to Canberra, retaining the informal poster format that has proved a popular way of engaging presenters and stimulating the exchange of scientific and technical information among the community.

In addition we have two invited keynote presentations – one by Dr David Skellern, CEO of NICTA, and one by Dr Brian Boyle FAA of CSIRO.

The abstracts of the posters have been reviewed by a technical program committee listed on the next page. We will also be publishing complete articles for those authors who wish to avail themselves of this opportunity, and of these articles a number will be selected for a special issue of the Radio Science journal.

In 2010 we continue the tradition of awarding a prize to the best student poster, and have also initiated an Australian Young Radio Scientist award which will allow one young scientist the opportunity to present their work at a third keynote session during WARS 2010.

I hope that you enjoy the opportunity to catch up with colleagues and friends, as well as discuss the exciting radio science work that is being conducted around Australia.

Andrew Parfitt

Chair, National Committee for Radio Science

TECHNICAL PROGRAM COMMITTEE

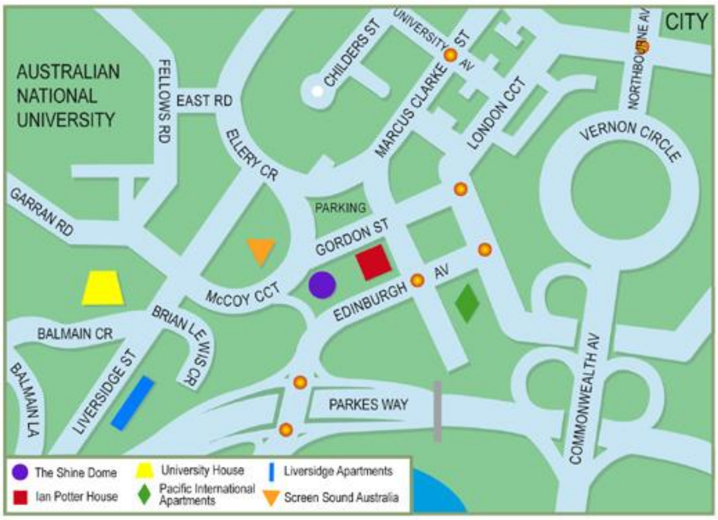
All abstracts were refereed by the Technical Program Committee prior to acceptance.

Associate Professor Mahfuz Aziz	University of South Australia
Professor Karu Esselle	Macquarie University
Dr John Kot	BAE Systems
Professor Ray Norris	CSIRO
Professor Andrew Parfitt	University of South Australia (Chair)
Professor Tony Parker	Macquarie University
Professor Paul Smith	Macquarie University
Dr Phil Wilkinson	IPS Radio Services
Ms Carol Wilson	CSIRO

VENUE – The Shine Dome

The Shine Dome has been a Canberra landmark since its construction in 1959. It was the first building in Canberra to be included on the National Heritage List. The Minister for the Environment and Heritage, Senator Ian Campbell, in his statement of 21 September 2005, said 'the building combined a unique design with structural ingenuity and was an excellent example of twentieth century architecture'. In addition to the National Heritage Listing, the Shine Dome has received numerous awards, and is one of seven projects the Royal Australian Institute of Architects has nominated to the World Register of Significant Twentieth Century Architecture.
(Source: http://www.science.org.au/dome/index.htm)

LOCATION MAP



CAR PARKING

There is no car parking available at the Shine Dome. The forecourt area of the Shine Dome is for set down and pick up only.

Public parking areas are situated close to the Shine Dome off Gordon Street and McCoy Crescent. A fee is payable during business hours – there is no charge in the evenings or at weekends. There is also parking available in public car-parking on London Circuit, approximately one block away from the venue. The public car parks have parking meters that will only take coin. A full day will probably cost in the vicinity of $10. Please be prepared for this if you are driving to the venue.

DISABLED ACCESS

Some parking is available for those needing disabled access parking. Please contact lesley.grady@unisa.edu.au if you need to book one of these spaces.

The Shine Dome is equipped with wheelchair access and disabled facilities.

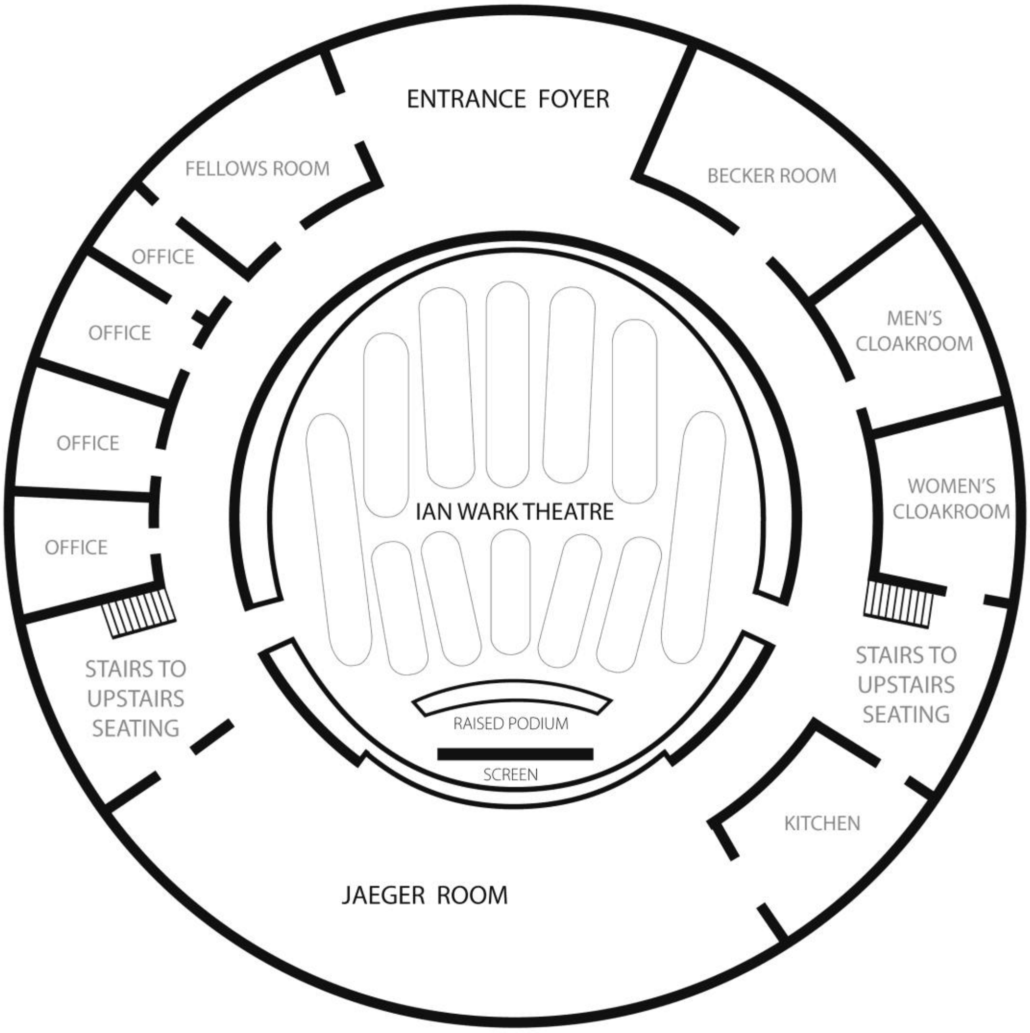
INTERNET ACCESS

Wireless internet access is available throughout the Dome. Conventional internet access is available from ports located in the Becker Room.

HOUSEKEEPING

- As the Shine Dome is a heritage listed building, there are regulations preventing fixing posters or any other media to the walls. Poster display panels will be provided for use in the poster sessions.
- Attendees are asked to respect the heritage aspects of the building at all times.
- Delegates are asked to ensure that **no food or drink** is taken into the Ian Wark Theatre.

SHINE DOME FLOOR PLAN



KEYNOTE SPEAKERS

1ST Keynote Session – 2.15 – 3.15 pm – Thursday 11 February 2010

Dr David Skellern, Chief Executive Officer, NICTA

Dr David Skellern has been CEO of National ICT Australia (NICTA) since mid-2005. He has a background as a successful ICT entrepreneur, following a career in scientific research, industrial R&D, and engineering education.

Dr Skellern spent 10 years from 1974 designing, building and commissioning instrumentation and extensions for the Fleurs Synthesis Radiotelescope before joining the academic staff at Sydney University's Electrical Engineering Department. In 1989 he moved to Macquarie University as Professor and Head of Electronics. He has worked for several companies on sabbaticals, including over two years at HP Labs.

In 1997 he co-founded Radiata Inc to build wireless LAN chips based on research he led at Macquarie University, in collaboration with CSIRO. Radiata demonstrated the world's first IEEE 802.11a chip-set in September 2000 and was acquired by Cisco Systems. Dr Skellern subsequently moved to California as Technology Director of Cisco's Wireless Networking Business Unit.

Dr Skellern has BSc, BE and PhD degrees from Sydney University. He was awarded the 2007 CSIRO Tony Benson Award for Individual Achievement in ICT and is an IEEE Fellow, an Honorary Fellow of Engineers Australia and a Fellow of the Australian Academy of Technological Sciences and Engineering.

In this keynote address, Dr David Skellern will give an overview of radio science activities in NICTA, including wireless technologies, imaging applications and system designs.

A significant portion of the talk will be dedicated to the emerging field of wireless vehicle communications and Dedicated Short Range Communications Systems. Wireless vehicle communications offer the exciting prospect of dramatic improvements in road safety through reduction in accidents, fatalities, and injuries to people and property.

Intelligent Dedicated Short Range Communications (DSRC) systems allow vehicles to communicate with each other and with roadside infrastructure such as overhead bridges, tunnels and traffic lights. DSRC technologies offer enormous potential to solve freight and logistics bottlenecks, provide drivers with a range of services such as traffic congestion and parking information, assist road authorities with traffic flow and road design, and reduce emissions via improved traffic flows.

The development of a DSRC platform will bring Australia into line with other countries such as the US and Japan that have already allocated spectrum in DSRC's dedicated 5.9GHz band. DSRC tests and demonstrators are already occurring overseas and vehicle manufacturers are planning the incorporation of these wireless devices in future models.

Dr Skellern will talk about the possible applications for these technologies, and how they are set to revolutionise the transport industry.

KEYNOTE SPEAKERS

2nd Keynote Session – 9.00 – 10.00 am – Friday 12 February 2010

Dr Brian Boyle FAA, SKA Director, CSIRO

Dr Brian Boyle completed his PhD at the University of Durham in the UK. He held positions at the University of Edinburgh; the Anglo-Australian Observatory; the University of Cambridge; was Director of the Anglo-Australian Observatory (1996 to 2003) and Director of CSIRO Australia Telescope (2003 to 2009) before his appointment to CSIRO SKA Director in February 2009. Dr Boyle has published more than 300 papers in astronomy.

His primary research interests are in the fields of quasars, active galaxies and cosmology. While at the AAO he led the 2dF QSO redshift survey program, and is currently involved in the Australia Telescope Large Area Survey (ATLAS). He plays a major role both nationally and internationally in the Square Kilometre Array (SKA) program; a project to build the world's largest cm-wavelength radio telescope.

Dr Boyle is an Adjunct Professor at the University of New South Wales, a Fellow of the Australian Institute of Company Directors, a Fellow of the Australian Academy of Science, and Honorary Fellow of the Royal Astronomical Society. In April 2003 he was awarded a Centenary Medal for 'services to Australian astronomy" and in September 2007 he shared in the 2007 Gruber Cosmology Prize.

He is currently a Member, National Committee for Astronomy (Australia) and was Chairman during the period 2004-2006. He is a member of the CSIRO Executive Management Committee, CSIRO Capital Asset Management Committee, Chairman, Australia New Zealand SKA Coordination Committee and Member, International Radio Astronomy Research Centre Board. He is a past member of the Australian Astronomy Board of Management, and past Chair of the International SKA Steering Committee and the eMERLIN review committee.

Dr Boyle will provide an overview of the current status of the international Square Kilometre Array (SKA) project and the Australian SKA Pathfinder project (ASKAP). The first ASKAP antenna is being constructed at the Murchison Radioastronomy site and over 300 scientists from 160 institutions around the world are now planning the radio surveys to be conducted with ASKAP when it becomes operational in 2012.

KEYNOTE SPEAKERS

3rd Keynote Session – 1.15 – 2.00 pm – Friday 12 February 2010

Dr Jean-Michel Le Floch, 2010 Young Radio Scientist

Dr Jean-Michel Le Floch was educated in France and was awarded a Bachelor Degree in Electricity Engineering Electronics Automation with option Signal theory in 2002 and subsequently achieved Honours in Radio Frequency and Optical Communications in 2003, at the University of Limoges.

In 2007 Jean-Michel completed a double badged doctorate jointly from the University of Limoges, France and the University of Western Australia (UWA). During his thesis he studied high Q dielectric resonators using Bragg reflectors and also whispering gallery modes for metrology applications.

In 2007, he was working as a Centre National de la Recherche Scientifique (National Centre for Scientific Research) postdoctoral fellow at XLIM Institute in Limoges on thin film ferroelectric microwave devices and characterizing thin film materials. In 2008, he was awarded an Australian Research Council postdoctoral fellowship within the ARC International linkage scheme to work with the Frequency Standards and Meteorology Group (FSM) at UWA in Perth. Then in 2009, he was appointed to a three year position as an ARC Research Fellow in the FSM Group where his work involves designing high-Q resonators and low phase noise oscillators at Extremely High Frequencies (EHF).

In 2008 Jean-Michel received an Early Career Award at the Conference on Precision Electromagnetic Measurements held in Colorado, USA, and the Young Scientist Award from the International Council for Science (ICSU) at International Union for Radio Science (URSI) held in Chicago, USA.

Jean-Michel 's poster is entitled "From micro to millimetre waves low phase noise and filtering devices design".

WARS 2010 PRIZES AND AWARDS

Young Radio Scientist Keynote Presentation Award

WARS 2010 will introduce a special award for young scientists (defined by URSI as scientists who are under 35 years of age) – the Young Radio Scientist Keynote Award.

The award will be based on the abstract submitted by a young scientist deemed by the technical program committee to have the highest scientific merit, and the awardee will be invited to present the third keynote address at WARS 2010.

This distinction will ensure that the best young scientist in the year of a WARS meeting is appropriately recognized by the Australian URSI community. The award will include free registration and lodging for one night at WARS 2010.

Applicants for this award must also submit a full paper by the required deadline for publication in the WARS proceedings.

The Technical Program Committee has announced that Jean-Michel Le Floch has won the Young Radio Scientist Keynote Presentation Award.

Best Student Poster Prize

A $500 cash prize will be awarded to the best poster presented by a student at WARS 2010.

The prize will be based on:

i) The scientific quality of the material presented in the poster

ii) The effectiveness of the poster in conveying the key research outcomes

iii) The engagement of the student in discussion at the WARS2010 poster session.

PROGRAM

Thursday 11 February 2010

Time	Location	Activity
11.30 am – 12.30 pm	Shine Dome Foyer	**Registration** Coffee and tea will be available on arrival (in Jaeger Room)
12.30 – 1.50 pm	Jaeger Room	**Networking Lunch**
1.50 – 2.15 pm	Ian Wark Theatre	**Welcome and Conference Opening** Professor Andrew Parfitt, Chair, National Committee for Radio Science
2.15 – 3.15 pm		**1st Keynote Speaker** **Dr David Skellern, Chief Executive Officer, NICTA**
3.15 – 3.30 pm	Jaeger Room	**Afternoon tea/coffee break**
3.30 – 5.15 pm		**1st Poster Session** **Posters allocated to this session –** information provided alphabetically by **Presenting Author,** *Authors,* **Poster Title**, Affiliation: **Sayed Ali Albahrani,** *Sayed Ali Albahrani, Anthony Edward Parker* **Characterization of Surface and Bulk traps in GaN HEMTs** Department of Physics and Engineering, Macquarie University
		King Yuk (Eric) Chan, *King Yuk Chan, Rodica Ramer* **The enabling technology for the next generation wireless communications: RF MEMS** School of Electrical Engineering and Telecommunications, UNSW
		Robert Scott Gardiner-Garden, *Robert Scott Gardiner-Garden* **Observing and modelling ionospheric variability over northern and western Australia** Defence, Science and Technology Organisation
		Richard M Hawkes, *Richard M Hawkes* **The reciprocity principle and the parabolic equation model** Defence, Science and Technology Organisation, Electronic Warfare and Radar Division
		K. Jeganathan, *K. Jeganathan, R. Gough, S. Mackay, M. Brothers, R. Chekkala* **Superheterodyne Receiver System for the Australian SKA Pathfinder** CSIRO Australia Telescope National Facility
		Ghaffer Kiani, *Ghaffer I. Kiani, Trevor S. Bird* **ASK Modulator based on Switchable FSS for the THz Applications** CSIRO ICT Centre

		Jean-Michel Le Floch, *Jean-Michel Le Floch, Georges Humbert, David Mouneyrac, Denis Ferachou, Gemma Hamilton, Michel Aubourg, Michael E. Tobar, John Hartnett, Dominique Cros, Jean-Marc Blondy, Jerzy Krupka* **From micro to millimetre waves low phase noise and filtering devices design**, School of Physics, University of Western Australia, XLIM, UMR CNRS Universite de Limoges, France, Institute of Microelectronics and Optoelectronics, Warsaw University of Technology, Poland
		Yue Li, *Yue Li, Dan Popescu and Andrew Hellicar* **De-convolution of reflection terahertz images** CSIRO ICT Centre
		Jacky Liu, *Jianjun Liu, Karu Esselle, Shunshi Zhong* **An Ultra-Wideband Antenna on Liquid Crystal Polymer Substrate, with A Band-Notched Response** Centre for Microwave and Wireless Applications, Electronic Engineering, Macquarie University; School of Communication and Information Engineering, Shanghai University
		David J Netherway, *David J Netherway* **Comparison of Power Measurements on Oblique Incidence Paths with Power Derived from an Ionospheric model** Defence Science and Technology Organisation
		Mikael Persson, *Mikael Persson, Markus Johansson and Hoi-Shun Lui* **Modeling Complex Sources Using Measured Phaseless Near-Field Data** Chalmers University of Technology, Sweden
		Md Masud Rana, *Md. Masud Rana and Ananda S. Mohan* **Propagation Modelling in Complex Tunnel environments using FDTD Method** Faculty of Engineering & Information Technology, University of Technology Sydney
		Oya Sevimli, *Oya Sevimli, Anthony E. Parker, Anthony P. Fattorini, James T. Harvey, and Simon J. Mahon* **Transistor Low Frequency Noise Modelling for Oscillator Phase Noise Simulation** Macquarie University, Mimix Broadband
		M.M. Sharma, *M.M. Sharma, Y. Ranga, and R.P. Yadav* **A compact wide band ellipse shape patch antenna for wide band applications** Department of ECE, Malaviya National Institute of Technology, Jaipur, India
		Darshan Thakkar, *D. Campbell-Wilson, D. Thakkar, L de Souza, A. Blake, M. Kesteven, J. Bunton, R. Hunstead, A. Green* **SKAMP: re-engineering the Molonglo radio telescope** School of Physics, Uni of Sydney; Australian Telescope National Facility, CSIRO, Information and Communication Technologies Centre, CSIRO
5.15 – 6.15 pm	Jaeger Room and outdoor area, Shine Dome	**Networking drinks**

7.00 pm	The Common Room, Australian National University	**WARS 2010 Dinner**

Friday 12 February 2010		
Time	**Location**	**Activity**
8.30 – 8.50 am	Jaeger Room	**Arrival** – coffee and tea available
8.50 – 9.00 am	Ian Wark Theatre	**Welcome to Day 2** Professor Andrew Parfitt, Chair, National Committee for Radio Science
9.00 – 10.00 am		**2nd Keynote Speaker** **Dr Brian Boyle, CSIRO SKA Director**
10.15 – 10.30 am	Jaeger Room	**Morning Tea/Coffee break**
10.30 am – 12.15 pm		**2nd Poster Session** **Posters allocated to this session –** information provided alphabetically by **Presenting Author,** *Authors,* **Poster Title**, Affiliation: **Gerard Borg,** *G.G. Borg* **A Novel, Distributed MIMO Based Wireless Network Architecture with Scalable Net Capacity and Improved Range and Coverage** Australian National University
		Christophe Granet, *C. Granet, I.M. Davis, J.S. Kot, G. Pope, K.Verran, T. Mellor* **Dual-band Feed-system Research and Development at BAE Systems Australia** BAE Systems Australia Ltd
		Venkata Gutta, *Venkata Gutta, Anthony Fattorini and Anthony E. Parker* **Analysis of Diode Mismatch in Anti-Parallel-Diode-Pair Circuits used for Millimeter-wave Frequency Conversion** Department of Physics and Engineering, Macquarie University
		Douglas Hayman, *Douglas B. Hayman, Trevor S Bird, Karu P. Esselle, and Peter J. Hall* **Focal plane array evaluation on a prototype radiotelescope** CSIRO ATNF, CSIRO ICT Centre, Dept Electronic Engineering, Macquarie University, Dept Electrical and Computer Engineering, Curtin University of Technology
		Andrew Hellicar, *Andrew Hellicar, Stephen Hanham, Dan Popescu, Yue Li* **Terahertz Radar** CSIRO ICT Centre
		Suzy Jackson*, S.A. Jackson, Y. Moghe, R.G. Gough, and C.A. Jackson* **Highly integrated Silicon on Sapphire receiver for next-generation radio telescopes** CSIRO Astronomy and Space Science, Sapphicon Semiconductor
		Rebecca McFadden, *R. McFadden, R. Ekers* **A New Method to Calibrate Ionospheric Pulse Dispersion using Polarised Emission from the Moon** University of Melbourne, CSIRO Australia Telescope National Facility
		Dave Neudegg, *D. Neudegg, M. Layoun, S.T. Hutchinson* **Short period variations in available HF radio frequencies due to atmospheric effects on the ionosphere** Ionospheric Prediction Service, Bureau of Meteorology
		Yogesh Ranga, *Y. Ranga, Karu P. Esselle and A.R. Weily* **Gain Enhancement Techniques for UWB Antennas** Centre of Wireless and Microwave Applications, Macquarie University; CSIRO ICT Centre

		Galyna Safonova, *Galyna Safonova, Elena Vinogradova* **Transmission line of arbitrary cross-section: rigorous approach** Department of Mathematics, Macquarie University
		Anton Shafalyuk, *Anton Shafalyuk, Elena Vinogradova* **Potential problem for two surfaces of revolution of arbitrary profile** Macquarie University
		Olena Shafalyuk, *Olena Shafalyuk, Paul Smith* **Rigorous simulation of resonant wave scattering by axially-symmetrical open structures** **Macquarie University**
		Jabra Tarazi, *Jabra Tarazi, Anthony E. Parker, Peter Vun and Simon J. Mahon* **Statistical Analysis of DC and Small Signal-model Parameters in GaAs HEMT** Department of Physics and Electronics, Macquarie University and Mimix Broadband
		Phil Wilkinson, *Phil Wilkinson* **What will solar cycle 24 be like?** IPS Radio and Space Services, Bureau of Meteorology
12.15 – 1.15 pm	Jaeger Room	**Lunch**
1.15 pm – 2.00 pm	Ian Wark Theatre	**3rd Keynote Speaker – 2010 Young Radio Scientist** **Jean-Michel Le Floch, University of Western Australia**
2.00 – 3.30 pm	Jaeger Room	**3rd Poster Session** **Tea and coffee will be available during this session** **Posters allocated to this session –** information provided alphabetically by **Presenting Author,** *Authors,* **Poster Title,** Affiliation: **Mark Bowen,** *M. Bowen, P. Doherty, A. Dunning, H. Kanoniuk, G. Moorey, L. Reilly, P. Sykes* **A Cryogenically Cooled 16-26GHz Receiver System for the Parkes Radio Telescope** Australian Telescope National Facility, CSIRO Astronomy and Space Science
		Iver Cairns, *Iver Cairns and the Steering Committee for the Decadal Plan* **Academy of Science endorses the Decadal Plan for Australian Space Science** University of Sydney
		Shital Desai, *Shital Desai, Dr Graham Brooker* **Multi-dimensional radar networks for urban terrain imaging** Australian Centre for Field Robotics, University of Sydney
		Christophe Granet, *S.G. Hay, C. Granet, J.S. Kot, D. DeBoer* **On the Use of Phased-Array Feeds at the Prime-Focus of offset Dual-Reflector Antennas for the SKA** CSIRO ICT Centre, BAE Systems Australia Ltd., CSIRO Australia Telescope National Facility
		Stephen Hanham, *Stephen Hanham, Trevor Bird, Andrew Hellicar and Robert Minasian* **Optimised Dielectric Rod Antennas** University of Sydney and CSIRO ICT Centre

		Murray Parkinson, *V.V. Kumar, M.L. Parkinson, P.L. Dyson, S. Prendergast, G.B. Burns* **On the Effects of Postive and Negative Cloud to Ground nad Intra-Cloud Lightning on the F-region Ionosphere** Department of Physics, LaTrobe University, Bureau of Meteorology IPS, Kattron Lightning Detection Network, Australian Antarctic Division
		Nasiha Nikolic, *Nasiha Nikolic, Graeme James, Kieran Greene, Andrew Weily, Steve Barker and Y. Jay Guo.* **Low Profile Lens Antenna for SOTM Application** CSIRO ICT Centre
		Mikael Persson, *Mikael Persson, Andreas Fhager, Hana Dobsicek Trefná, Xuezhi Zeng* **Broadband microwave based diagnostics and treatment** Chalmers University of Technology, Sweden
		Stevan Preradovic, *Stevan Preradovic and Nemai Karmakar* **Chipless RFID Tag for Banknote Tagging Applications** Monash University
		Reuben Shar, *Reuben Shar, Paul Axon* **Near and Far Field HF antenna modelling for Naval applications** Thales Australia
		Paul Smith, *Paul D. Smith,* **Wideband responses of highly resonant scatterers: regularisation methods** Macquarie University
		Elena Vinogradova, *E.D. Vinogradova, A.V. Brovenko, P.N. Melejik, A.E. Poedinchuk, A.S. Troshilo* **Resonant Response of Strip Grating on Ferromagnetic Half-Space** Department of Mathematics, Macquarie University, Radiophysics & Electronics Institute of National Academy of Science, Ukraine
3.30 - 4.00 pm	Ian Wark Theatre	**WARS 2010 Conclusion and Prize Presentation** Professor Andrew Parfitt, Chair, National Committee for Radio Science
4.00 pm approx		**Close**

WARS 2010 ABSTRACTS

1st Poster Session – 3.30 – 5.15 pm – Thursday 11 February 2010

TITLE:	Characterization of Surface and Bulk traps in GaN HEMTs

AUTHORS: Sayed Ali Albahrani[1], Anthony Edward Parker[2]
AFFILIATION: Department of Physics and Engineering, Macquarie University, Sydney NSW Australia 2109
CONTACT DETAILS: [1]sayed@science.mq.edu.au [2]tonyp@ieee.org

Charge trapping, and its manifestation of current lag, is exacerbated in GaN transistors because the time constants can be many thousands of seconds. Thus obtaining true dc characteristics is problematic. The problem is that dc characteristics are not representative of high-frequency operation because of anomalous dispersion effects of which some are referred to in the literature as dispersion, current slump, current compression, power slump, knee walk-out, and gate lag. Charge trapping, which occurs in both GaAs and GaN technologies, is responsible for most of these. The observed current collapse is attributed to surface and bulk trapping and this can be more pronounced in GaN devices.

Within the transistor there are trap-centres that are well described by capture and recombination processes as a function of the transistor's terminal potentials (*VGS* and *VDS*). The potential of the trap-centres affect the properties of the active layers in the HEMT either as a change in pinch-off potential or of the access resistance. In this paper it will be shown that to account for the influence of traps located in the bulk region, the potential of the trap-centre has to be added to the gate potential. Whereas to account for the influence of traps located in the surface region, the resistance of the surface region has be made a function of the potential of the trap-centre. It will be shown also that the anomalous kink effect that is observed in the drain current versus drain voltage characteristic (I_{DS}-V_{DS} characteristic) can be modelled by adding the potential of the trap-centre located in the bulk to the gate voltage. This agrees with the experimental data that shows that it is the threshold voltage, V_{th}, which is shifted in the trans-conductance vs. gate-source voltage characteristic (g_m-V_{GS} characteristic) of the transistor under test. On the other hand, it will be shown that the knee walk-out that is observed in the I_{DS}-V_{DS} characteristic can be modelled by an access resistance that is controlled by the potential of trap-centres located in the surface region.

The trap position in the transistor can be determined by the g_m-V_{GS} characteristic of the transistor. If the trap is located in the surface, this characteristic faces a shift in the *peak trans-conductance*, $g_{m,peak}$, in the pulsed-IV measurement, and if the trap is located in the bulk, this characteristic faces a shift in V_{th}. Accordingly, it could be concluded that surface trap affects trans-conductance through series resistances increase in the surface region, while bulk trap affects trans-conductance through gate-source voltage increase.

Recently, a new model of a trap-centre based on Shockley-Read-Hall (SRH) theory was proposed. Trap-centres within field-effect transistors affect their channel properties such that the drain-source current, I_{DS}, is a function of its terminal potentials and the potentials at the trap-centres. The latter are a function of the polarity and charge state of the traps.

A detailed measurement of dispersion effect that manifests itself in g_m-V_{GS} and I_{DS}-V_{DS} characteristics, and a simulation study using the SRH trap model, are presented in this paper.

TITLE: **The enabling technology for next generation wireless communications: RF MEMS**	

AUTHORS: **King Yuk Chan, Rodica Ramer**
AFFILIATION: **School of Electrical Engineering and Telecommunications, UNSW, Sydney**
CONTACT DETAILS: kyc@student.unsw.edu.au, ror@unsw.edu.au

Wireless technologies are being widely investigated in industry, universities, government and international organizations and more importantly, they are being increasingly utilized in our daily living. Today's mobile phones handle not only voice but also internet data and GPS signals. We are facing an explosion of information data transmission, and all the estimates suggest that this will grow exponentially over the next few years. Thus, the data transmission has to be able to handle multiple frequency bands and provide multiple channels for different signals. The only realistic solution is to combine the increase in bandwidth (ultra-wide bandwidth) and speed, thus develop technologies for the transceiver architecture. This, in turn, requires new technologies and fabrication processes for circuits, devices and components, as well as the development of new materials. A preferred approach of majority of research centres is to focus on the reconfigurable communication systems with multifunctional capabilities. In this paper, we propose designs that can lead us to the goal by using RF MEMS technology in the new communications systems.

One solution to handle multiple frequency bands and signals is to provide physical routing capability to the transceiver. While signal routing at low frequencies could be easily achieved, this becomes progressively more complex as frequency increases. Switch matrices exist for many years, however due to the technology limitation provided by solid state semiconductor FET and PIN diodes, existing switch matrices cannot support the requirements for the next generation wireless communications. Here, we propose using the RF MEMS technology. With the advantages given by MEMS, we have successfully developed switch matrices that overcome the bandwidth limitation and outmatch the RF performance that are provided by all existing technologies. We have also developed novel reconfigurable filters using RF MEMS that can switch filter band without using several separate different filters.

A novel RF MEMS crossbar switch matrix topology is presented and a 3x3 switch matrix is fabricated as a proof of concept. The fabricated switch matrix exhibits RF performance that is superior than any other existing technologies, with an operating bandwidth from DC to 40 GHz. This topology has the potential to replace the large coaxial-based systems in use on satellites for system redundancy. This design could also be applied to mobile phone transceiver frontend in order to switch between frequency bands.

A novel reconfigurable three pole band pass filter is also presented. It is designed using RF MEMS contact switches. Our unique reconfigurable filter design technique allows a design that can switch between three different frequency bands located at 8, 9 and 10GHz, while maintaining the desired bandwidths of 1GHz.

TITLE:	**Observing and modelling ionospheric variability over northern and western Australia**
AUTHORS:	**Robert Scott Gardiner-Garden**
AFFILIATION:	**Defence Science and Technology organisation**
CONTACT DETAILS:	**robert.gardiner-garden@dsto.defence.gov.au**

The Australian Defence Organisation and DSTO maintains a network of vertical incidence sounders and a network of oblique incidence sounders around Northern and Western Australia

This paper describes some of the temporal and spatial structure of variability that has been observed in the northern Australian region. While there is considerable variability on the seasonal and diurnal scale this dense network of soundings allows a description of the vertical and horizontal spatial structure of the day to day and hour to hour variability in the Sporadic E and F2 layers on an unprecedented scale.

Results of integrating these different observations into a single consistent real time model of the ionosphere are discussed.

TITLE:	The Reciprocity Principle and the Parabolic Equation Model
AUTHORS:	Richard M. Hawkes
AFFILIATION:	Defence Science and Technology Organisation, Electronic Warfare and Radar Division
CONTACT DETAILS:	PO Box 1500, Edinburgh SA 5111 Email: richard.hawkes@dsto.defence.gov.au

A tropospheric propagation model based on the Parabolic Equation (PE) is presented in this paper. To model surface reflection the PE field solution is calculated by adding an image field to the direct field at each range step. The image field is obtained by flipping the direct field about the zero vertical height axis and multiplying by a reflection coefficient in the PE propagation angle spectrum domain. The reflection coefficient used to multiply with the flipped direct field is derived from the reflection coefficients of the various range sections of a given propagation path (e.g. land and sea) and applying the Reciprocity Principle. The algorithm carries forward to subsequent range steps only the direct field (and not the combined direct and image field) solution from a given range step. This approach provides a surface reflection model for the PE that is straightforward to implement and gives good algorithm stability. Setting up the PE algorithm to ensure that the spatial phase is correct will also be discussed in this paper (see Hawkes et al, 2005, 2006). To illustrate the method a number of examples are given of propagation over irregular terrain and in the presence of atmospheric ducts. Propagation predictions obtained with the model are compared with those of AREPS (the 2 MHz to 57 GHz, Advanced Refractive Effects Prediction System of the Space and Naval Warfare Systems Center, San Diego, USA, Amalia Barrios et al) and measured propagation loss data. Tests with AREPS around 3 MHz show that Reciprocity does not appear to be obeyed while the PE model presented in this paper does give correct Reciprocity when transmitter and receiver are interchanged. Also, the PE model of this paper gives good agreement in comparisons with observed propagation loss data. The PE model developed in this paper is part of ongoing research at DSTO and elsewhere to provide efficient and relatively straightforward propagation models based on Maxwell's equations that can be applied to a wide range of frequencies, environmental conditions and applications (see the references listed below).

REFERENCES

[1] M. Levy, *Parabolic Equation Methods for Electromagnetic Wave Propagation*, London, UK: The Institution of Electrical Engineers, 2000.

[2] T.F. Eibert, "Irregular Terrain Wave Propagation by a Fourier Split-step Wide-angle Parabolic Wave Equation Technique for Linearly Bridged Knife-edges", *Radio Science*, vol. 37 (1), pp. 5.1-5.12, 2002.

[3] R.M. Hawkes, T.A. Spencer, and R.A. Walker, "Three Dimensional Model for Propagation in the Troposphere and Inverse Diffraction" *Proceedings of the Workshop on the Applications of Radio Science (WARS2006)*, Leura, NSW, 15-17 February, 2006.

See http://www.ips.gov.au/IPSHosted/NCRS/wars/wars2006/proceedings/index.htm

[4] R.M.Hawkes, T.A. Spencer, and R.A. Walker, "Tropospheric Propagation Model using Huygens' Principle", *Proceedings of the Second IASTED International Conference: ANTENNAS, RADAR AND WAVE PROPAGATION*, Banff, Alberta, Canada, pp. 7-12, 2005.

See http://www.iasted.org/conferences/pastconferences.html

[5] R.M. Hawkes, and C.P. Baker, "Tropospheric Propagation Model for Land Warfare", *Land Warfare Conference 2003*, Adelaide, Australia, pp. 507-516, 2003.

TITLE: Superheterodyne Receiver System for the Australian SKA Pathfinder	

AUTHORS: K.Jeganathan, R. Gough, S. Mackay, M. Brothers, R. Chekkala
AFFILIATION: CSIRO Australia Telescope National Facility, Marsfield, NSW, Australia
CONTACT DETAILS: E-mail: Kanapathippillai.Jeganathan@csiro.au

The Australia SKA Pathfinder (ASKAP) is an innovative, next-generation radio telescope providing high dynamic range and a wide field of view, currently under development at CSIRO Australia Telescope National Facility in Marsfield, NSW. It will be composed of 36 antennas, each 12 metres in diameter, and will be deployed at the Murchison Radio Observatory, a new, radio-quiet site, in Western Australia. It will use a world-class computing facility to collect, process and store astronomical data which will be available on demand to astronomers.

There are 188 independent receiver chains per antenna, each comprising a differential Low Noise Amplifier (LNA) which is fed from one antenna element of a Phased-Array Feed (PAF), a gain block, and a conversion module. The LNA and the gain block are located together with the PAF at the prime focus, and the conversion module is located at the pedestal. A 40m RF cable connects each gain block with the corresponding conversion module.

Gain Block: The prime receiving element at each antenna is a 10x10 focal plane phased array feed, that will cover a wide field of view to maximise the speed of astronomical surveys. The gain block provides an amplified signal and suppresses unwanted carriers and their harmonics. The instantaneous frequency band of 300 MHz is tuneable over the observing frequency band of 700 – 1800 MHz. The observing frequency band is sub-divided into Band 1, 700-1300MHz, and Band 2, 1000-1800MHz, with 300MHz overlap. The gain block compensates for the RF cable loss and gain slope of 24dB and ±7dB respectively. The printed circuit board that houses the gain block also provides a remotely monitored and pre-regulated power supply, with power shut-down and troubleshooting capability, to each LNA.

Conversion Module: The conversion module is based on a double conversion superheterodyne architecture. Its frequency plan, given in Table 1, is optimised to ease the filtering of unwanted carriers and improve selectivity at a minimum cost. The desired signal is amplified and frequency-translated to an intermediate frequency for sampling by the Analogue to Digital Converter. The module also provides digitally controlled gain adjustment, self-testing capability, local oscillator level detection, supply monitoring and power shut-down facilities.

Parameters	Frequency (MHz)
RF input	700 – 1300 / 1000 - 1800
Intermediate Frequency 1 (IF1)	5000 +/-150
Intermediate Frequency 2 (IF2)	420 - 720
Local Oscillator 1 (tuneable)	5850 - 6650
Local Oscillator 2 (fixed)	4430

Table 1: Conversion module frequency plan

We will present the system's architecture in detail and show the measured performance of the initial prototype modules.

TITLE:	**ASK Modulator Based on Switchable FSS for THz Applications**
AUTHORS:	**Ghaffer I. Kiani, Trevor S. Bird**
AFFILIATION:	**CSIRO, ICT Centre, Marsfield, NSW, Australia**
CONTACT DETAILS:	**ghaffer.kiani@csiro.au, trevor.bird@csiro.au**

For a reliable and compact indoor THz communication system, efficient and high-speed modulators along with other electronic components are very important. Unfortunately, such modulators are not currently available commercially which makes the realisation of THz indoor wireless communication quite difficult. Successful development of these modulators holds the key for future THz communication [1]. Recently, amplitude modulation technique has been used to transmit a music signal at THz frequencies [2]. A two-dimensional electron gas (2DEG) modulator is used in this research with a channel bandwidth of few KHz. The improvement in this particular technique might allow to achieve a bandwidth of few MHz, but this can not provide data rates in multi-gigabit range. Another THz wave modulator based on a silicon oxide/polyaniline photonic crystal is proposed in [3]. In this research the modulation is based on a dynamic shift of the photonic band gap by the applied external electric field with 3 dB modulation bandwidth of 10 kHz at 1 THz. Therefore, this technique cannot be considered for very-high throughput communication systems due to bandwidth restrictions. Some potential modulators described in the literature use a tuneable phase shift with a liquid crystal device [4] and metamaterials [5].

The approach proposed here is an Amplitude Shift Keying (ASK) modulator based on a switchable frequency selective surface (FSS) (see Fig. 1). PIN diodes are used in a FSS to achieve about a 19 dB transmission loss at 600 GHz, when the diodes are switched between ON and OFF states. A square loop aperture is used as the FSS element to obtain high bandwidth and good angle of incidence stability (see Fig. 2). Four PIN diodes are placed orthogonal to each other on a unit cell of the FSS to obtain a stable frequency response at oblique TE/TM incidences. Negative dc biasing is provided from the reverse side of the dielectric substrate by means of symmetrical cross shaped bias lines. The metallic square plate on the front side of unit cell is connected to the centre of cross shaped negative bias lines with the help of a through pin having a diameter of 0.2 µm. The positive dc biasing is provided from the outer end of square loop aperture on the front side of FSS. Theoretically, this ASK modulator can provide data rates in gigabit range as opposed to the modulators described in [3] to [5]. The entire structure could be fabricated on an Indium Gallium Arsenide substrate. The poster will describe the structure and give results in greater detail.

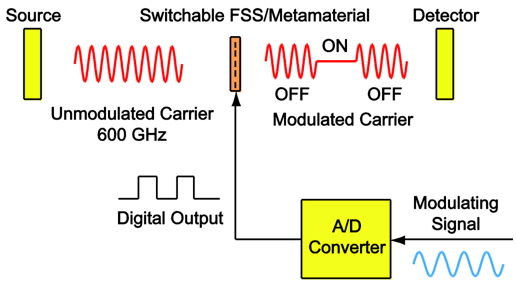


Fig. 1: Proposed method for achieving ASK modulation using switchable frequency selective surface.

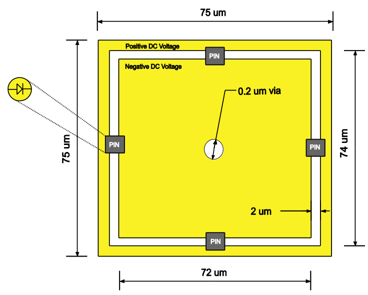


Fig. 2: Front view of the Switchable FSS Unit cell.

References:

[1] T. S. Bird, "Terahertz Radio Systems: The Next Frontiers?" Workshop on Application of Radio Science, Leura, 15-17 February, 2006.
[2] T. Kleine-Ostmann, M. Koch, G. Hein, K. Pien, and P. Dawson, "Electrically driven room temperature THz modulators," Conference on Lasers and Electro-Optics, 2004.
[3] J. Li, "Terahertz modulator using photonic crystals," Optics Communications 269, 98–101, 2007.
[4] Y. C. Chao, F. H. Cho, F. L. Yea, P. P. Ru, and L. P. Ci, "Magnetically tunable room-temperature 2 pi liquid crystal terahertz phase shifter," Optical Express 12, 2625–2630, 2004.
[5] O. Paul, C. Imhof, B. Lgel, S. Wolff, J. Heinrich, S. Hfling, A. Forchel, R. Zengerle, R. Beigang, and M. Rahm, "Polarisation-Independent Active Metamaterial for High-Frequency Terahertz Modulation," Optics Express 17, 819–827, 2009.

TITLE: **From micro to millimetre waves low phase noise and filtering devices design**

AUTHORS: **Jean-Michel Le Floch[1], Georges Humbert[2], David Mouneyrac[1,2], Denis Férachou[2], Gemma Hamilton[1], Michel Aubourg[2], Michael E. Tobar[1], John Hartnett[1], Dominique Cros[2], Jean-Marc Blondy[2], Jerzy Krupka[3]**

AFFILIATION:
[1]School of Physics, University of Western Australia, 35 Stirling Hwy, 6009 Crawley, Australia
[2]XLIM, UMR CNRS Université de Limoges n°6172, 123 avenue A. Thomas, 87060 Limoges Cedex, France
[3]Institute of Microelectronics and Optoelectronics, Warsaw University of Technology, 00-662 Warsaw, Poland

CONTACT DETAILS: **Jean-Michel Le Floch : lefloch@cyllene.uwa.edu.au**

Dielectric resonators are vital components in many microwave circuits and applications including high-Q filters and frequency-determining elements for precision frequency synthesis. Multilayered and bulk crystal dielectric structures have become very important for designing such devices, which may range from microwave to optical frequencies [1-5]. To properly design such structures requires careful electromagnetic characterisation of low-loss material properties [6]. This includes exact simulation with precision numerical software and precise measurements of resonant modes. For example, we have developed the Whispering Gallery mode technique, which has now become the standard for characterizing low-loss structures [7-8].

Other technology we have developed includes multilayered structures (sandwich, spherical, cylindrical structures) have achieved high Q-factors in excess of the loss tangent limit and the surface resistance limit of a normal dielectric loaded cavity. These resonators concentrated the energy inside an inner region of free space where no losses are present using a layered anti-resonant outer region based on the concept of Bragg reflection (this concept is similar to that of the energy band gap in the outer region of photonic band-gap fibres). More recently we have just developed a new structure, in collaboration with XLIM at the University of Limoges, based on a new out-of-plane photonic-band-gap resonator (PBGR) at 30 GHz, which has resulted from adapting the existing optical waveguide technology to millimetre wave frequencies.

We now have a research program, which combines and adapts optical and microwave technology to develop new devices in the millimeter frequencies band. This band is undeveloped and represents the next frontier, with potential for a higher re-use of the spectrum, a higher density of users, more compact devices and higher resolution important for space communications and realizing the full potential of high frequency very long based interferometer (VLBI).

References:

[1] – R. Comte, S. Gendraud, and P. Guillon,“ New concept for low loss microwave devices,” Electron. Lett., vol. 30, pp. 419–420, 1994.
[2] – C.A. Flory and H.L. Ko,“ Microwave oscillators incorporating high performance distributed Bragg reflector resonators,” IEEE Ultrason., Ferroelec., Freq. Contr. (UFFC), v. 45, pp. 824–829, 1998.
[3] – J-M. Le Floch, M.E. Tobar, and D. Mouneyrac,“ Discovery of Bragg confined hybrid modes with high *Q* factor in a hollow dielectric resonator,” Appl. Phys. Lett., vol. 91, 142907, 2007.
[4] – M.E. Tobar, J-M. Le Floch, D. Cros, and J.G. Hartnett,“ Distributed Bragg Reflector Resonators with Cylindrical Symmetry and Extremely High Q-factors,” IEEE UFFC, vol. 52, 2005.
[5] – J-M. Le Floch, M.E. Tobar, D. Cros, J. Krupka,“ High Q-factor Distributed Bragg Reflector Resonators with Reflectors of Arbitrary Thickness,” IEEE UFFC, 54, 12, pp. 2689-2695, 2007
[6] – J-M. Le Floch, M.E. Tobar, D. Cros, J. Krupka,“ Low-loss Materials for high Q-factor Microwave Bragg Reflector Resonators,” Applied Physics Letters, APL, 92, 1, 032901, 2008
[7] – J. Krupka, K. Derzakowski, M.E. Tobar, J. Hartnett, R.G. Geyerk,“ Complex permittivity of some ultralow loss dielectric crystals at cryogenic temperatures,” Meas. Sci. Tech. 10, pp.387–392, 1999
[8] – J-M. Le Floch, J.D. Anstie, M.E. Tobar, J.G. Hartnett, P-Y. Bourgeois, D. Cros, “Whispering Modes in Anisotropic and Isotropic Dielectric Spherical Resonators,” Physics Letter A, 359, 1,pp. 1-7, 2006

TITLE:	de-convolution of reflection terahertz images
AUTHORS:	Yue Li, Dan Popescu, and Andrew Hellicar
AFFILIATION:	ICT Centre, CSIRO
CONTACT DETAILS:	Cnr Vimiera and Pembroke Roads, Marsfield, NSW 2122, yue.li@csiro.au

Terahertz imaging has found applications in many fields. To explore these applications, two coherent terahertz imaging systems have been built. One operates at 610 GHz and another at 186 GHz. Both systems can acquire transmission and reflection images. Since de-convolution algorithms can improve image resolution beyond the diffraction limit of an imaging system, several algorithms have been tested on images formed using these two systems. The 610 GHz system only measures the power of the received signal, because it is difficult to measure the phase of received signals at this frequency. As a result, coherent de-convolution algorithms (such as Wiener and Tikhonov algorithms) cannot be used on these images and the incoherent Richardson-Lucy (R-L) algorithm was tested to evaluate its performances on a coherent imaging system. Previously we have tested and compared the performances of these algorithms on transmission images. Experimental results have demonstrated that the coherent Wiener and Tikhonov algorithms are capable of improving the resolution of images acquired using the 186 GHz imaging system. However, when the Richardson-Lucy algorithm was used to de-convolve the intensity image of the 610 GHz system, even though the resolution has been improved, some artifacts appeared in the processed images, due to the coherent nature of the imaging system. In this paper, we present testing results of the Wiener and Tikhonov algorithms on reflection images acquired using the 186 GHz system. A steel ball was used as a point target to estimate the point spread function of the imaging system and a phantom target was imaged in order to quantitatively compare the performances of these de-convolution algorithms.

TITLE:	An Ultra-Wideband Antenna on Liquid Crystal Polymer Substrate, with A Band-Notched Response
AUTHORS:	Jianjun Liu[1, 2], Karu Esselle[1], Shunshi Zhong[2]
AFFILIATION:	[1]Centre for Microwave and Wireless Applications, Electronic Engineering, Macquarie University, NSW 2019, Australia,[2]School of Communication and Information Engineering, Shanghai University, Shanghai 200072, China
CONTACT DETAILS:	[1,2]jianjun@science.mq.edu.au, [1]Karu.esselle@mq.edu.au, [2]shshzhong@163.com

The use of Liquid Crystal Polymer (LCP) as a substrate for antennas is receiving great attention because of the advantages of LCP. It is a recyclable RF material and it has a nearly constant dielectric constant across a very wide frequency range, making it suitable for ultra-wideband (UWB) antennas. Its flexibility helps the antenna designer to make the best use of limited spaces [1].

On the other hand, within the operating bandwidth of UWB systems, there exist bands used by other wireless systems such as 802.11a wireless local-area networks (WLAN), which operate in the 5.15-5.825 GHz range. To avoid the interference between the UWB and WLAN systems, it is desirable to design antennas with notches in its frequency response. An antenna with an arc-shaped slot or a U-shaped slot can generate a notch band, centred at 5.5GHz to isolate 802.11a WLAN systems [2] [3]. However, these slot layouts bring horizontal surface currents which lead to a high cross-polarization in other operating frequencies of the UWB antenna.

In this paper, a simple and compact UWB antenna on an LCP substrate is proposed. The antenna consists of a trapezoid ground plane and an elliptical patch which can provide wide bandwidth. The simulation results indicate that its impedance bandwidth ranges from 2.4 to 16GHz which is wider than that of the same antenna on an ordinary substrate. Moreover, the CPW feeding line with a tuning stub is designed to introduce a notch band from 5.09-5.92 GHz and hence avoid WLAN interference in this band. In addition, the proposed antenna can provide a nearly omni-directional radiation pattern across the entire bandwidth.

Reference:

1. Sanguk Park, Jungyup Lee, Joonghee Lee, and Austin S. Kim, "Dual-port LCP Multi-band Antenna for wibro/mWiMax MIMO, Bluetooth and GPS Applications in Mobile phone", IEEE Antennas and Propagation Society, AP-S(2009),1-4.
2. X.A. Qu, S.S. Zhong, and W. Wang, "Study of the band-notch function for a UWB circular disc monopole antenna", Microwave Opt Technol Lett 48 (2006), 1667–1670.
3. Tharaka Dissanayake, Karu P. Esselle, "Prediction of the Notch Frequency of Slot Loaded Printed UWB Antennas", IEEE Trans. Antennas Propagation, 55 (2007), 3320-3325.

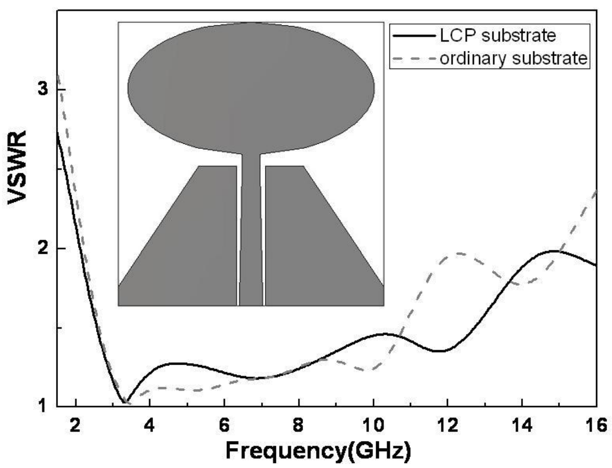


Figure 1 VSWR comparison between Different substrates

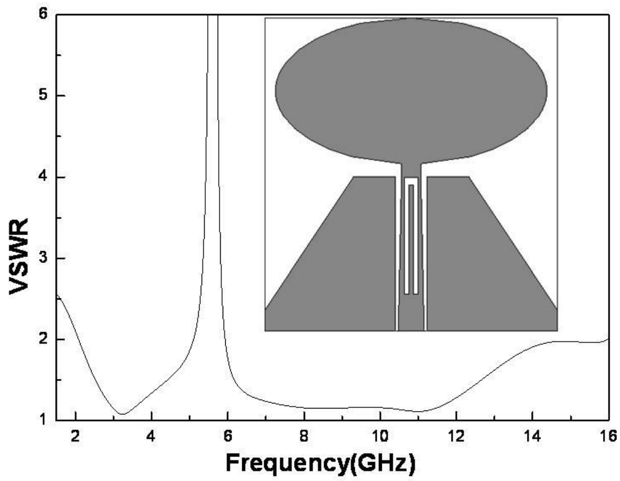


Figure 2 VSWR of the antenna with the notch band

TITLE:	Comparison of Power Measurements on Oblique Incidence Paths with Power Derived from an Ionospheric model
AUTHORS:	David J Netherway
AFFILIATION:	Defence Science and Technology Organisation
CONTACT DETAILS:	david.netherway@dsto.defence.gov.au

An ionospheric model[1] similar to that used by the Jindalee Operational Radar Network (JORN) has been used to model power measurements on several Oblique Incidence Sounder (OIS) paths within Australia. The ionospheric model was based on data from up to 13 Vertical Incidence Sounders (VIS) throughout the northern half of Australia, most being near the coast and at JORN radar sites. The VIS sounders collected data every 3’45” with the ionospheric model updated every 10 minutes. This ionospheric model has been used to synthesise HF propagation through the ionosphere via two-dimensional numerical ray-tracing (2D NRT) and comparisons of observed and synthesised OIS features have been performed[2]. Here, preliminary results of comparisons of power estimates derived from 2D NRT and observed power measurements are presented.

The power model includes ray divergence, absorption, antenna gains and forward scattering loss (for multi-hop propagation). While the model includes features that are not known precisely, an initial examination of the data found that the power levels were in general agreement with those expected; for example, within 6 dB on average for 1F2 low propagation. As expected there was substantially more variability in the measured data than in the data based on an ionospheric model which has been temporally and spatially smoothed. For E mode propagation at low elevation angles the power estimate was found to be very dependent on the antenna gain pattern because of the rapid decrease in gain as zero elevation is approached.

The estimation of power, and its variability, in each propagation mode at a given frequency is important for the mode assignment problem in radar applications.

References

[1] Northey, B and Gardiner-Garden, RS. Improvements to a Real-Time Ionospheric Model for Northern Australia, Australian Institute of Physics 18th National Congress, Adelaide, December, 2008.

[2] Gardiner-Garden, RS, Heitmann, A, Northey, B and Turley, M. Modelling Uncertainty in a Real-Time Model (Nowcast) of the Ionosphere. 12th International Ionospheric Effects Symposium, IES2008, Alexandria, USA, 2008.

TITLE:	Modeling Complex Sources Using Measured Phaseless Near-Field Data
AUTHORS:	Mikael Persson, Markus Johansson and Hoi-Shun Lui
AFFILIATION:	Chalmers University of Technology
CONTACT DETAILS:	SE41296 Göteborg, Sweden

Phase-retrieval from measured phaseless field data is of interest for source modeling in dosimetry applications and electromagnetic compatibility investigations as well as for near- field to far- field transformations and antenna diagnostics.

We here present results for a new phase-retrieval method. The method uses an optimization algorithm based on the phase angle gradients of a functional. In the method used, we search for the phase angles that together with measured field amplitudes on one measurement plane, give correct calculated field amplitudes on two other planes despite that we do phase retrieval for cases with plane distances much smaller than the wavelength.

To show that we can do phase retrieval for the intended kind of test cases, with relevant distances much smaller than the wavelength, we have used different test cases. One such test case with measured 50 Hz magnetic flux density in front of a transformer. The obtained phase angles on a measurement plane in front of the source gives calculated field amplitudes on other measurement planes that agree well with the measured field. The ratios between the largest amplitude difference and the largest measured amplitude for the three Cartesian magnetic flux density components, for one of the planes, are for example 6.62 %, 9.51 % and 6.40 %.

TITLE: **Propagation Modelling in Complex Tunnel environments Using FDTD Method**

AUTHORS: **Md.Masud Rana and Ananda.S. Mohan**
AFFILIATION: **Faculty of Engineering & Information Technology, University of Technology Sydney (UTS).**
CONTACT DETAILS: mrana@eng.uts.edu.au, ananda@eng.uts.edu.au

Introduction:

Wireless Sensor Networks (WSN) is becoming popular for the monitoring and assessment of civil infrastructure [1]. In particular, when deployed for the monitoring and assessment of the condition of tunnels, signal Propagation prediction in terms of Path Loss estimation will be helpful in determining the critical communication parameters such as maximum distance etc. It is well known that radio signal propagation in complex shaped tunnels exhibits distinct near and far regions with quite different propagation characteristics [2]. In this paper we aim to develop a model that can predict propagation losses in the complex shaped tunnels. Incorporating the correction factor method [3], we obtain modified 2D Finite-Difference Time Domain (FDTD) method to model the signal propagation in a tunnel that has cast iron lining at a frequency of 2.45GHz when the transmitting antenna is positioned close to the tunnel wall. We compare our simulated results on path loss with experimental results provided by Wu et al [3].

Methodology:

For modelling radio propagation in tunnels, a common approach is to treat them as a large scale waveguides. In [2], Zhang concluded that there are two propagation regions in a tunnel. However, the conventional modal theory of electromagnetic (EM) propagation in conducting tunnels cannot accurately predict the near distance Path Loss. Particularly for obtaining fields in close- to- wall antenna deployment scenarios, the accuracy of prediction can be poor when using the conventional techniques. In this paper, the 2D FDTD technique is used for predicting the path loss. The FDTD technique is modified for predictions inside complex tunnel by subtracting the correction factor originally proposed in [3].

Results and Discussion:

It is well known that the transmit frequency, antenna position, tunnel diameter, building materials etc., are the main factors which affect radio propagation in a tunnel. In the FDTD simulation for the 2D tunnel structure, the unit cell size is chosen to be 0.61cm at 2.45GHz. In terms of the physical constants at each unit cell, the cast iron lining is represented using ε_r=1.0, μ_r=1.0 $\sigma=20\times10^3$. We set the number of time steps to be 8 times larger than the time steps needed for the FDTD to cover the entire length of the tunnel. For predicting the propagation path loss, this method has been employed at short ranges (i,e., several hundred metres). We have obtained a close correspondence between our simulation results and the published measured results. This confirms that the usefulness of the technique for further exploring more challenging propagation scenarios involving wireless sensor networks.

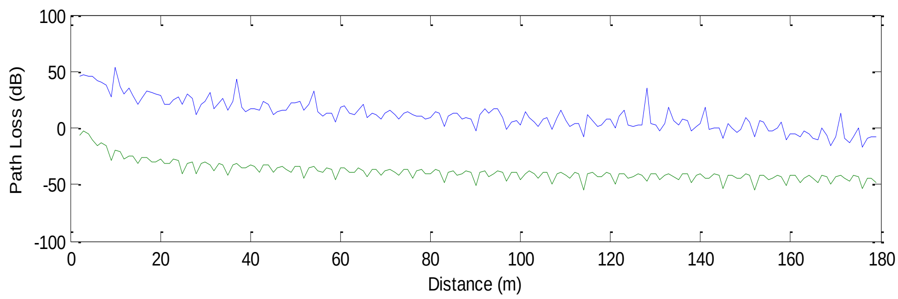


Fig.1. Predicted Path Loss using FDTD inside a tunnel.

References:

[1] D. Culler, D. Estrin, M. Srivastava, “Overview of Wireless Sensor Networks”, IEEE Computer, Special issue in Sensor Networks, vol., no., pp, August 2004.

[2] Y.P.Zhang, “Novel Model for Propagation Loss Prediction in Tunnel”, IEEE, Trans. Veh. Technol., vol. 52, No. 5, pp. 1308-1314, Sep. 2003.

[3] Y. Wu, M. Lin, and I.J. Wassell, “Modified 2D Finite-Difference Time-Domain Technique for Tunnel Path Loss Prediction”, the 2nd International Conference on Wireless Communication in Underground and Confined Areas, Aug. 2008, Quebec, Canada.

TITLE: **Transistor Low Frequency Noise Modelling for Oscillator Phase Noise Simulation**	

AUTHORS: **Oya Sevimli, Anthony E. Parker, Anthony P. Fattorini*, James T. Harvey*, and Simon J. Mahon***
AFFILIATION: **Macquarie University, North Ryde, NSW, Australia, *Mimix Broadband, North Sydney, NSW, Australia**
CONTACT DETAILS: osevimli@ics.mq.edu.au **Ph: (02) 9850 9076**

Voltage controlled oscillators (VCOs) are an essential part of microwave radios and designing them has been getting easier with the availability of automated simulation and layout software. However, predicting the phase noise when the VCO is monolithically integrated (MMIC) is still challenging.

Phase noise of the oscillator includes the upconverted low frequency noise (coloured) and the microwave noise (white) shaped by the resonator bandwidth. For MMIC VCOs with integrated resonators, the resonator bandwidth is necessarily wide and the phase noise is largely determined by the upconverted low frequency noise of the transistors. GaAs HBTs (Heterojunction Bipolar Transistors) generate relatively less low-frequency noise and they are a good active device candidate for microwave VCOs.

The low frequency noise models for transistors are still empirical [1]. The standard GaAs HBT large signal models provided by the manufacturers for VCO design include one low-frequency noise source at the base-emitter junction. Parameters of this noise source are left to be adjusted by the circuit designer to describe the low frequency noise measured at the collector. This model is then used to predict the VCO performance and its phase noise. Recently, it has been suggested that one low-frequency noise source is not enough to model the total noise of the HBT [2] accurately. Two uncorrelated noise sources can be extracted unambiguously from the two port low-frequency noise measurements and, although the exact placement of these noise sources is not unique [2], [3], the resulting advanced noise model of the HBT has been reported to predict the VCO phase noise accurately [3]. However, magnitude of the first low-frequency noise source at the base-emitter junction is usually much higher than the second source, and the error in neglecting the second source by simply using the industry standard model is not clear.

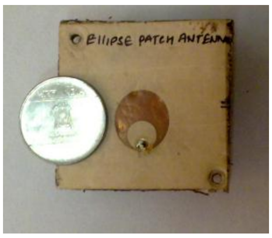
We have measured low frequency s-parameters of GaAs HBTs on wafer and found the dispersion could be modelled with a simple modification to the foundry provided standard nonlinear HBT model [4]. This model with correct dispersion behaviour could then be used for extracting the low frequency noise parameters. We have been experimenting with one port and two port low frequency noise measurements and the calibration of the on-wafer noise measurement. We will report on the low frequency noise measurements and modelling of the GaAs HBTs suitable for VCO phase noise simulation.

[1] F. N. Hooge, "1/f noise sources," *IEEE Trans. Elect. Dev.*, vol. 41, no. 11, pp. 1926–1935, Nov. 1994.
[2] M. Rudolph and F. Bonani, "Low-Frequency noise in nonlinear systems," *IEEE Microw. Mag.*, pp. 84-92, Feb. 2009.
[3] J. C. Nallatamby, M. Prigent, A. Sion, C. Gourdon, and J. J. Obregon, "An advanced low-frequency noise model of GaInP–GaAs HBT for accurate prediction of phase noise in oscillators," *IEEE Trans. Microw. Theory Tech.*, vol. 53, no. 5, pp. 1601–1612, May 2005.
[4] O. Sevimli, A. E. Parker, A. P. Fattorini, and J. T. Harvey, "Low frequency s-parameters for HBT dispersion modeling," *Submitted to the IEEE MTT Intern. Microw. Symp.,* May 2010.

TITLE:	A Compact Wide Band Ellipse Shape Patch Antenna for Wide Band Applications
AUTHORS:	M.M. Sharma[1], Y. Ranga[2], and R.P. Yadav[3]
AFFILIATION:	[1,3] Department of ECE, Malaviya National Institute of Technology, Jaipur, India
CONTACT DETAILS:	mmsjpr@gmail.com , [2] yranga@ieee.org +919413346999

With recent developments in communication systems, there is an increasing demand for compact antennas to integrate into three-dimensional packages as well as design antennas on multilayer laminates. This poses a challenge, especially in the design of antennas with broad band characteristics. The printed multilayered antenna can be integrated into the circuit, and the ground plane can also be used to isolate the antenna from the other components in the circuit. Microstrip antennas on a high–low dielectric substrate combination reduce the element size because of the shorter wavelengths and also enhance the impedance bandwidth. It is well known that one of the most serious limitations of the basic microstrip antennas technology is the narrow bandwidth, which is usually around a few percent. Over the years, many conventional methods have been proposed to enhance its bandwidth, such as adding an impedance matching network, using thick and low permittivity substrates, stacked patches, edge-coupled parasitic patches, lossy materials etc. Recently simple techniques such as the use of crescent patches and elliptical patches have been investigated to achieve wide band microstrip antennas.

In this paper, a novel compact wide band ellipse shape patch antenna is proposed that would significantly reduce the overall antenna size and increase the impedance bandwidth. A hardware prototype of proposed configurations is shown in Fig.1. On a circular patch, the distribution of the current is small at the centre and concentrated on its periphery. The current modes are in the form of higher order Bessel functions of the first kind and responsible for a broad antenna bandwidth [1-2]. This study follows the analogy of current modes that exist on a circular patch. Proposed structure is an elliptical shape patch with a symmetrical aperture in it. Antenna is fabricated on a Roger RO3003, 5 mil substrate with 4 mm optimized foam sandwiched between substrate and ground plane. Ellipse shape patch is designed with a major axis of 18mm and minor axis of 16mm, a circular region of radius 4.5mm is etched out from the ellipse geometry. The idea of this circular region is derived from the inspection of current distribution of the patch. It is observed that the currents on the elliptical patch at all frequencies are concentrated on its periphery, with very low current density towards its centre. The compact wide band ellipse shape patch antenna prototype is fabricated and tested. The measured return loss, gain and radiation pattern are characterized and discussed. Through the numerical study of the vector current distribution of the antenna prototype, only one characteristic mode is found to exist on the ellipse shape patch over the band 12.45 to 18.975 GHz, This can be considered as a dominant mode. Since the height of the substrate $h << \lambda_0$, the field do not vary along the z-direction. Therefore the electric field within the substrate has only z component, and the magnetic field essentially has a ρ and ϕ component. The impedance bandwidth for $S_{11} < -10$ dB is about 6.5GHz covering the entire Ku band is shown in Fig.1. The gain are measured at 12.45 GHz, 14 GHz, 16.25 GHz and 18.97 GHz and giving 2.43 dBi, 2.05 dBi, 2.40 dBi and 3.37 dBi respectively. The patch was simulated using the commercial software CST Microwave Studio 2009.



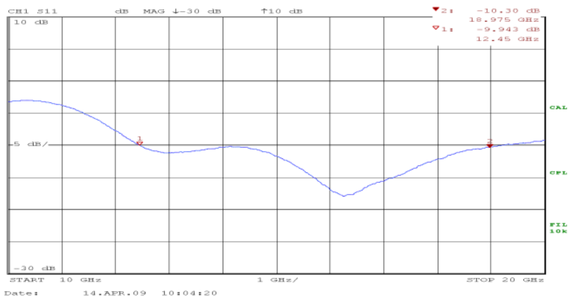


Figure.1 Hardware Prototype and Measured reflection coefficient of ellipse shape patch antenna

References:

[1] Ntsanderh C. Azenui and H.Y.D. Yang, A Printed Crescent Patch Antenna for Ultrawideband Applications," IEEE Antennas and Wireless Propagation Letters, vol.6, pp.113-116, 2007.

[2] A. K. H. Obsiye, H. E. AbdEl-Raouf and R. EL-Islam, "Modified printed crescent patch antenna for Ultrawideband RFID (UWB-RFID) tag", RF and Microwave Conference, 2008. RFM 2008. 2-4 Dec. 2008pp. 274-276

TITLE: **SKAMP: re-engineering the Molonglo radio telescope**

AUTHORS: **D. Campbell-Wilson(1)*, D. Thakkar(1), L. de Souza(2), A. Blake(1), M. Kesteven(2), J. Bunton(3), R. Hunstead(1), A. Green(1)**

AFFILIATION: **(1) School of Physics, The University of Sydney; (2) Australian Telescope National Facility, CSIRO; (3) Information and Communication Technologies Centre, CSIRO**

CONTACT DETAILS: ***dcw@physics.usyd.edu.au**

The Square Kilometre Array Molonglo Prototype (SKAMP) uses innovative technologies to transform the scientific capabilities of the University of Sydney's Molonglo Radio Observatory, located outside Canberra. SKAMP is trialling technologies and concepts that may be adopted in the future Square Kilometre Array. The telescope is being re-equipped with new wideband feeds, ultra-low-noise room temperature amplifiers and beamformers, digital receivers, filterbanks and correlators. The final stage of the SKAMP upgrade is a 6480-channel spectrometer capable of operating in the frequency range 700-1100 MHz, with an instantaneous operating bandwidth of 100 MHz. This paper details the completed and ongoing activities of the SKAMP upgrade.

The first stage, SKAMP I, involved the construction and installation of a 96-station continuum correlator with 3 MHz of bandwidth centred at 843 MHz, while using the existing front-end feeds and signal pathways of the Molonglo Observatory Synthesis Telescope. The second stage, SKAMP II, encompasses the development and construction of a spectral-line correlator with an operating bandwidth of 30 MHz centred at 843 MHz. SKAMP II will use the existing broadside array configuration and low-noise amplifiers (LNA) in conjunction with a new control system, local oscillator and optic-fibre based distribution system. The final stage, SKAMP III, requires new feeds and a finer mesh, which will improve the telescope performance and increase the operating frequency range.

SKAMP III consists of 16,896 feed elements spread across the 88 bays. The signal from each feed element is fed to an LNA and after beamforming, each bay feeds 2 orthogonal polarisations to a receiver. The receiver downconverts a selectable 100 MHz slice of spectrum to baseband. The in-phase and quadrature components of the baseband signal are digitised and fed to the receiver FPGA. After initial processing, the data is transmitted over optical fibre links to the central control room. Digital signal processing is carried out on the data using an FX (filter and cross-multiply) correlator. The correlator output is then sent to a disk array for post processing and archiving.

The paper reports the lessons learnt from the activities of the massive upgrade process. In particular, the SKAMP II/III receiver architecture and its implementation are discussed in detail. The paper also presents insights into the relevant engineering aspects of the upgrade process. The core challenges faced by the instrumentation team, their solutions and the innovative approaches have been addressed.

WARS 2010 ABSTRACTS

2nd Poster Session – 10.30 am – 12.15 pm – Friday 12 February 2010

TITLE: **A Novel, Distributed MIMO Based Wireless Network Architecture with Scalable Net Capacity and Improved Range and Coverage**

AUTHORS: **G.G. Borg**

AFFILIATION: **Australian National University**

CONTACT DETAILS: **College of Engineering and Computer Science, Research School of Physics and Engineering, ANU.**

Wireless networks generally involve simple point-to-point, SISO or SU-MIMO links. Network throughput is limited at the wireless interface at the base station / wireless router that connects to the Internet backbone. In this paper we propose a new wireless architecture in which a vast distributed array of base stations connects a large number of remote users to the Internet simultaneously on the same spectrum. The distributed nature of the network allows each base station to use the full legal EIRP. In order to communicate, the base stations use beam forming based on time reversal precoding. When the number of remote users is much less than the number of base stations, the net capacity scales with the number of remotes. For a Rayleigh fading channel, it may be shown that the net capacity scales as

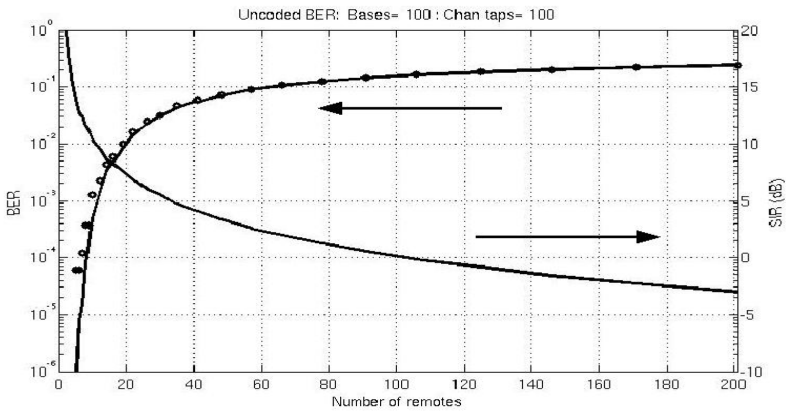
$$C = M\ log_2(1 + N/(M-1))$$

where M≪N is the number of remotes and N is the number of base stations. Coverage and range are also superior to that of a conventional SISO/SU-MIMO cellular network. The ratio of the range of the network compared to a SISO link of the same power per base is given by,

$$R_M/R_S = \sqrt{(N/M)(N-M+1)}$$

The performance of such a network is limited by CCI and hence Signal to Interference Ratio (SIR). The SIR plays the same role in the capacity formula as SNR in Shannon's rule. For QPSK modulation, we may compare the BER computed from simple hard decision theory with the observed BER from a simulation. The figure shows the BER and SIR vs the number of remotes for 100 base stations in a Rayleigh channel with 100 symbol rate channel impulse response taps.

The figure shows that the network is degraded by the addition of new users in the same manner



that a conventional network is degraded by AWGN. As a result the remotes may use conventional FEC to approach the above Shannon capacity.

We provide a detailed analysis of performance limits indicating that the proposed network significantly outperforms current infrastructure technologies with respect to coverage and capacity. We compare the performance of a conventional cellular network to an equivalent network of the new architecture for the same level of service. Finally we provide a detailed discussion of the technical details of how to implement such a network.

TITLE:	DUAL-BAND FEED-SYSTEM RESEARCH & DEVELOPMENT AT BAE SYSTEMS AUSTRALIA
AUTHORS:	C. Granet, I.M. Davis, J.S. Kot, G. Pope, K. Verran, T. Mellor
AFFILIATION:	BAE Systems Australia Ltd
CONTACT DETAILS:	Christophe.Granet@baesystems.com

Feed-systems capable of operating in two or multiple frequency bands simultaneously are not new, but are increasingly becoming more sought after for satellite communications (SATCOM) and radio-astronomy applications. Earlier examples of dual-band feed systems only required very narrow, well separated bands. Nowadays however, specifications are becoming much more difficult in terms of required bandwidth and band separation.

In most cases, dual-band operations are required and BAE Systems Australia has invested Research and Development funds to look at the performance and manufacture of such systems.

The dual-band feed-systems we have looked at so far are:

- Simultaneous X/Ka for military SATCOM
- S/X for low earth orbit satellite tracking and radio astronomy
- Ku/Ka for commercial and military SATCOM

The paper will present a number of solutions for commercial, military and radio astronomy applications. It will highlight the technical difficulties associated with multiband feed-systems, i.e.:

- Ability to provide a good radiation pattern in both bands
- Issues with phase-centre collocation
- Return loss
- Achievable Bandwidth and band separation
- Mechanical design

TITLE:	Analysis of Diode Mismatch in Anti-Parallel-Diode-Pair Circuits used for Millimeter-wave Frequency Conversion
AUTHORS:	Venkata Gutta, Anthony Fattorini, and Anthony E. Parker
AFFILIATION:	Department of Physics and Engineering, Macquarie University, Sydney, Australia
CONTACT DETAILS:	Ph (2) 9850 7410, email: vgutta@ieee.org

This paper aims to provide a verifiable understanding of the impact of diode size on the conversion efficiency and the inherent rejection of even-order frequency products in anti-parallel-diode-pair sub-harmonic mixers and anti-parallel-diode-pair frequency multipliers. It will utilize analyses of the impact of diode parameters on the even-order non-linear characteristics and experimental results of the statistics of the anti-parallel-diode-pair circuits.

Antiparallel-diode-pair circuits are comprised of two diodes connected in an anti-symmetrical arrangement. The diodes used in millimeter-wave applications are predominantly metal-semiconductor Schottky junctions. The result is a non-linear transfer characteristic, which is responsible for an inherent suppression of even-order frequency products including the dc offset and the second harmonic product in the output spectrum.

Sub-harmonic mixers using antiparallel-diode-pair circuits require only half the local oscillator pump frequency and generate no virtual local oscillator leakage at twice the local oscillator pump frequency. Frequency multipliers using antiparallel-diode-pair circuits generate an output signal at three times the input signal frequency, while generating no second-harmonic frequency products. The use of Antiparallel-diode-pair circuits in mixing and multiplication results in improved spurious performance and consequently eliminates the need for filtering. Filters are expensive and are not often feasible for low-intermediate-frequency systems.

The inherent suppression of even-order frequency products is dependent on the diode match in anti-parallel-diode-pair circuits. However, random variations in the fabrication process and thermal effects arising as an artefact of device geometry and circuit topology result in diode mismatch. The impact of the random variations is not uniform across the semiconductor wafer. As a result, the unwanted effects of diode mismatch can not be altogether eliminated. However, they can be minimized in a statistical sense by an informed selection of diode size and the input signal power.

The mean and variance of the mismatch between the intrinsic diode parameters such as reverse saturation current, Ideality factor, series resistance and the built-in potential of the diodes in anti-parallel-diode-pair circuits are a function of the diode size. Owing to the random nature of the variations, a quantitative knowledge of the impact of diode size on diode match would appear difficult. But, deterministic trends between the random variables denoting the statistics of the diode parameters provide a qualitative understanding of the impact of diode size on diode match and the inherent rejection of even-harmonic frequency products. Consequently, an intelligent selection of diode size and input signal power result in improved diode match and reduced even-order frequency products in sub-harmonic mixers and frequency multipliers.

However, the choice of diode size also impacts on the conversion efficiency in the sub-harmonic mixer and the frequency multiplier across various power levels. The selection of diode size for reduced even-order frequency products results in a trade-off with conversion efficiency. This issue will be studied in considerable detail so as to provide design methodologies for improved circuit yield in mixers and multipliers based on anti-parallel-diode-pair circuits.

TITLE:	**Focal plane array evaluation on a prototype radiotelescope**
AUTHORS:	**Douglas B. Hayman[1-3], Trevor S. Bird[2,3], Karu P. Esselle[3], and Peter J. Hall[4]**
AFFILIATION:	**[1] CSIRO ATNF, [2] CSIRO ICT Centre, [3] Dept Electronic Engineering, Macquarie University, [4] Dept Electrical and Computer Engineering, Curtin University of Technology**
CONTACT DETAILS:	**douglas.hayman (at) csiro.au**

The radioastronomy community is developing dense focal plane arrays (FPAs) as feed antennas for both future systems such as the Australian Square Kilometre Array Pathfinder (ASKAP) and to retrofit existing large radiotelescopes. The attraction of dense FPAs is the increased survey speed with the capability of producing many more beams than discretely processed arrays of feeds.

To study FPAs systems, a prototype radiotelescope, the New Technology Demonstrator (NTD) Interferometer, was built at the Radiophysics laboratory in Sydney. This demonstrator has been detailed previously [1]. It consisted of two 14 m antennas, one of which was fitted with an FPA that was equipped with the first real-time digital beamformed fitted to a prototype radiotelescope. The beamformer was used to combine 21 of the 64 (8×8) elements of the FPA into the desired illumination of the reflector. The methods used for evaluating the FPA on the NTD Interferometer are described in this poster.

A “black box” approach to the FPA was adopted as its internal details and the primary radiation patterns were not well known. The beamformer was used to maximize the sensitivity of the system using parameters readily measured in an operating radiotelescope.

Radiation patterns were measured with the system acting as an interferometer and using a celestial radio source. The gain and system temperature were determined using a combination of:

- The received power ratio of pointing on and off a source of known strength.
- The ratio of the received power with and without microwave absorber placed under the feed.
- An estimate of the receiver noise temperature.

In summary, practical beamforming and evaluation techniques were developed for a real-time digital FPA system. The results of the project have had a significant impact on the selection of technology and approach for radiotelescopes at Parkes and ASKAP.

The development of the NTD interferometer instrument involved a large team including those listed in [1]. We also acknowledge the advice and encouragement of Stuart Hay, John O'Sullivan and Mike Kesteven.

[1] D. Hayman, R. Beresford, J. Bunton, C. Cantrall, T. Cornwell, A. Grancea, C. Granet, J. Joseph, M. Kesteven, J. O’Sullivan, J. Pathikulangara, T. Sweetnam, and M. Voronkov, “The NTD interferometer: A phased array feed test bed,” *Workshop on Applications of Radio Science*, 2008.

TITLE:	**Terahertz Radar**
AUTHORS:	**Andrew Hellicar, Stephen Hanham, Dan Popescu, Yue Li**
AFFILIATION:	**ICT Centre, CSIRO**
CONTACT DETAILS:	**Cnr Vimiera and Pembroke Roads, Marsfield, NSW 2122, andrew.hellicar@csiro.au**

Imaging at terahertz (THz) frequencies (300 GHz – 10 THz) is an active and growing area of research. This is in part due to the unique combination of phenomena (for example transmission through materials and fine resolution) which can be exploited to yield THz solutions in security, medical, and non-destructive testing. However, research interest also exists due to a second reason: the alluring prospect that solutions to the many technical challenges that are stopping practical terahertz systems from becoming a reality, are near. These challenges, such as the creation of high power sources, sensitive detectors, and rapid efficient scanning, have kept terahertz systems mostly in the realm of laboratories. Indeed the most popular THz imaging systems today are based on a technology first demonstrated in 1995 [1].

Terahertz imaging applications are diverse and, although the authors have been targeting the security domain, measurements by the authors have been conducted in medical, non-destructive testing areas and other application areas. To target such a diverse application set an active approach (THz illumination) has been taken which allows for flexibility in system design and also assists in improving signal to noise levels not attainable with passive techniques.

This paper discusses results generated by an active, reflection mode system which measures amplitude and phase across a variety of frequencies. Due to reasons of simplification the approach was tested in the mm-wave band at 200 GHz as a proof of concept with extension to 0.6 THz possible in the future. The approach allows for the 3-D structure of a target to be constructed, and clutter signals to be eliminated. Results show the ability of the approach to resolve 3-D structures and assist in the identification of objects that may be concealed.

[1] B. B. **Hu** and M. C. **Nuss**, "**Imaging with terahertz waves**," Opt. Lett. 20, 1716-1718 (**1995**)

TITLE: **Highly integrated Silicon on Sapphire receiver for next-generation radio telescopes**

AUTHORS: **S. A. Jackson[1], Y. Moghe[2], R. G. Gough[1] and C. A. Jackson[1]**
AFFILIATION: **1: CSIRO Astronomy and Space Science, 2: Sapphicon Semiconductor**
CONTACT DETAILS: **PO Box 76, Epping NSW 1710**

A new System-on-Chip (SoC) receiver is proposed utilising an advanced Silicon on Sapphire CMOS process, to be developed as a collaborative venture between CSIRO Astronomy and Space Science and an industrial partner. This receiver, as depicted in Fig. 1, is targeted for mid-band Square Kilometre Array (SKA) pathfinder use, covering an RF tuning range in excess of 700 to 1800 MHz, with a 300 MHz instantaneous bandwidth. The receiver features high dynamic range and low noise figure.

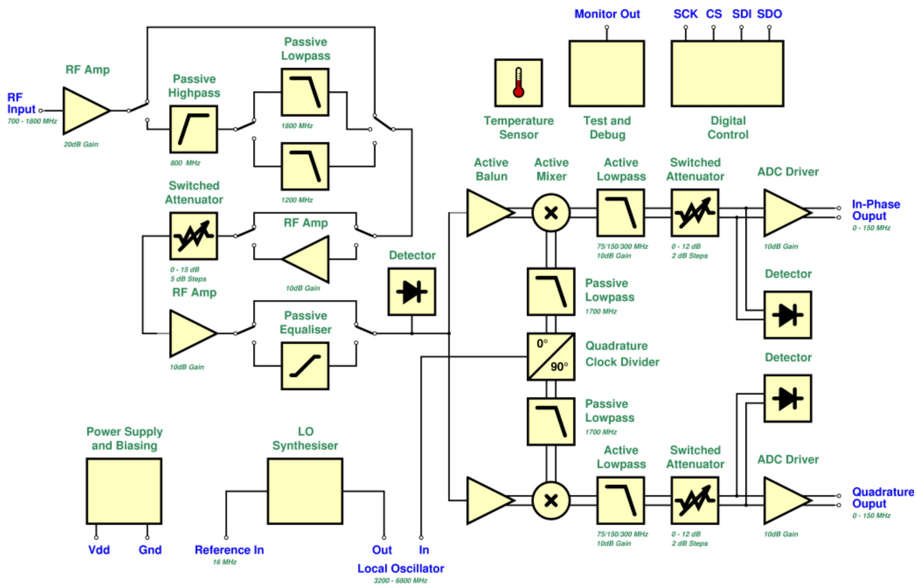


Figure 1: Silicon on Sapphire receiver block diagram.

The Silicon on Sapphire process promises high reverse isolation and good device matching, allowing the use of a quadrature I/Q downconversion scheme. Table 1 details the expected performance specifications for the receiver. This poster provides an overview of the proposed receiver design and highlights the significant benefits that an integrated SOC offers for complex phased array design and implementation.

RF frequency range	700 – 1800 MHz (250 – 2500 MHz with RF filters bypassed)
Instantaneous BW	150/300/600 MHz selectable
Dynamic range	> 40 dB
RF input NF	2 dB
RF gain range	14 – 39 dB, variable in 5 dB steps
RF and LO input	Single ended 50 Ohms
Baseband output	0 to 75/150/300 MHz DC coupled quadrature buffered differential I and Q signals suitable for direct connection to ADC
Baseband gain range	8 – 20 dB, variable in 2 dB steps
I/Q mismatch	< 1 degree and 0.05 dB over baseband frequency range
Power consumption	< 5 W

Table 1: Silicon on Sapphire receiver specifications.

TITLE: A New Method to Calibrate Ionospheric Pulse Dispersion using Polarised Emission from the Moon
AUTHORS: R. McFadden (1,2), R. Ekers (2)
AFFILIATION: 1. University of Melbourne 2. CSIRO Australia Telescope National Facility
CONTACT DETAILS: rmcfadde@physics.unimelb.edu.au

The emerging field of Ultra High Energy (UHE) neutrino astronomy promises to provide an exceptional probe for distant astronomical sources. Neutrinos make ideal messengers since they have extremely small interaction cross-sections and any neutrino flux will be almost unattenuated over cosmological distances. Direct detection of UHE neutrinos is very difficult due to their extremely small interaction cross-sections. Instead, they may be detected indirectly via observation of the Askar'yan effect [1] in the lunar regolith. Using the Moon as a large volume neutrino detector, coherent radio Čerenkov emission from neutrino-induced cascades in the lunar regolith can be observed with ground-based telescopes.

Lunar Čerenkov emission produces an extremely narrow pulse (sub-nanosecond duration). These pulses travel through the ionosphere and experience a frequency dependent time delay resulting in pulse dispersion and therefore lunar Čerenkov pulses received on an Earth based radio telescope will be dispersed by the ionosphere and further broadened by receiver band limiting. Ionospheric pulse dispersion must be corrected in real time to maximise the received signal to noise ratio and subsequent chances of pulse detection [2]. Coherent pulse dedispersion requires an accurate knowledge of the ionospheric dispersion characteristic which can be parameterised by the instantaneous ionospheric Total Electron Content (TEC).

A new method to calibrate the dispersive effect of the ionosphere on lunar Čerenkov pulses is presented. This method exploits radial symmetries of the lunar polarisation distribution to make Faraday rotation measurements in the visibility domain using synthesis array data. The Faraday rotation measurements are then combined with geomagnetic field models to estimate the ionospheric Total Electron Content (TEC). An accurate knowledge of the ionospheric TEC can be used to perform pulse dedispersion and recover maximum Čerenkov pulse amplitude before detection. This method of ionospheric calibration is particularly attractive for the lunar Čerenkov technique as it can be used in real time to give values of the ionospheric TEC which are line-of-sight to the Moon.

[1] Askar'yan, G.A., Sov.Phys. JETP, 14, 441 (1962)

[2] T.H. Hankins, R.D. Ekers, J.D. O'Sullivan, MNRAS, 283, 1027 (1996)

TITLE: **Short period variations in available HF radio frequencies due to atmospheric effects on the ionosphere.**

AUTHORS: **D. Neudegg , M. Layoun, S.T. Hutchinson**
AFFILIATION: **Ionospheric Prediction Service, Bureau of Meteorology**
CONTACT DETAILS: **dave.n@ips.gov.au,**
IPS Radio and Space Services, PO Box 1386, Haymarket NSW 1240, Australia

The lower edge of space, the electrically charged ionosphere from 90-500km altitude, is driven by the solar radiation, the geomagnetic field but also the neutral thermosphere atmospheric region, within which the ionosphere comprises a trace component. Vertical radio sounding in the high-frequency (HF 3-30MHz) range is the traditional method of measuring this ionisation, particularly the maximum frequency foF2 reflected by the F2 layer near 300km altitude. Oblique HF radio sounding allows measurement of reflection points above oceans and other locations where it is not practical to position vertical sounders. Oblique sounding paths have been operated between New Zealand and Australia since 2002, covering a range of the 11 year solar cycle. The maximum observed frequency (MOF) on the oblique paths are used to compare with statistical predictions from the standard IPS HF propagation model, which uses monthly median climatological foF2 data. Variations may be interpreted in terms of transient upper atmosphere and geomagnetic effects. During solar minimum 2007-09 the relatively quiet geomagnetic conditions reveal a range of atmospheric driven disturbances. Closely spaced multiple paths and reflection points also allow smaller scale ionospheric structure to be investigated than vertical sounding.

TITLE:	Gain Enhancement Techniques for UWB Antennas
AUTHORS:	Y. Ranga[1, 2], Karu P. Esselle[1] and A. R. Weily[2]
AFFILIATION:	[1]CENTER OF WIRELESS AND MICROWAVE APPLICATIONS, MACQUARIE UNIVERSITY, NSW, 2109, AUSTRALIA [2]CSIRO ICT Centre, PO Box 76, NSW, 1710, Australia
CONTACT DETAILS:	+61 02 9850 8437

With the allocation of various unlicensed frequency bands (0-960 MHz, 3.1-10.6 GHz, and 22-29 GHz) to ultra-wideband (UWB) systems by Federal Communications Committee (FCC), research on UWB has gained much attention by academia and industry. Several planar monopole UWB antennas have been investigated [1] for FCC-based UWB systems operating from 3.1 GHz to 10.6 GHz. Most of these antennas have very wide impedance bandwidths and nearly omni-directional radiation patterns in the azimuth plane. These antennas have low gains and their gain increases with frequency at lower frequencies (3 to 6 GHz) in the UWB band. On the other hand, the transmission transfer function of an ideal UWB antenna should have a flat gain response and a linear phase response for faithful radiation of short UWB pulses [1]. A critical analysis of the effect of antenna gain and group delay variations on pulse preserving capabilities of 3.1–10.6 GHz UWB antennas [2] shows that the fidelity factor drops from 0.9867 and the pulse stretch ratio increases from 1.202, with larger variations of the gain and the group delay in the band.

In this paper we present our recently developed UWB antennas, shown in Fig.1. In our research, efforts were made to enhance the gain of printed monopole antennas at lower frequencies in the UWB band. A printed circular monopole antenna (PCMA) [3] is taken as reference and the surface waves of the structure are modified using composite substrates. Metallic cavities are formed on the main substrate to trap and direct surface waves in the direction of the main beam (direction perpendicular to monopole). Theoretical results indicate that this antenna covers a wide band from 4 to 10 GHz, which is close to the FCC UWB band. Theoretical results show a significant increase of gain at the lower frequencies (3 to 8 GHz) where the gain is relatively low otherwise. The increase of gain is 4-5 dBi around 3 GHz. This frequency-dependent gain boost results in an antenna that has a constant gain across the whole impedance-matched band of 4 to 10 GHz. Further to improve the impedance bandwidth, the concept of the two-plate short horn has been incorporated. The resulting antenna has a short, two-plate horn mounted on the surface of a printed circular monopole antenna (PCMA) [3]. The preliminary theoretical and experimental results of this antenna indicate nearly constant gain (4.8 ± 0.7 dBi) over an ultra-wide bandwidth from 2.75 GHz to 10 GHz. A thorough performance analysis of short horn, on different shapes of monopole and slot configurations, shows improved pulse performance and enhanced gain over an UWB impedance bandwidth.

References

[1] H. Schantz, “The Art and Science of Ultrawideband Antennas”, Artech House, 2005

[2] D.- H. Kwon, “Effect of antenna gain and group delay variations on pulse-preserving capabilities of ultrawideband antennas”, IEEE Trans Antennas Propag, vol.54, no. 8, pp 2208-2215, Aug. 2006

[3] L. Jianxin, C. C. Chiau, C. Xiaodong and C. G. Parini, “Study of a printed circular disc monopole antenna for UWB systems”, IEEE Trans. Antennas Propag., vol. 53, no. 11, pp. 3500-3504, Nov. 2005.

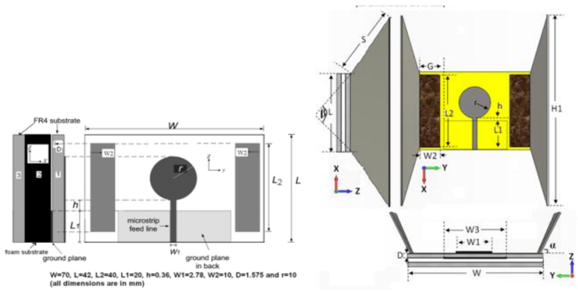


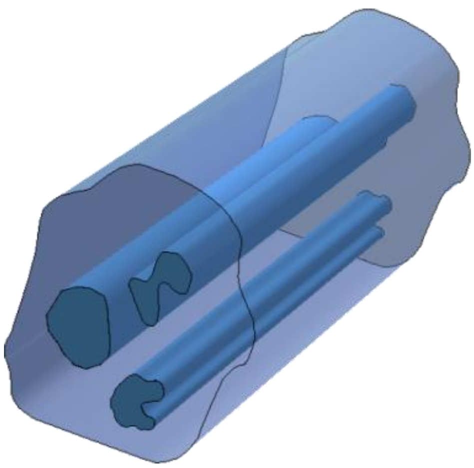
Fig.1. (a) Surface wave enhanced printed circular monopole (b) Surface-mounted short horn antenna

TITLE:	Transmission line of arbitrary cross-section: rigorous approach

AUTHORS:	Galyna Safonova, Elena Vinogradova
AFFILIATION:	Department of Mathematics, Macquarie university
CONTACT DETAILS:	Department of Mathematics, Macquarie university, NSW 2109, Email gsafonov@maths.mq.edu.au

The development of rigorous analytical-numerical techniques that result in stable and rapidly convergent algorithms for accurate solution is obviously desirable for comprehensive studies of electromagnetic wave scattering and propagation. One such approach, the Method of Regularisation, has been developed in electromagnetics to solve diffraction from various classes of scatterers. The key idea behind this semi-analytical, semi-numerical technique is analytical regularisation, based on Abel's integral equation transform, of integral (or series) equations that are initially ill-posed. This provides a stable efficient algorithm and yields the solution with guaranteed accuracy. We extend this technique to obtain rigorous solution to electromagnetic wave propagation along an infinite cylindrical transmission line.

The main aim of this research is to obtain mathematically rigorous solution to the electromagnetic wave propagation along an infinite cylindrical structure represented on the sketch. The structure consists of N metallic cylinders placed inside the outer cylinder with dielectric material between them. All cylinders have cross-sections of arbitrary profile. Electromagnetic theory proves that the main type of wave that propagates in such system is TEM-wave. Mathematically this problem is modelled by a two-dimensional Dirichlet boundary value problem for the Laplace equation in the interior. The solution must satisfy boundary conditions specified by potential values on the metallic surfaces.



This paper focuses on the results obtained for one cylinder placed inside the outer cylinder; both cylinders are of the arbitrary cross-sections. This case captures most of the mathematical difficulties of the problem for N cylinders. The developed algorithm allows the reliable analysis of the dependence of spectral characteristics on the shape of cylindrical profile of a double-wire transmission line. It also represents the benchmark solution to the multiconductor transmission line.

The main challenge of the above non-canonical problems (in which boundaries of the structure do not coincide with coordinate surfaces in classical coordinate systems) is dealing with arbitrary-shaped boundaries. Using a Green's functions method we construct an integral representation of the solution. This is a first kind Fredholm system of integral equations that takes into account the reciprocal influence of the charged metallic structures. We transform it analytically into a second kind system of linear algebraic equations using the Method of Analytical Regularization (MoR).

This infinite system of linear equations can be effectively solved numerically by the truncation method; solution of the truncated system converges to the solution of the initial system. The developed algorithm provides solution with the accuracy that may be pre-specified.

TITLE:	**Potential problem for two surfaces of revolution of arbitrary profile.**
AUTHORS:	**Anton Shafalyuk, Elena Vinogradova**
AFFILIATION:	**Macquarie University**
CONTACT DETAILS:	**ashafaly@maths.mq.edu.au**

A rigorous approach to solving the electrostatic two-body problem for co-axial arbitrary shaped charged conductors is developed.

The potential problem is treated as a classical boundary value problem for the Laplace equation

$$\Delta U(q) = 0 \quad (1)$$

with Dirichlet boundary conditions imposed on electrostatic potential $U(q)$ at the surface of each conductor S_1 and S_2:

$$\begin{cases} U(q) = \Phi_1(q), & q \in S_1 \\ U(q) = \Phi_2(q), & q \in S_2 \end{cases} \quad (2)$$

We use the superposition principle expressing the total potential $U(q)$ as the sum of two potentials $U_1(q)$ and $U_2(q)$ caused by each charged conductor. The potentials $U_i(q)$ $(i = 1,2)$ are represented in the form of the single-layer potentials using the unknown surface charge densities $\sigma_i(p)$:

$$U_i(q) = \frac{1}{4\pi} \iint_{S_i} \frac{\sigma_i(p)}{|q-p|} ds_p \quad (3)$$

After obeying the boundary conditions (2) we arrive at the system of two coupled integral equations of the first kind for the unknown functions $\sigma_i(p)$, that may be solved by one of many numerical techniques. The approach we use regards these equations as only the initial point for further analytical transforms leading to the well-conditioned linear system of the algebraic equations of the second kind. The approach applied is based on the Method of Regularization (*MoR*) described in detail in [1], [2]. Apart from its own significance, the developed solution is an essential step in the obtaining of the rigorous solution to wave scattering problems for geometrically similar objects.

References:

[1] S.S. Vinogradov, P.D. Smith, E.D. Vinogradova, *Canonical Problems in Scattering and Potential Theory. Part 1: Canonical Structures in Potential Theory,* Chapman & Hall/CRC, 2001, -374 p.

[2] S.Panin, et.al. , *Electromagnetics*, 2009.

[3] S.S. Vinogradov, P.D. Smith, E.D. Vinogradova, *Canonical Problems in Scattering and Potential Theory. Part 2: Acoustic and Electromagnetic Diffraction by Canonical Structures,* Chapman & Hall/CRC, 2002, -503 p.

TITLE:	**Rigorous simulation of resonant wave scattering by axially-symmetrical open structures.**
AUTHORS:	**Olena Shafalyuk, Paul Smith**
AFFILIATION:	**Macquarie University**
CONTACT DETAILS:	oshafaly@maths.mq.edu.au

The focus of electromagnetic theory is the solution of initial boundary value problems for Maxwell's equations in time domain and boundary value problems in frequency domain. At this time, most of the results for the open resonant structures have been obtained by frequency domain methods. Although time-domain methods are more universal and can be used for the solution of many applied problems, their implementation involves a number of theoretical difficulties. One of them is the proper and efficient truncation of the computational domain in so-called open problems, i.e. the problems where the computational domain is infinite along one or more spatial coordinates.

We are trying to use time-domain methods for the case of axially-symmetric compact resonators with waveguide feed lines. On fig.1 you can see the cross-section of a model for this problem in the plane $\phi = \pi / 2$ in cylindrical coordinates.

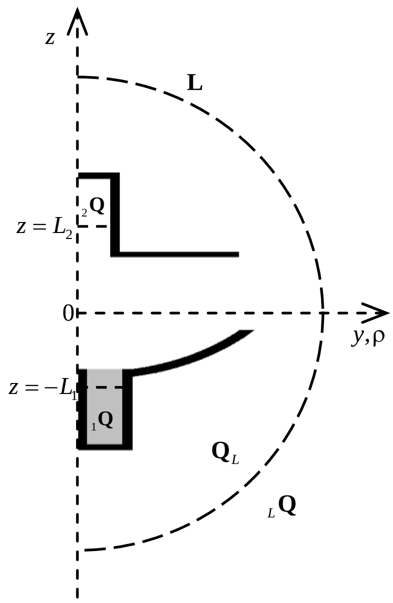


Fig. 1. Geometry of the problem in the plane $\phi = \pi/2$.

In order to solve the described problem, we develop the approach based on the construction of Exact Absorbing Conditions. They allow reducing an open problem to an equivalent closed one with a bounded domain of analysis. After that, the closed problem can be solved numerically with the finite-difference method. In contrast to the approximate solutions based on the Absorbing Boundary Conditions and Perfectly Matched Layers, the described approach avoids the problem of unpredictable behaviour of computational errors for large observation times. This is especially important for resonant problems we are dealing with.

We will formulate the initial boundary-value problem for Maxwell's equations describing the pulsed wave distributions in axially-symmetrical open resonant structures. The exact absorbing conditions for the spherical boundary will be derived. With these conditions involved, we will formulate our initial boundary-value problem in a bounded domain of analysis. We will also show that the modified problem is equivalent to the initial one in open domain.

Along with constructing the solution in a closed domain, we will also show a transport operator allowing one to calculate efficiently the field in the far-field zone of the structure ($_L\mathbf{Q}$) from the field in the near zone ($\mathbf{Q}_L$).

TITLE:	Statistical Analysis of DC and Small Signal-model Parameters in GaAs HEMT

AUTHORS:	Jabra Tarazi , Anthony E. Parker, Peter Vun and Simon J. Mahon
AFFILIATION:	Department of physics and Electronics, Macquarie University 2109 NSW and Mimix broadband
CONTACT DETAILS:	email: jtarazi@ics.mq.edu.au , phone: 02 9850 7413

Some electrical properties of GaAs High Electron Mobility Transistor (HEMT) such as dc characteristics and small-signal model parameters could vary from device to device on different wafer and across the same wafer. This variation is related to many factors such as substrate material variation, variation in epitaxial growth and variation in device processing.

For designers, it's very important to know the nature of these variations and how much they vary from wafer to wafer as well as across the wafer itself as these variations affect the device performance and hence design's specifications. So by knowing the distribution function of every parameter for a device will help the designers to pick the right device on the wafer and also will help them to know the margin of tolerance they have for their designs.

Different semiconductor manufacturers and foundries may provide some DC and RF statistical information about a process taken from measuring some samples on the wafer, but they don't provide full information about every device on the wafer as they can't measure every device on the wafer they provide. Also, they don't provide correlations between a parameter and another, for example, the correlation between the breakdown voltage and the pinch off voltage.

In this paper, a full DC and a small-signal model statistical analysis and correlations between different parameters will be presented, where 800 samples of a 50um wide gate finger pair in the WIN low-noise 0.15um e-beam process (PL15-10) on four different quarter wafers were measured and analysed. Two of these quarters are BCB coated and the other two are with no BCB. All of the four quarters were measured with the same measurement setup except two different calibrations were used for the BCB and the non-BCB wafers. It is shown that the DC characteristics such as breakdown and pinch-off voltages vary significantly from wafer to another as well as on the same wafer. Moreover, RF small-signal model parameters have been extracted and are presented here.

Gate-drain Breakdown of a HEMT is defined by manufacturers as the voltage between the gate and drain when the gate current reaches some threshold value at some constant drain voltage. In this paper we will show the variation in breakdown voltages and we will discuss the correlation between the breakdown voltage and the pinch off voltage and other parameters as these correlations are not considered by manufacturers.

TITLE:	What will solar cycle 24 be like?
AUTHORS:	Phil Wilkinson
AFFILIATION:	IPS Radio and Space Services, Bureau of Meteorology
CONTACT DETAILS:	P O Box 1386, Haymarket, NSW 1240, email: phil@ips.gov.au, Telephone: (02) 9213 8001

The current solar minimum has persisted longer than for any solar cycle observed over the last fifty years, making this the longest solar minimum of the space age. Comparing this solar minimum period with previous solar minima of earlier solar cycles suggests solar cycle 24 could be the lowest solar cycle of the space age.

So what will solar cycle 24 be like?

A low solar cycle means there would be a low number of sunspots observed at solar maximum compared with the last five or six solar cycles and, as a consequence, lower solar fluxes are expected leading to less ionisation in the ionosphere and a cooler thermosphere. These conditions are advantageous for the space industry, potentially reducing wear-and-tear on space-based assets. Conversely, High Frequency (HF) radio systems, which depend on the ionosphere for their operation, could be adversely affected by the reduced available bandwidth of available frequencies. However, a low solar cycle does not necessarily mean there will be less intense geo-effective solar disturbances or even less solar disturbances in number. These competing influences will define the forthcoming solar cycle 24.

This paper will speculate on the nature of the forthcoming solar cycle 24 and what we might expect it to be like. Of course, given the number of solar cycles observed so far (23), these prognostications may eventually turn out to be the product of a small sample, statistical extrapolation.

WARS 2010 ABSTRACTS

3rd Poster Session – 2.00 – 3.30 pm – Friday 12 February 2010

TITLE: A Cryogenically Cooled 16-26GHz Receiver System for the Parkes Radio Telescope

AUTHORS: M. Bowen[(1)], P. Doherty[(2)], A. Dunning[(3)], H. Kanoniuk[(4)], G. Moorey[(5)], L. Reilly[(6)] and P. Sykes[(7)]
AFFILIATION: Australia Telescope National Facility, CSIRO Astronomy and Space Science.
CONTACT DETAILS: [(1)]P.O. Box 76, Epping 1710, NSW, Australia, Email: Mark.Bowen@csiro.au
[(2)]As (1) above, but Email: Paul.Doherty@csiro.au
[(3)]As (1) above, but Email: Alex.Dunning@csiro.au
[(4)]As (1) above, but Email: Henry.Kanoniuk@csiro.au
[(5)]As (1) above, but Email: gjmoorey@ar.com.au
[(6)]As (1) above, but Email: Lesley.Reilly@csiro.au
[(7)]As (1) above, but Email: pbsykes@ozemail.com.au

A cryogenically cooled millimetre-wave receiver system covering the frequency range 16 to 26 GHz was recently installed on the Parkes Radio Telescope. The Parkes Radio Telescope is a 64 metre diameter prime focus antenna operated by CSIRO Astronomy and Space Science as part of the Australia Telescope National Facility. The receiver system operates either with dual linear polarisation over the full 16 to 26 GHz frequency range or with circular polarisation over a narrower band in the range 21.6 to 22.1 GHz.

The receiver package consists of a number of systems. The Radio Frequency (RF) low noise system includes the vacuum dewar and the low noise RF components required to obtain dual orthogonal linear polarisation over the 16-26 GHz band. Circular polarisation in the 21.6 to 22.1 GHz band is generated using a quarter wave plate in the input waveguide external to the vacuum dewar. The critical components of this RF low noise system, the Ortho Mode Transducer (OMT) and Low Noise Amplifiers (LNAs) are cooled to less than 15 Kelvin by a closed cycle helium refrigeration system. The wide band OMT was designed by CSIRO and consists of two orthogonal, stepped, double ridged waveguide sections. The cryogenic LNAs are 3-stage, InP HEMT, Monolithic Microwave Integrated Circuits (MMIC) designed and packaged by CSIRO. To ensure optimal performance of each amplifier the LNA bias voltages and currents can be individually set for each amplifier stage.

After amplification in the RF low noise system, the conversion and Local Oscillator (LO) system converts signals in the 16 to 26 GHz RF band down to an Intermediate Frequency (IF) of 4 to 6 GHz which is compatible with the existing Parkes telescope back end systems. The system consists of two dual polarisation conversion chains. Each pair of conversion chains can be independently tuned to place the 2 GHz wide IF output channels anywhere within the 16 to 26 GHz RF frequency range. To maximise the image rejection and ensure full coverage of the band, the conversion is implemented using a dual down conversion with a fixed second LO frequency. The first LO is tuneable between 28 and 36 GHz and is generated by multiplying a reference signal in the range 3.5 to 4.5 GHz by a factor of eight.

The receiver system also includes control and monitor electronics that provide comprehensive local and remote monitoring of all the important parameters including: temperatures, vacuum, helium pressures and LNA bias parameters. In addition, RF detectors throughout the signal path allow monitoring of reference signal and local oscillator levels.

The receiver system will be described in detail and the receiver system performance will be discussed. Some preliminary astronomical results will also be presented.

TITLE:	Academy of Science endorses the Decadal Plan for Australian Space Science
AUTHORS:	Iver Cairns and the Steering Committee for the Decadal Plan
AFFILIATION:	University of Sydney
CONTACT DETAILS:	cairns@physics.usyd.edu.au

The Academy of Science has just endorsed the "Decadal Plan for Australian Space Science: 2010-2019", prepared under the aegis of the Academy's National Committee for Space Science. Some of you will remember the invitation at WARS 2006 to participate in the Plan process. Some of you will have participated. This presentation briefly reviews the major items of the Plan, many of which are of strong interest to the radio science community. These include digital radars, space weather prediction and mitigation, and Flagship Projects such as SpaceShip Australis (a ground-based network to space weather events from the Sun and space to Earth), the Marabibi Constellation of near-Earth satellites (space weather, Earth observations, and space technology), CASSS Pty Ltd (Coordination of Australian Space Science), and a National Institute for Space Science.

TITLE: Multi-dimensional radar networks for urban terrain imaging	
AUTHORS: Shital Desai, Dr. Graham Brooker	
AFFILIATION: Australian Centre for Field Robotics, J04 Rose Street Building, The University of Sydney, NSW 2006	
CONTACT DETAILS: s.desai@acfr.usyd.edu.au, gbrooker@acfr.usyd.edu.au	

The Australian Centre for Field Robotics (ACFR) has built numerous Millimetre Wave (77 GHz and 94 GHz) 3-D Monostatic radars for autonomous ground (AGV) and aerial (UAV) vehicles. These radars have their limitations in terms of target detection and localisation when used in urban environments such as Sydney harbour. At the same time, autonomous vehicles are increasingly used for applications such as urban surveillance. Urban terrain is characterized by targets of differing geometries and material compositions. The roughness on the target decides whether the energy is backscattered, scattered in all directions or specularly scattered. In monostatic radar mounted aboard the UAV platform, the target is detected only if the energy is backscattered back to the radar. Returns from trees are unpredictable as some penetration occurs even in the millimeter-wave band depending on the foliage density. Man-made structures such as buildings, ships, poles and other vehicles are often present which further adds complexity to the urban terrain imaging problem. Specular reflection of radar signals from the ground can have a number of effects on target detection probability, radar image quality and tracking accuracy. Trees and tall buildings also act as sources of multipath and result in an incorrect estimation of target position. Multipath sources cannot be predicted easily as their distribution changes with the changes in the environment and the radar position. Radar measures time delay and thus the slant range, a scatterer elevated in height, its echo will be indistinguishable from that of a scatterer located on the ground plane at the range where the planar wavefront impacting the elevated scatterer also strikes the ground plane. The imaging of the elevated scatterer at an incorrect range coordinate is termed either layover or foreshortening, depending on the terrain slope and grazing angle and the resultant effect on the image. Layover is particularly evident when imaging vertical walls, such as sides of buildings in urban areas, where the radar is always above the normal to the wall surface. Urban terrain thus presents a challenging task of target detection and localization. *This paper proposes introducing 4th dimension to the imaging system in the form of spatial dimension.* If a ground terrain is observed from different angles at the *same time*, the information derived from the fused data offer improved target detection and resolution and thus improved image resolution. In Radar literature, this configuration is referred to as *Multistatic Radars or Radar Networks* or *Netted Radars*. Since radar signals received at each receiver site differ in their response to multipath, absence of fused target detections between or among receivers can provide an effective means of identifying multipath produced false targets seen by the primary monostatic radar. An advantage of netted radar is the ability to optimize the coverage area. Owing to the use of multiple transmitting and receiving stations, the geometry of the netted radar can be tailored to meet the needs of specific requirements. Combined with suitable data fusion algorithms, extension of the coverage area in a given direction is achievable. Another advantage is the increase of system sensitivity. Due to the additional use of radar transmitters, the received signal power will be augmented, leading to an increase in overall signal to noise ratio (SNR), and consequently system sensitivity. In netted radar cases, the target is observed from multiple perspectives rather than from a single direction. This makes better use of the scattered energy. Target classification and recognition can be improved due to the more information retrieved from different perspectives.

This paper will present the proposed Netted Radar System architecture, synchronisation of the Radar nodes and Bistatic, Monostatic and Netted RCS analysis of some urban targets.

TITLE: **ON THE USE OF PHASED-ARRAY FEEDS AT THE PRIME-FOCUS OF OFFSET DUAL-REFLECTOR ANTENNAS FOR THE SKA**	
AUTHORS: **S.G. Hay (1), C. Granet (2), J.S. Kot (2), D. DeBoer (3)**	
AFFILIATION: **(1) CSIRO ICT Centre, (2) BAE Systems Australia Ltd, (3) CSIRO Australia Telescope National Facility**	
CONTACT DETAILS: **Christophe.Granet@baesystems.com**	

There is currently significant international research and development effort into antenna technology for the Square Kilometre Array (SKA), covering the SKA frequency range of 300 MHz to 10 GHz [1]. Wide instantaneous field of view (FoV) is a highly desirable capability for the SKA antenna system, as it increases survey speed and provides unique possibilities for scientific discovery.

One approach to wide FoV currently being pursued by various research institutions, particularly in the 0.7-1.8 GHz frequency range, is the use of reflector antennas with phased-array feeds (PAF) [2, 3, 4, 5]. This approach combines the benefits of the collecting area of a reflector antenna with the wide FoV capability of a phased array. The PAF approach gives complete sampling of the FoV with highly sensitive and stable beams, formed by digitizing and linearly combining the individual array-element signals. This requires the spacing of the array elements to be less than half the minimum wavelength, distinguishing the approach from current multi-beam focal-plane systems. Beam stability is important for high dynamic range and requires close calibration of the element responses.

Australia is currently deploying a significant wide FoV SKA pathfinder instrument, ASKAP [5], comprising 36 symmetrical 12m-diameter reflector antennas equipped with a PAF developed by the CSIRO at the prime focus. The antennas employ a third axis whereby the entire reflector structure rotates over the course of an astronomical observation.

The international SKA community is developing offset dual-reflector antennas equipped with wide-band single-pixel feeds designed to operate to the top of the SKA frequency band. The single-pixel feed is located at the secondary focus of the antenna system and offers the advantages of wide frequency operation, but has no wide FoV capability.

In this paper we report on the results of a theoretical modelling study where the CSIRO-developed PAF technology is combined with some of the current proposals for dual offset reflector systems being investigated by the SKA community. The performance of a number of these systems with the CSIRO PAF at the prime-focus has been assessed, and the performance of the different systems compared. The results of the present study show that high aperture efficiency and wide FoV can be obtained by using a PAF at the prime-focus of a dual-reflector system.

[1] URL http://www.skatelescope.org

[2] M.V. Ivashina, O.A. Lupikov, R. Maaskant, W.A. van Cappellen, L. Bakker and T. Oosterloo, “Off-axis Beam Performance of Focal Plane Arrays for the Westerbork Synthesis Radio Telescope – Initial Results of a Prototype System”, IEEE Intl. Symp. Ant. Prop., 2009.

[3] B Veidt, T. Burgess, R. Messing, G. Hovey and R. Smegal, “The DRAO Phased Array Feed Demonstrator”, 13th Int. Symp. Ant. Tech. Appl. Electromag. Canadian Radio Sci. Meeting, 2009.

[4] K.F. Warnick, B.D. Jeffs, J. Landon, J. Waldron, D. Jones, R.J. Fisher and R. Norrod, “Phased Array Antenna Design and Characterization for Next-Generation Radio Telescopes”, IEEE Int. Workshop on Antenna Technology, March 2009.

[5] D. DeBoer et al., “Australian SKA Pathfinder: High-Dynamic Range Wide-Field of View Survey Telescope Array”, Proc. IEEE Aug., 2009.

TITLE:	Optimised Dielectric Rod Antennas
AUTHORS:	Stephen Hanham, Trevor Bird, Andrew Hellicar and Robert Minasian
AFFILIATION:	University of Sydney and CSIRO ICT Centre
CONTACT DETAILS:	stephen.hanham@csiro.au

Dielectric rod antennas use an open dielectric waveguide which is traditionally linearly tapered to transform the guided surface-wave into a free-space wave that radiates in a forward direction. Despite being first studied in the 1940s by Mueller *et al* [1] and Mallach [2] their use in the microwave regime has been limited. In the millimetre-wave and terahertz frequency ranges; however, they offer several advantages such as convenience of fabrication, potential for integration and lower loss. In addition, the small cross-sectional area of the rods makes them suitable for use in closely spaced antenna arrays.

Here we consider non-linear profiled dielectric rod antennas that are designed for a specific radiation pattern objective and improved performance over traditional tapers. A body of rotation method of moments technique (BoR-MoM) is used to rapidly analyse arbitrarily profiled dielectric rods and a genetic algorithm is used to perform the optimisation. As examples we will present rods optimised for maximum gain and low sidelobes. Measured results will be presented for several optimised rods, which compare well with calculated radiation patterns.

Fig. 1a shows one of the dielectric rods that was designed for maximum boresight gain. It can be seen from Fig. 1c that the optimised oscillatory profile leads to a complex radiation behaviour. The resulting radiation pattern is given in Fig. 1b and demonstrates a gain of 13 dBi for a 2λ long rod. This compares with a gain of 10 dBi for a rod with a linear taper.

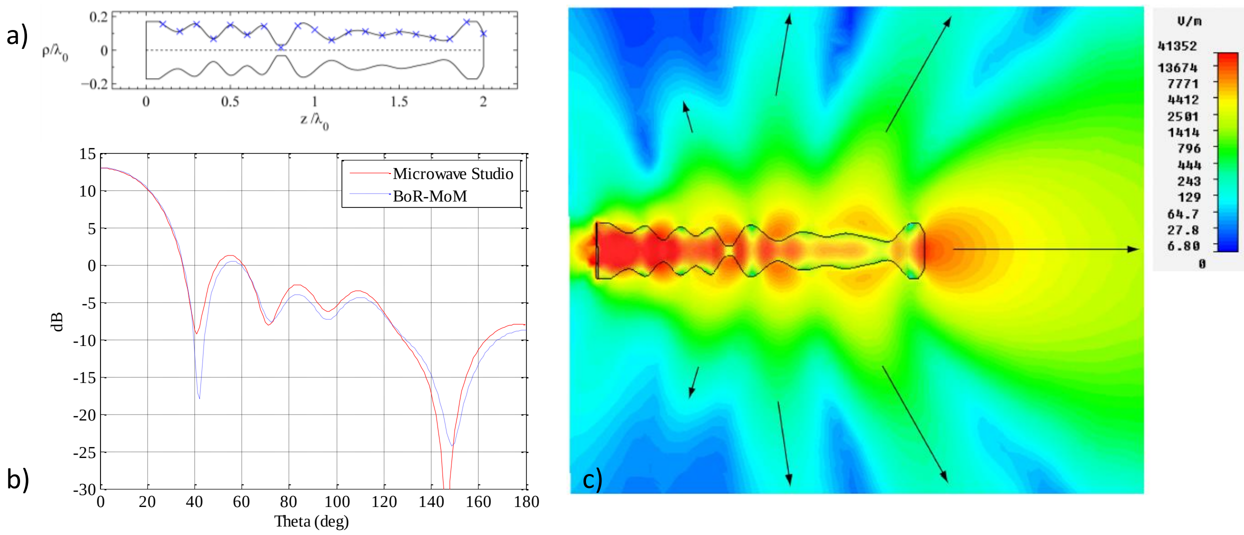


Figure 1: a) Profile of gain optimised dielectric rod antenna b) Simulated E-plane radiation pattern c) Electric field pattern when the antenna is radiating.

References

[1] G. Mueller and W. Tyrrell, "Polyrod antennas," Bell Syst. Tech. J, vol. 26, pp. 837-851, Oct. 1947.

[2] P. Mallach, "Diëlektrische richtstrahler," Fernmelde - technische zeitschrift, vol. 2, pp. 33-39, Feb. 1949.

TITLE:	On the Effects of Positive and Negative Cloud-to-Ground and Intra-Cloud Lightning on the F-region Ionosphere

AUTHORS: V. V. Kumar[1], M. L. Parkinson[2], P. L. Dyson[1], S. Prendergast[3], G. B. Burns[4]
AFFILIATION: [1]Department of Physics, La Trobe University, Bundoora, Victoria, 3086, Australia
[2]Bureau of Meteorology, IPS Radio and Space Services, Haymarket, NSW 1240, Australia
[3]Kattron Lightning Detection Network, Chittaway Bay, NSW 2261, Australia
[4]Australian Antarctic Division, Australian Government, Kingston 7050, Australia
CONTACT DETAILS: Dr. Murray L. Parkinson m.parkinson@bom.gov.au

Thunderstorms and other severe weather events are thought to be a major source of atmospheric gravity waves (AGWs) which propagate to great heights and affect the motion and density of plasma in the F–region ionosphere. Intense quasi-DC electric fields penetrate to great heights above thunderstorms and lightning emits a broad spectrum of electromagnetic radiation from VLF to X-ray frequencies which may also affect the ionosphere and magnetosphere. Sprites are cloud-to-ionosphere lightning known to occur in association with intense positive cloud-to-ground (+CG) lightning strikes. This paper investigates possible relationships between lightning polarity and the motion of F-region plasma during the passage of thunderstorms. The Australian Kattron lightning detection network measures the location, time, peak current, and polarity of return strokes throughout South East Australia. These lightning strokes were used as the control times for a superimposed epoch analysis (SEA) of ionospheric drift velocity measured by a digital ionosonde located at the mid-latitude station Bundoora, Melbourne (145.1°E, 37.7°S geographic). The Kattron lightning events were separated into four geographical quadrants and the three main lightning types, namely intra-cloud (IC) lightning defined by return stroke peak absolute currents = 0 kA, large negative cloud-to-ground (–CG) strokes with currents <−17.5 kA, and large +CG strokes with currents >17.5 kA. The effects of each lightning type on the F-region was determined by using these 12 subsets as the SEA controls (*t*=0). Both rapid (± 2 mins of each stroke) and slow (± 48 hrs of each stroke) F-region SEA analyses showed the largest downward perturbation in F-region vertical drifts (V_z) of up to –8 m s^{-1} were associated with +CGs occurring to the west of the station on the afternoon before thunderstorms arrived. Other important features were electrostatic-like responses in drift direction (A_z) associated with lightning located toward the west, and an approximately 20% drop in F-region velocity counts on the day of lightning. The results can be explained by the prevailing westward thermospheric wind directionally filtering the thunderstorm-generated AGWs which subsequently gave rise to medium-scale traveling ionospheric disturbances (MSTIDs). However, since there was a greater proportion of intense +CGs towards the west of Bundoora, the ionospheric perturbations might have been associated with sprites and elves.

TITLE: Low Profile Lens Antenna for SOTM Applications
AUTHORS: Nasiha Nikolic, Graeme James, Kieran Greene, Andrew Weily, Steve Barker and Y. Jay Guo
AFFILIATION: CSIRO, ICT Centre, PO Box 76, Epping NSW 1710, Australia
CONTACT DETAILS: (02)9372 4524, Nasiha.Nikolic@csiro.au, Andrew.Weily@csiro.au, Graeme.James@csiro.au, Kieran.Greene@csiro.au, Steve.Barker@csiro.au, Jay.Guo@csiro.au

Mobile satellite communication systems suitable for mounting on moving vehicles are increasingly in demand. There are already a number of these so-called satellite-on-the-move (SOTM) systems on the market and a number of others are reported in the literature. That not one of these systems is clearly technologically superior is evidence of the demanding, and at times conflicting, requirements of SOTM systems. They must combine the performance generally expected from a VSAT-type fixed-service satellite communication antenna with the ability to retain satellite acquisition rapidly in all directions. Being mounted on a moving vehicle they need to be rugged, reliable and of low profile.

Current SOTM systems fall broadly into the following groups: planar arrays, reflectors and systems where lens antennas, in particular, the hemispherical Luneburg lens, are the basis of the design. A single hemispherical Luneburg lens, shown in Figure 1, or an array of hemispherical lenses placed on a ground has a distinct advantage compared to the other candidates since it satisfies low-profile requirements and the beam may be mechanically scanned over a wide angular range with relatively constant antenna gain [1].

The aim of our work was to optimize the lens parameters (radius and dielectric permittivity of each layer, shown in Figure 2) to achieve low profile, high gain and satisfy regulatory sidelobe envelopes at Ku-band. The spherical wave expansion (SWE) method, the Genetic Algorithm and software package CST MWS [3] were used for accurate representation of the feed horn radiation pattern and optimization of the lens-feed system [2]. The results of our work show that an optimized four layer hemispherical Luneburg lens can provide a low profile solution for a Ku-band SOTM system, which balances fabrication complexity with aperture efficiency and side lobe level.

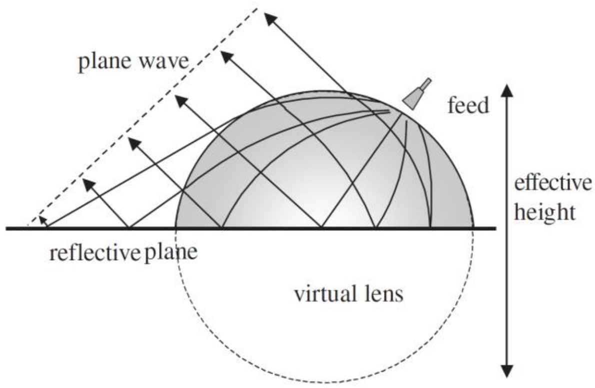


Fig. 1: Low profile hemispherical Luneburg lens

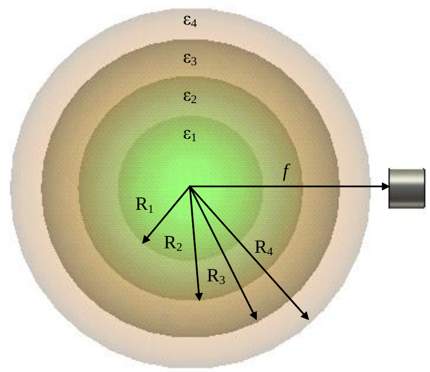


Fig. 2: Luneburg lens with four discrete shells

References:

[1] M. Rayner, "Use of the Luneburg lens for low profile applications", Datron/Transco Inc., Microwave Product Digest, pp. 1-13, Dec 1999.

[2] N. Nikolic and J.S. Kot, "Optimization of Luneburg lens fed by a corrugated horn antenna", WARS Conference 2006.

[3] CST Microwave Studio, (www.cst.com).

TITLE:	Broadband microwave based diagnostics and treatment
AUTHORS:	Mikael Persson, Andreas Fhager, Hana Dobsicek Trefná, Xuezhi Zeng
AFFILIATION:	Chalmers University of Technology
CONTACT DETAILS:	SE41296 Göteborg, Sweden

An efficient 3D microwave tomography system based on wide band antennas and detailed modelling using the finite difference time domain methods is presented together with a microwave system design study and a novel microwave hyperthermia cancer treatment system based on a time reversal algorithms.

In recent years microwave imaging has attracted increasing interest within the research community. A number of potentially useful applications have been identified in areas as diverse as biomedical imaging, ground surface mapping, detection of buried objects, non-destructive testing of materials and the detection of defects and cracks in construction materials. The development has accelerated with the increase in computational power and algorithm improvements during. For imaging of high contrast objects it is necessary to use iterative, non-linear reconstruction algorithms. The operational bandwidth of microwave tomography systems ranges from several hundreds megahertz to several gigahertz depending on the particular application. The ultra wideband (UWB) measurement can be performed in the frequency domain with a network analyzer [5]. However, this measurement strategy is relatively slow due to the switching required between different antennas pairs of an antenna array. In addition, the size and high cost of network analyzer are also limiting factors for many commercial applications. We are therefore considering developing a dedicated time domain system for microwave tomography.

During the last decade clinical studies have demonstrated the ability of microwave hyperthermia to dramatically enhance the response to radiation therapy and chemotherapy leading to increased cancer patient survival. One of the challenges of hyperthermia is to adequately heat deep-seated tumors while preventing surrounding healthy tissue from undesired heating and damage. We here present at system that attempts to resolve this challenge.

TITLE: Chipless RFID Tag for Banknote Tagging Applications

AUTHORS: Stevan Preradovic and Nemai Karmakar
AFFILIATION: Monash University, Melbourne
CONTACT DETAILS: Stevan.Preradovic@ieee.org

I. Introduction A printable chipless RFID tag has been designed in order to reduce the cost of the entire RFID system. This article reports a chipless RFID tag printed on flexible laminate. The final application of the chipless RFID tag is for Australian banknote tagging. The tag has been developed by the authors at Monas University with the support from the ARC, Securency Pty. Ltd (*www.securency.com.au*) and Satnet Pty. Ltd.

II. Design The proof-of-concept tag and 35-bit tag on PCB were reported by the authors in [1] and [2]. The third generation tag is a fully printable 23-bit chipless RFID tag designed on 90-µm thin Taconic TF290 (ε_r=2.9, h=90µm, tanδ=0.0028) laminate using CPW and is presented in Fig. 1. CPW provides superior spiral resonator performance on thinner substrates than microstrip due to the conductor losses. The chipless tag consists of two cross-polarized ultra-wide band antennas and a multiresonating (23 cascaded spiral rsonators) circuit. The data encoding is performed in the multiresonating circuit which is comprised of multiple stopband spiral resonators. Each resonator has a specific resonant frequency which has a 1:1 correspondence with a data bit (*n* resonators = *n* bits). These resonances are recognized as logic '0' at the reader end, while their absence is logic '1'. Data encoding is done using "spiral shorting" as shown in Fig. 2. Spiral shorting shifts the resonances of the spiral outside the band of interest, enables minimum layout modifications for data encoding and provides negligible frequency shifts of the other resonances [1]. The cross-polarized antennas maximize isolation between the interrogation signal and the encoded tag signal as shown in Fig. 3.

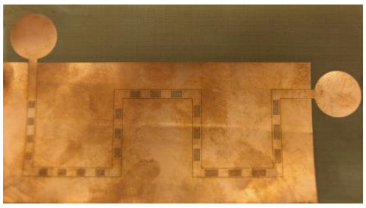


Fig. 1 Photo of 23-bit chipless RFID tag.

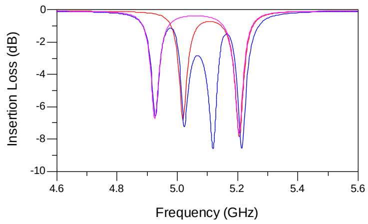


Fig. 2 Example of 4-bit spiral shorting encoding.

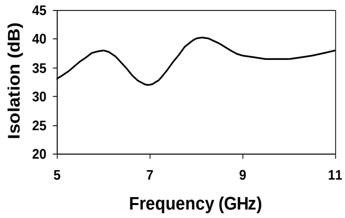


Fig. 3 Measured isolation between tag antennas

III. Chipless Tag Interrogation The experimental setup (Fig. 4) for confirming the successful operation of the designed tag was composed of the chipless tag, Agilent's performance network analyzer (PNA) E8361A as the reader and two horn antennas as the reader antennas. The experiment was conducted in the Monash anechoic chamber in order to validate the successful encoding of the tag and its detection at the reader end using the network analyzer. The chipless tag and the reader antennas were mounted on plastic stands and placed into the anechoic chamber. As the horn antennas covered the frequency range from 6.9 -11.5 GHz the tag was interrogated starting from 7 GHz. This resulted in reading 13 bits of the entire 23-bit data encoded by the tag. This was enough to prove the successful operation of the tag. Figs 5 and 6 show the normalized magnitude and phase of two different tag spectral signatures. The presence of frequency shift is due to the chemical etching tolerances (±18 µm) during tag manufacturing. For printing on the tag on the banknote much higher resolution and finer tolerances are possible using gravure or offset printing (up to 2400dpi). The spectral signatures of the two tags was normalized using the readings of a chipless tag with no resonances (all spirals shorted) recorded previously. From Figs 5 and 6 it is clear that Tag 1 has all 13 resonances present while Tag2 has 4 resonances. This confirms the successful detection and encoding capabilities of the tag

Fig.4 Experimental set up of chipless tag in anechoic chamber

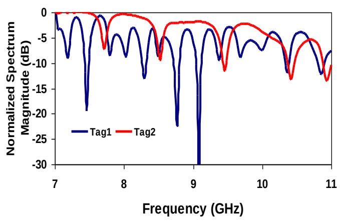


Fig. 5 Normalized magnitude of received chipless tag spectral signatures.

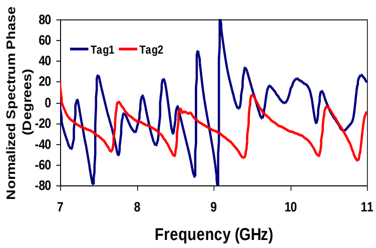


Fig. 6 Normalized phase of received chipless tag spectral signatures

IV. Conclusions In this paper we have presented a novel fully printable chipless CPW RFID tag which can be used for tracking low-cost items such as banknotes, envelopes and other paper/plastic based items. The chipless RFID tag encodes data using spectral signature. The spectral signature data is created by spiral resonators designed in the tag instead of a silicon microchip. This feature significantly decreases the price of the tag and increases its robustness without losing the functionality of data encoding.

V. References

[1] S. Preradovic, I. Balbin, N. C. Karmakar, G. F. Swiegers, "Multiresonator-based chipless RFID system for low-cost item tracking", *IEEE Transactions on Microwave Theory and Techniques*, vol. 57, no. 5, pp: 1411-1419, May 2009.

[2] S. Preradovic, N. Karmakar, "Design of fully printable planar chipless RFID transponder with 35-bit data capacity", *39th European Microwave Week*, pp:13-16, Rome, Italy, September 2009.

TITLE:	**Near and Far Field HF antenna modelling for Naval applications**
AUTHORS:	**Reuben Shar, Paul Axon**
AFFILIATION:	**Thales Australia**
CONTACT DETAILS:	reuben.shar@thalesgroup.com.au, paul.axon@thalesgroup.com.au

The reliable integration of communication system elements which use the RF spectrum into modern naval platforms is supported by electromagnetic simulation tools and system engineering methodology. The platform geometry and ambient environment are applied to the HF antenna simulation to ensure safety, compatibility with other subsystems and to optimise the system performance. This paper provides an overview of the numerical electromagnetic simulations and analysis used by the authors and more widely by the Defence industry to support integration of RF elements onto naval platforms.

It illustrates use of a combination of off-the-shelf simulation tools, specially developed software, systems engineering (SE) and radio frequency (RF) engineering skills to guide the integrated design and to optimise the attained performance.

Field strength predictions for near-fields and far-fields are related to the standards for Radiation Hazard Safety (RADHAZ) and to EM compatibility and inter-operability for system integration of advanced systems which are increasingly using commercial off the shelf (COTS) subsystems.

TITLE: **Wideband responses of highly resonant scatterers: regularisation methods**
AUTHORS: **Paul D Smith**
AFFILIATION: **Macquarie University**
CONTACT DETAILS: **Department of Mathematics, Sydney 2109. Email: pdsmith@maths.mq.edu.au**

Numerical techniques for electromagnetic wave scattering from structures at low to intermediate frequencies are usually based on either Maxwell's equations or an equivalent integral equation formulation. Structures incorporating cavities and sharp edges often display strong resonances across this frequency band and often encounter difficulties of accuracy and convergence especially as the size (in wavelengths) increases. Despite progress in numerical modelling techniques, and the availability of powerful computing resources, good computational accuracy is often not achieved, because convergence of solutions computed with increasingly refined grids is not normally guaranteed. As most customary approaches rely on the numerical solution of a first kind Fredholm integral equation, the intrinsic difficulty of which is its ill-posedness, standard computational schemes (e.g. Method of Moments) are not stable and convergence is questionable.

One option is to transform this type of equation into a second kind Fredholm equation for which stable and fast converging computational algorithms can be readily devised, and enable us to reach a specified accuracy. This paper surveys recent progress in techniques that address these difficulties for a variety of structures, some canonical and some of more general shape. Fundamentally a process of analytical regularisation is used to transform the basic equations to a second kind Fredholm matrix equation. For cavities of spherical and other canonical shapes [1], the main tool exploited is the Abel integral transform applied to dual series equations (derived from spherical harmonic expansions) involving trigonometric. The transformed equations are well-conditioned (in contrast to the original formulation derived from Maxwell's equations); standard numerical techniques are easily applicable and scattered field results may be computed reliably and accurately.

This approach has been adapted to the study of two-dimensional scattering and propagation problems, including arbitrarily shaped (non-symmetric) cavity structures and shielded microstrip structures, particularly to determine the propagation constant of higher order modes. It has also been extended to cavity structures that are axisymmetric [2], and provides a rigorous analysis of diffraction from an arbitrarily shaped open shell of revolution under excitation by an axially located vertical electric dipole or scalar wave illumination. It relies on decomposing the kernel in the integral equation formulation into a singular part, which may be analytically inverted by exploiting the solution for the canonical problem of the punctured sphere, and a smooth remainder. A large number of physically interesting solutions are of this nature.

Stable time domain responses of such cavity structures are difficult to compute by direct methods applied to integral equation formulations. However the wideband stability of the transformed second kind equations provides an accurate means of computing the transient response [3]. The Singularity Expansion Method shows that the long term response of a cavity structure such as the punctured sphere can be expressed as a sum of decaying exponential terms whose Laplace transform is a meromorphic function with poles in the left half plane. An open question, of importance in devising target identification algorithms based upon time domain responses, concerns the order of the poles. For the punctured sphere with small aperture, the structure of the regularized equations allows us to deduce that the poles are simple (order one).

References.

[1] S.S. Vinogradov, P.D. Smith & E.D. Vinogradova, *Canonical Problems in Scattering and Potential Theory, Part II: Acoustic and Electromagnetic Diffraction by Canonical Structures*, Chapman and Hall/CRC Press (2002).

[2] S.B. Panin, P.D. Smith, E.D. Vinogradova, Y.A. Tuchin & S.S. Vinogradov, Diffraction from arbitrary shaped bodies of revolution: Analytical regularization, *Journal of Engineering Mathematics*, DOI:10.1007/s10665-009-9276-0 (2009).

[3] S.M. Booker, P.D. Smith, S.S. Vinogradov & E.D. Vinogradova, Benchmark problems for transient and ultrawideband scattering by metallic targets, *Electromagnetics*, 23 (2) (2003).

TITLE: Resonant Response of Strip Grating on Ferromagnetic Half-Space	

AUTHORS: E.D. Vinogradova [1], A.V. Brovenko [2] P.N. Melejik [2], A.E. Poedinchuk [2], A.S. Troshilo [2]

AFFILIATION: [1] *Department of Mathematics, Macquarie University, Sydney, NSW 2109, Australia*

[2] *Radiophysics & Electronics Institute of National Academy of Science, 12, Proscury Str., Kharkov, Ukraine*

CONTACT DETAILS: evinogra@maths.mq.edu.au

Nowadays the effects arising under propagation, diffraction and radiation of the electromagnetic waves in the presence of different medium interfaces, such as ferromagnetic materials, chiral composites, meta-materials, etc., is the focus of intensive investigations. On the one hand it is caused by development of technology for synthesis of new artificial materials which reveal unusual electromagnetic properties. On the other hand these investigations are motivated by the design requirement for structures to reflect or absorb electromagnetic waves more efficiently than existing devices. Furthermore, it is highly desirable to have such structures with so-called “guided” scattering properties. It has been shown that embedding of a periodic strip structure at the interface of above-mentioned materials gives raise to some specific resonance phenomena.

In this paper, the problem of diffraction of electromagnetic plane waves from a PEC strip grating is solved when the grating lies at the half-space interface between a lossy ferromagnetic medium and free space. Our concern is development of the method of analytical regularization for those dual series equations which describe the general class of diffraction problems concerning travelling monochromatic plane waves striking the strip gratings placed at interfaces of gyro-magnetic media. Furthermore, we conduct numerical calculations to study the specific interaction process between the incident plane wave and ferromagnetic medium which is under external steady magnetic field with the strip grating embedded at the ferromagnetic interface. Our methods are built upon the techniques described in [1-3].

References

[1] V.P Shestopalov, Yu. A. Tuchkin, and Yu. A. Poedinchuk, *New methods of solving direct and inverse diffraction problems*. Osnova, Kharkhiv, Ukraine, 1997 (285pp).

[2] A.V. Brovenko, P. N. Melezhik, and A.Ye. Poyedinchuk, “The H-polarized wave diffraction by a partially screened cylinder with magnetic active plasma properties: The analytical regularization procedure”. *Symposium Proceedings of the Fourth International Kharkov Symposium* “Physics and Engineering of Millimeter and Sub-Millimeter Waves”, Kharkov, Ukraine, June 4-9, 2001, p. 211-213.

[3] A.V. Brovenko, P. N. Melezhik, and A.Ye. Poyedinchuk, “The plane H-polarized wave diffraction by a metal grating with a magnetoactive plasma”. *Conference Proceedings 2002 International Conference on Mathematical Methods in Electromagnetic Theory*, p. 573-575.

Alphabetical List of Presenting Authors

WARS 2010 has been organised with the support of the University of South Australia

University of
South Australia