WARS2006

Leura 15 - 17 February 2006

Workshop on the Applications of Radio Science

CONFERENCE

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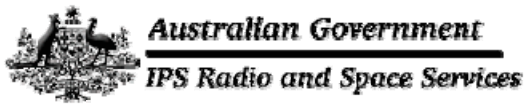

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WARS2006 is the sixth in a series of conferences of national significance organised by the National Committee for Radio Science. It brings together Australian and International scientists and engineers conducting research in areas relevant to the various Commissions of URSI (Union Radio Science International) with which Australia is affiliated through the work of the National Committee for Radio Science. Through the invited speakers program, Australian scientists of international standing review a number of new developments in international radio science in which Australia is a leading player. Submitted papers provided an opportunity for Australian scientists and postgraduate students to present their work to their national peers and in particular, to provide an important opportunity for cross-fertilisation of ideas between the wide range of sub-areas that make up radio science in Australia and internationally.

Each Research paper was reviewed by independent reviewers. Authors were required to respond to reviewer comments and papers undergoing major revision were sent to referees a second time. Reviewers were issued with guidelines and criteria for publication consistent with those issued by several international journals, premier in their field. For a paper to be accepted for publication, two referees had to be satisfied that it met these guidelines and criteria.

An editorial panel that carried out these tasks was:

Proceedings Editor - Phil Wilkinson

Commission B Editor – John Kot

Commission F Editor - David Noon

Commission G Editor - Peter Dyson

Commission H Editor - Brian Fraser

Commission J Editor - Ray Norris

Local Organising Committee (LOC)

Christophe Granet, CSIRO Telecommunications and Industrial Physics

John Kot, CSIRO Telecommunications and Industrial Physics

Dallas Rolph, CSIRO Telecommunications and Industrial Physics

Phil Wilkinson, IPS Radio and Space Services, Sydney

The National Committee for Radio Science (NCRS) has a moderated electronic mailing list.

- Go to http://www.ips.gov.au/mailman/listinfo to enroll in **ncrs-general,**
- If you want to send a message to other radio scientists in Australia, use the mailing list.

Note: the membership of the mailing list is not intentionally disclosed to anybody outside the NCRS.

Wednesday 15th February 2006			Start	Length	End
Registration			11:00	2:00	13:00
Lunch (Light lunch)			12:30	1:30	14:00
Opening Address	Phil Wilkinson	Welcome.	14:00	0:15	14:15
Poster session talks	Leader: Ray Norris		14:15	1:00	15:15
Poster Session 1 (plus afternoon Tea) (includes student papers)			15:15	2:00	17:15
Open discussion	Leader: Phil Wilkinson	Preparations for AP-RASC, Perth, 2007	17:15	1:15	18:30
Dinner			19:00	3:00	22:00
Thursday 16th February 2006					
Invited Speaker 1	Trevor Bird	Terahertz Radio Systems – the Next Frontier	9:00	0:45	9:45
Invited Speaker 2	Le Nguyen Binh	Electronic and Photonic Processing in Advanced Photonic Long-Haul Transmission	9:45	0:45	10:30
Poster Session 2 (plus morning Tea) (includes student papers)			10:30	2:00	12:30
Lunch			12:30	1:30	14:00
Invited Speaker 3:	Ron Ekers	Paths to Discovery in Radio Astronomy	14:00	0:45	14:45
Poster Session 3 (plus afternoon Tea) (may include student papers) Sub-Topic: SKA			14:45	2:00	16:45
discussion session			16:45	2:15	19:00
Dinner			19:00	3:00	22:00
Friday 17th February 2006					
Invited Speaker 4	Peter Kemeny	The Australian Synchrotron	9:00	0:45	9:45
Invited Speaker 5	Iver Cairns	A Decadal Plan for Space Science	9:45	0:45	10:30
Poster Session 4 (plus morning Tea) (no student papers)			10:30	2:00	12:30
Lunch			12:30	1:30	14:00
Open discussion	Leader: Iver Cairns	A Decadal Plan for Space Science	14:00		

Session 1: Wednesday PM	
Presenter	**Paper**
	Oral presentations of posters
Ables	Cross-phase gradients in ULF magnetometer data from a small square array in Antarctica
Blockley	Nonlinear Network Analysis and Measurement
Boan	Radio Propagation in Fire Environments
Dissanayake	How do you select the best antenna for your UWB system?
Fraser	The Measurement of Ion Density in Magnetospheric Plasma Plumes
Frazer	Implications of O-X mode interference on large HF receive arrays
Gardiner-Garden	Ionospheric variability in sounding data from JORN
Hyde	HF spectrum monitoring using a commercial PC-based scanning receiver
Janapsatya	Designing Printed Slot Antennas for Multi-band Applications
Kurniawan	Near Field and Dosimetry of RF Bioeffects Research
Lindsay	Geolocation of HF signals using Time Difference of Arrival methods
Matthews	High Resolution Observations of the Magellanic Stream
Nasimuddin	Optimization of Stacked Microstrip Antenna for Circular Polarization
Neudegg	Preliminary comparison of IPS HF skywave propagation model with observations
Norman	Mapping the Ionosphere Using a HF Radar Backscatter Inversion Technique
O'Sullivan	NTD Interferometer Experiment at Marsfield
Wilkinson	Using STORM to support short-term ionospheric forecasts.

Session 2: Thursday AM	
Presenter	**Paper**
Bird	Invited Talk: Terahertz radio systems - the next frontier
Le Binh	Invited Talk: Electronic and Photonic Processing in Advanced Photonic Long-Haul Transmission
Caruana	Ionospheric Scatter Parameters from Digital Ionograms
Dimitrov	Fedsat Observations of the Topside Ionospheric and Plasmaspheric Response to the Major Magnetic Storm Of 15 May 2005
Dung	Simulation of a Novel Photonic Transmission System using M-ary Amplitude - Phase Differential Shift Keying Modulation Format
Ge	A Class of Multi-Arm Monopole Antennas for Multi-Band Wireless/Mobile Applications
Greenwood	SUPERDARN: A New Network of HF Radars For Oceanographic Research
Jacka	Australian Roadmap from NTD to SKA
Li	Prototyping dual-band artificial magnetic conductors with laser micromachining
Lynn	The Dynamics of the Low-Latitude Ionosphere
Maher	Development of Digital Terrain Model dependent VHF/UHF Radio Prediction Software employing Emperical and Semi Deterministic Propagation
Meehan	An analysis of Oblique Ionograms collected in the USA in November 2005.
Moorey	A 77 – 117 Ghz Radioastronomy Receiver Frequency Conversion and Local Oscillator System
Morley	Do substorms need a solar wind trigger?
O'Sullivan	Digital Beamforming for Parabolic Reflector Focal Plane Phased Arrays
Sciffer	A Simple Model for the Deposition of ULF Wave Energy on the Ionosphere
Yau	Fading of High Frequency radio signals propagating in the ionosphere - Results from the Jindalee radar experiment
Zaman	Modelling electron trapping effects on gate lag in Field Effect Devices

Session 3: Thursday PM	
Presenter	**Paper**
Ekers	Invited Talk: Paths to discovery in Radio Astronomy
Bird	CSIRO 4.5m MultiBeam Antennas for the New Danish Radio Multimedia Building in Copenhagen
Carrad	A Cryogenically Cooled, Seven Beam, 21 Cm Wavelength Receiver for the Arecibo Radio Telescope
Cornwell	xNTD — A Parallel Radio Telescope
Ford	Coupling of the Sun's internal oscillations to the solar wind
Grancea	Receiver Design for the NTD Focal Plane Array
Hartnett	GPS Carrier Phase and TWSTFT comparisons of clock ensembles based at UWA and NMI
Hawkes	Three Dimensional Model for Propagation in the Troposphere and Inverse Diffraction
Hislop	Phase retrieval of scattered fields
Jacka	NTD and xNTD Technology Demonstrators for SKA
Jackson	Australian Industry Engagement in R&D for the xNTD
Le Binh	Phase and Amplitude Modulation Formats for Hybrid 40Gbps and 10Gbps DWDM Photonic Long-haul Transmission
Makarevich	Identification and implication of multiple flow channels in the TIGER data
Moorey	A 77 – 117 Ghz Cryogenically Cooled Receiver for Radioastronomy
Morley	Combined geostationary, low-Earth orbit and ground-based observations of electromagnetic ion-cyclotron waves.
Nikolic	Optimisation of a Luneburg Lens Fed by a Corrugated Horn Antenna
Terkildsen	Ionospheric TEC variability at sub-equatorial latitudes

Session 4: Friday AM	
Presenter	**Paper**
Kemeney	Invited Talk: The Australian Synchrotron
Cairns	Invited Talk: Towards a first Australian Decadal Plan for Space Science
Brinkhoff	Symmetric Hemt Drain Current Model For Intermodulation Distortion Prediction
Cairns	Solar Terrestrial and Space Physics Research at the University Of Sydney
Christophe	Design of a Prime-Focus Dual-Band Feed for the Giant Metre-Wave Radio Telescope in India
Coleman	Radio Wave Propagation Algorithms Based on the Reciprocity Principle
Dyson	Space Physics Research at La Trobe University
Fraser	Research in the University of Newcastle Space Physics Group
Harris	DSTO, ISRD and Over-the-Horizon Radar
Norris	ATLAS: Deep radio observations of the CDFS-SWIRE field
Parfitt	Fedsat: Three Years of Space Science and Technology
Parker	Characterising Microwave Transistor Dynamics With Small-Signal Measurements
Parkinson	Why Do We Need "DIGIDARN" – A Global Network Of Digital SUPERDARN Radars?
Ponomarenko	On the spectral width of HF echoes from high latitudes
Storey	Radio Quiet Zone in support of Australia's Bid to Host the SKA
Terkildsen	The effects of polar magnetic field aligned currents on the attitude control system of low earth orbit satellite FEDSAT
Tobar	Testing Relativity with Cryogenic Sapphire Oscillators
Turley	Spatial and Temporal Ionospheric Mapping with Outlier and Missing Samples
Waters	Telluric currents induced in a North Queensland gas pipeline by geomagnetic variations
Weily	Ku Band Electromagnetic Bandgap Antennas

Abstracts for Invited Speakers

Speaker 1: Thursday AM

Terahertz Radio Systems – The Next Frontier

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Email: Trevor.Bird@csiro.au

Abstract

Terahertz (THz) frequencies (also called T-rays) have almost unlimited potential in a wide variety of applications including imaging, spectroscopy, sensing and actuation, and wideband communications. The main reasons are that the THz spectrum, which covers frequencies from about 300 GHz to 10 THz, is currently largely unallocated, which opens up the prospect of huge bandwidths, and also electromagnetic waves at these frequencies give millimetre resolution of objects. This resolution is essential in imaging of metallic and non-metallic objects for medical, non-destructive testing and security applications. In addition, most molecules have vibrational and rotational spectra at THz frequencies. However, the techniques used at THz frequencies are in early stages of development, although some components and systems are now available. Also, two distinct approaches to THz systems have evolved from the radio frequency and the optical domains. Terahertz is a region where the two domains mix, and practical systems of the future will undoubtedly combine the best of both domains.

This talk will outline the progress being made in technology and applications for potential radio systems operating in the THz frequency range. Most technologies used to date derive from scaling components from the microwave or optical domains. However, in some cases, these scaled components are either too small from the microwave domain or too large from the optical domain to be of practical use. An example of this is THz sources. Most electronic sources cannot be extended directly upwards in frequency due to materials, time delay or fabrication constraints. Therefore, the most common technique to create power electronically is to use a high-power millimetre wave source and multiply in frequency. This approach has proved very successful although its maximum power efficiency is typically only a few percent. At the other extreme, an optical laser approach can produce high powers although the equipment tends to be very large and not very portable. The development of new sources for the THz region, such as those based on GaSe and other crystals, will be important to its future development. Another issue at THz frequencies is that the material properties are often quite different from microwave or millimetre-wave frequencies and some of the most useful components in waveguide and printed circuits technologies are very lossy. A way to reduce the amount of loss and simultaneously create new and compact components is to use artificial materials such as electromagnetic bandgap (EBG) or metamaterials.

Examples of recent technologies applicable to THz sources and components will be given in the talk. This will be accompanied by a description of particular THz radio systems. The applications considered will be a THz camera, which could provide images in dark or foggy conditions, electromagnetic sensors to measure the molecular constituents of the earth's atmosphere and other planets, and extremely wideband communication systems. The paper will discuss some of the current methods and applications as well the technical challenges being faced to deliver radio systems operating at the fringes of current capability.

Abstracts for Invited Speakers

Speaker 2: Thursday AM

Electronic and Photonic Processing in Advanced Photonic Long-Haul Transmission

Le Nguyen Binh
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Abstract

The advancement of electronic integrated circuit technology and photonics in the last decade have allowed the design and demonstration of ultra-high bit-rate transmission over advanced optical fiber transmission line employing in-line optical amplification as well as electronic compensation and equalisation of linear and nonlinear distortion effects. The research and development of novel modulation techniques to achieve effective signal bandwidth and energy distribution per bit for extending the transmission reach are also attracting intensive interests. This paper presents: (i) A brief overview of optical fiber communications employing advanced modulation and novel formats, especially the amplitude and phase shift keying (ii) Distortion and dispersion effects due to linear and nonlinear effects and experimental demonstration of electronic and photonic compensation methodologies (iii)Practical demonstration of the transmission of multiple channels at 40 Gb/s over several fiber spans of dispersion managed optical fibers (iv) Demonstration of 40 Gb/s over 10 Gb/s wavelength multiplexed optically amplified long haul transmission for capacity upgrading.

Abstracts for Invited Speakers

Speaker 3: Thursday PM

Paths to discovery in Radio Astronomy

Ron Ekers, Australia Telescope National Facility, CSIRO

Abstract

One of the most important events in twentieth century astronomy was the birth of radio astronomy. For the first time ever astronomers were able to view the Universe in a region of the electromagnetic spectrum outside the narrow optical window. These early discoveries were completely unexpected and were made by individual scientists from other disciplines who built very unconventional "telescopes". These early pioneers discovered a plethora of cosmic phenomena that revolutionized our knowledge of the Universe.

Modern observations of some of these discoveries, such as the relic radiation from the big bang, are still the most exciting research areas in modern astronomy.

What can we learn from this about the future of the new class of radio telescopes, such as the SKA, which are planned for the twenty first century?

Abstracts for Invited Speakers

Speaker 4: Friday AM

The Australian Synchrotron

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Computer Systems Engineering
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Abstract

The theme of this presentation is the description of the application of synchrotron radiation to the fabrication of photonic and electronic devices. Synchrotron radiation, produced when high energy (GeV) electrons are deflected by a strong magnetic field, has a number of remarkable properties compared to other common photon sources. These include the very wide, continuously tuneable, spectral range, spanning the electromagnetic spectrum from the infrared to hard x-rays, the very high intensities that are achievable, the high degree of collimation, the well-defined polarisation, and the extremely small beam cross-section (1 μm).

For photonic devices in particular, these characteristics enable the fabrication of very high aspect ratio, small feature size structures (width : height ratio of 1:100) with vertical or controlled sidewalls that are smooth on the nanometre scale, leading to the possibility of fabricating a new generation of devices such as photonic bandgap structures with low excess loss.

In the first part of this paper the Australian Synchrotron, presently under construction in Victoria, will be described, along with some of its relevant optical characteristics. The second part will focus on the devices that may be fabricated with this new light source, the fabrication methods and facilities that are required, and work that already is underway at Monash University and elsewhere to exploit the many advantages of this new facility for the development of novel photonic devices.

Abstracts for Invited Speakers

Speaker 5: Friday AM

TOWARDS A FIRST AUSTRALIAN DECADAL PLAN FOR SPACE SCIENCE

Iver H. Cairns [1,2] **and the National Committee for Space Science** [2]

[1] **School of Physics, University of Sydney, NSW 2006, Australia; i.cairns@physics.usyd.edu.au**

[2] ***Australian Academy of Science, http://www.science.org.au/natcoms/ss-decadal.htm; ncss@physics.usyd.edu.au***

Abstract

The National Committee for Space Science, chartered by the Australian Academy of Science, is in the process of developing the first Decadal Plan for Space Science in Australia. The purview is of the science, industry, and government needs associated with solar system phenomena and objects. The primary emphasis is on science associated with solar terrestrial physics, space weather, atmospheric forcing, remote sensing, and planetary science (including astrobiology). Goals of this talk are (1) to describe the current status of and motivations for the Decadal Plan, including the organizational structure, "strawman" science aims and projects, and initial submissions (see also the web page at http://www.physics.usyd.edu.au/~ncss), and (2) to stimulate people to volunteer feedback, new ideas, and their time and energy to develop and popularize the Decadal Plan among Australian scientists, industry, and Government. Time has been reserved after the talk for an extended discussion and feedback session.

Session 1: Wednesday PM

Cross-phase gradients in ULF magnetometer data from a small square array in Antarctica

S.T. Ables[(1)], B. J. Fraser [(1)]
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Magnetometer data from Davis, Antarctica (74.49^o S, 100.03^o E CGM) often exhibit spectral characteristics which can be interpreted as field line resonance (FLRs) signatures of the last closed field-lines in the dayside magnetosphere. In particular, cross-phase measurements in the Pc5 band (1-10 mHz) show spatial gradients which, after allowing for mapped propagation from the equatorial magnetopause, can provide information on field-line topology via small variations in the resonance frequency. We present here examples of diurnal cross-phase data from two pairs of closely spaced (~110 km), azimuthally separated stations in a square array including Davis, and define a new index - Φ5 as averaged cross-phase between 2 and 4 mHz. We have constructed a model based on the T01 geomagnetic field, and a simple power law plasma density model which allows us to determine the time of flight of Alfvén waves along closed field lines, and thence resonance frequency gradients. For quiet to moderate conditions we find this model shows good functional agreement with the data. During disturbed conditions we find propagation signatures suggestive of reconnection replace/mask the FLR phase pattern.

Nonlinear Network Analysis and Measurement

Peter S. Blockley(1), Jonathan B. Scott(2), Daniel Gunyan(3) and Anthony E. Parker(4),
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A measurement system that enables next generation broadband communications systems is described. The measurements are fully calibrated and are traceable to the national standards laboratories. The system has immediate applications in the deployment of wide-bandwidth, power efficient, low-cost telecommunications infrastructure. It also has potential applications in automotive radar for collision detection, delivery of broadband Internet and high definition TV to homes and other novel applications with large bandwidth requirements.

RADIO PROPAGATION IN FIRE ENVIRONMENTS

Jonathan Boan(1)
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In this paper we discuss the representation of a bushfire environment as a radio propagation medium. Basic physical models are presented to model the refractive index and combustion induced plasmas. Combustion induced plasmas will particularly focus on chemi-ionisation and thermal ionisation for electron generation. Numerical schemes are introduced to evaluate radio propagation in long range calculations concurrently with cold plasma mediums. A case study fire is used to present some results to compare the effect of propagation phenomena.

HOW DO YOU SELECT THE BEST ANTENNA FOR YOUR UWB SYSTEM?

Tharaka Dissanayake(1), and Karu P. Esselle(2)
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(2)As (1) above, esselle@ics.mq.edu.au

In addition to impedance matching of the antenna, the stability of the radiation pattern in the operating frequency band is crucial to achieve good performance from a UWB system. How do you know your antenna pattern is stable enough for your UWB application? How do you pick the antenna that has the most stable pattern? To address these and several other related issues, we first define a new figure of merit – the pattern stability factor (PSF)- to quantify pattern stability of a wideband antenna. Then several practical UWB antennas are assessed from the stability point of view to demonstrate the use and advantages of the PSF in UWB system design.

The Measurement of Ion Density in Magnetospheric Plasma Plumes

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[(3)] Department of Physics and Astronomy, Rice University, Houston, Texas, USA
[(4)] Space Science Department, Marshall Space Flight Center, National Space Science & Technology Center, Huntsville, AL 35805
[(5)] Los Alamos National Laboratory, Los Alamos, New Mexico, USA

Recent intercalibration studies on the measurement of plasmasphere-magnetosphere density have been undertaken using ULF wave data in conjunction with satellite data variations measuring electron, proton, helium (He^+) and sometimes oxygen (O^+) densities. There is now a need to understand what species are being measured as the relative concentration of species can vary with time and radial distance and, for example, may influence the locations of the plasmapause. More recently it has been established that electromagnetic ion cyclotron waves are seen in association with plasma plumes in the middle magnetosphere. These also provide a method of determining heavy ion relative concentrations and when used in conjunction with satellite density and modelling has the capability of completely describing the plasmasphere and magnetosphere cold plasma composition. Results will be presented including data from IMAGE-EUV, LANL, GOES, CRRES and DE-1 satellites

Implications of O-X mode interference on large HF receive arrays

G.J. Frazer, T.J. Harris
ISRD, Defence Science and Technology Organisation, Edinburgh, SA 5111, AUSTRALIA

High time resolution radar observations were made of the angle-of-arrival, power, group-delay and Doppler characteristics of oblique HF propagation at fixed frequencies, over a 1850km path in the north of Australia, during a 24-hour period in April 2004. It was observed that when the ordinary (O) and extra-ordinary (X) propagation modes in the F2 low ray were not separable, the expected amplitude fading occurred. Along with the energy fading, apparent elevation and azimuthal deviations were also observed indicating that the spatial structure of the received signal is distorted and non-planar. By increasing the effective Doppler and range resolutions the O and X modes are resolved and all of these "interference" effects were removed. It is concluded that interaction between unresolved O and X components in a given propagation path will cause received energy and angle-of-arrival to fluctuate on the tens of seconds time scale. When O and X components are resolved this fluctuation does not occur. The results shown, although measured by a comparatively small array (<100m per arm for a "L" array) imply that for the case of a large array, unless the received signal propagation paths are resolved into O and X components, there is likely to be at least one fade located somewhere spatially within the large array. This will distort the spatial signature of the received signal and may render spatial processing algorithms, such as classical beamforming and various adaptive spatial processing algorithms, ineffective. These algorithms are generally based on assumptions of a plane-wave, or set of plane-waves, impinging on the array. Polarimetric antenna elements can be used to separate O and X components in each propagation path. It is widely accepted that a polarimetric array can be used to ameliorate energy fading and in the case of HF radar can be used to improve target radar cross section properties. The result presented here suggests a third motivation for the use of a polarimetric array; that of preserving the spatial structure of the received signal for the case of very large receiving arrays. This may be crucial and as such can not be ignored in the design of large HF receiving systems, such as used in HF radar or radio astronomy. Mostly, in these cases, the prime purpose of the large array is to estimate, with high resolution, the spatial structure of received signals; or, to use the inherent spatial processing capability of the large array to improve the signal to noise ratio of a desired signal. In either case, we believe that spatial distortion of a skywave propagated signal will occur with increasing likelihood as the size of the receiving aperture increases and may in fact place an upper bound on the effective aperture of large HF arrays. This limitation may be removed using an array containing polarimetric elements.

Ionospheric variability in sounding data from JORN.

Robert S. Gardiner-Garden
Defence Science and Technology Organisation, Edinburgh, SA, 5111, Australia.

JORN supports a network of Lowell vertical incident sounders (VIS's) around western and northern Australia. These sounders sample the ionosphere regularly and automatically every 3'45" (since 2002). They provide a unique opportunity to quantitatively describe the variability in the ionosphere in the Australian region, particularly, "fast" variations with periods of 10-90 minutes that are inherently missed or under-sampled in hourly data.

This poster shows samples of JORN VIS data and describes techniques used to clean and process the raw VIS trace data in order to extract a quantitative description of the "mesoscale" ionospheric disturbances observed (with periods of 10-90 minutes). These disturbances are frequently found to have spatial and temporally correlated structures consistent with models of medium scale travelling ionospheric disturbances (mTID's). This poster shows how data describing the spatial and seasonal "climatology" of these "mesoscale" ionospheric disturbances can be extracted from the JORN VIS data.

HF spectrum monitoring using a PC-based scanning receiver

Michael Hyde, IPS Radio and Space Services, Sydney, AUSTRALia

Real-time HF spectrum monitoring using scanning receivers has traditionally required expensive radio equipment with a hardware computer interface, dedicated logging equipment, and custom software. These diverse components can require considerable expertise to integrate into a working system sufficiently reliable to deploy at remote sites. This presentation describes a simple, relatively low-cost setup using one of the new PC based scanning receivers. The system consists only of a PC with installed receiver card, and an antenna. There is a freely available form of interpreted BASIC programming language for these receivers, which includes commands to control receiver functions. Commands are also available to control data logging and produce simple on-screen graphics. This small instruction-set language makes monitoring acquisition and control program development quick and easy, even for novice or non-programmers. Given a stable mains power supply, the system is sufficiently reliable to operate unattended for many months. Some HF spectrum data from scans acquired during field trials on a range of antennas are presented. A near-real-time short-wave fadeout monitoring application is also discussed and some sample field data presented.

DESIGNING PRINTED SLOT ANTENNAS FOR MULTI-BAND APPLICATIONS

Januar Janapsatya(1) and Karu Esselle(2)
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(2) Macquarie University, Department of Electronics, ICS Division, esselle@ics.mq.edu.au

This paper describes the design of printed slot antennas for multi-band applications. The aim of this design is to develop a single antenna that can be used by all the IEEE 802.11 WLAN network standards collectively known as Wi-Fi. It is required to have a polarisation complementary to that of multi-band printed monopole antennas, to achieve polarisation diversity. Design of a printed slot antenna element operating in the 2.4 and 5 GHz bands is discussed. Parametric studies are presented and different types of feedline configurations are investigated. The theoretical results are promising.

Near Field and Dosimetry of RF Bioeffects Research

By Teddy Kurniawan, Swinburne University of Technology, Swinburne

In this study, the authors would like to propose a refinement and alternative approach of near field analysis related to mobile phone radiation. First, the near field solutions of a dipole antenna used to represent the mobile phone antenna is discussed, followed by pseudo-static capacitive analysis of electric field in the near field region for free space and thin-layered slabs. Preliminary investigation focuses on antenna of Hertzian-dipole type. Initial results of simulations from the beta version of the developed tools in MATLAB® are then presented. Future research work will extend the investigation into a more accurate model of antenna and consequently its near field analysis, which will be verified with simulations using xFDTD and other available data in the literature. Furthermore, a theoretical approach in calculating the energy absorbed by thin-layered slabs based on energy calculation for static field, which takes into account the relative permittivity properties, is proposed and to be investigated.

GEOLOCATION OF HF SIGNALS USING TIME DIFFERENCE OF ARRIVAL METHODS

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The time difference of arrival of a signal at geographically separated receiving sites may be used to geolocate signals interest. In the HF environment these signals are often subject to strong interference and background noise can be correlated across the sites due to large numbers of weak interferers. For these reasons simple thresholding and crosscorrelation methods are inappropriate. A matched filtering approach can avoid these problems but relies on adequate knowledge of the signal type and parameters. A robust method of determining these is desirable. Several signals from November data have been geolocated including a known JORN transmission, an unknown FMCW signal and an unknown wideband parabolic signal.

HIGH-RESOLUTION OBSERVATIONS OF THE MAGELLANIC STREAM

Deanna Matthews(1), Lister Staveley-Smith(2), Peter Dyson(1)
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The Magellanic Stream consists of a stream of gas stretching from the Magellanic Clouds, which extends well into the northern hemisphere. Except for small regions, existing observations of neutral hydrogen (HI) in the Magellanic Stream have only been made at relatively low angular resolution (~14 arcmin or larger). In this paper, we present our initial study of the Magellanic Stream at higher resolution using the Australia Telescope Compact Array (ATCA)1. To overcome the "short-spacing" problem inherent with interferometer observations, we combine our data with recent Parkes data to allow the first detailed HI study of the important region at the head of the Stream, where it peels away from the Magellanic Bridge and Small Magellanic Cloud. Over a region of area 140 deg^2, we are able to fully image all structures with spatial scales in the range 0.1 to 2 kpc. In this paper, we present a preliminary analysis of the morphology of the gas distribution.

OPTIMIZATION OF STACKED MICROSTRIP ANTENNA FOR CIRCULAR POLARIZATION

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We propose a new C-type feed location to achieve circular polarization from stacked rectangular microstrip antennas. A systematic process to optimise the axial ratio (AR) bandwidth and ellipticity is presented. A main radiator and a parasitic patch of identical size are considered and the separation between them has been optimized to achieve a directive gain of 8.82 dBi, 3-dB AR-bandwidth of 14% and ellipticity (minimum AR) of 0.07dB at centre frequency. The proposed technique is very useful for rapid design of circularly polarized stacked microstrip antennas with high gain and large AR-bandwidth.

PRELIMINARY COMPARISONS OF THE IPS HF SKYWAVE PROPAGATION MODEL WITH IONOSPHERIC SOUNDING DATA

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The availability of oblique radio sounding data through the ionosphere has offered the opportunity of comparison with the IPS HF radio propagation model. The model is at the core of space weather prediction systems in the Regional Warning Center, Advanced Stand Alone Prediction Service (ASAPS) software and the system to determine the coverage of HF skywave for over-the-horizon -communication or surveillance networks. The ionospheric sounding between New Zealand and the east coast of Australia indicates the maximum first-hop oblique frequency (FMUF) to compare with that produced from real time vertical radio sounding and converted to an oblique equivalent via the propagation model. The relation between the observed and modelled data is examined as a function of ionospheric and solar activity parameterised by the T index, diurnal variation and the ionospheric gradient between the transmitter and receiver.

MAPPING THE IONOSPHERE USING A HF RADAR BACKSCATTER INVERSION TECHNIQUE

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High Frequency radar ground backscatter inversion to obtain ionospheric electron density profiles has the potential to provide remote sensing of the ionosphere up to thousands of kilometers from the transmitter/receiver location. The inversion technique requires radar data in the form of group path versus elevation angle profiles. The radar data is inverted to obtain a multiple quasi-parabolic segment plasma frequency profile of the true ionosphere. Using frequency scanning radar, the down-range gradients in electron density can be determined. In this paper, a prototype HF radar backscatter inversion is exercised using real data recorded with the Tasman International Geospace Environment Radar.

NTD Interferometer Experiment at Marsfield

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CSIRO ICT Centre and ATNF staff are jointly working on two projects that are on Australia's roadmap towards the Square Kilometre Array radio telescope (SKA). The major project currently is the NTD (New Technology Demonstrator), which is a preliminary to a much larger project known as xNTD (Extended NTD). This paper outlines an experiment currently being prepared for the NTD, and relies on the installation of two recently refurbished 13.7 m diameter antennas which will be fitted with various feed technologies resulting from CSIRO's research program into Focal Plane Array technology using fully digital beamforming techniques. The NTD and xNTD will be using critically sampled focal plane arrays (CSFPAs), a concept that offers promising solutions but it is not yet clear how well they may achieve these results. It is becoming apparent that artefacts such as coma, mutual coupling between elements, and the frequency dependence of the array will introduce new challenges which need to be compensated for with either the digital hardware or the following post-correlation software.

The main goal of the initial observations with the NTD interferometer is to understand the performance of the CSFPA in both single dish and interferometric observations.

Using STORM to support short-term ionospheric forecasts

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The International Reference Ionosphere, IRI2001, now contains a parameterised ionospheric storm model, called STORM. Using Ap indices, this predicts the nature of the global ionosphere by producing a latitudinal correction for peak electron-density F2-region maps. This paper explores the use of STORM to support ionospheric forecasts. To do this, a corrected global index of ionospheric activity is constructed using STORM and the results of using this index are compared with manual forecasts made locally.

Session 2 : Thursday AM

Ionospheric Scatter Parameters from Digital Ionograms

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It is well known that High Frequency (HF) radio signals reflected from the ionosphere suffer time and frequency spreading due to scattering processes in the ionosphere. This is because the ionosphere is not an ideal, stationary, solid "mirror in the sky", but a plasma of ions and free electrons, which is in continual motion and often contains moving irregularities. Consequently, besides the specular return due to ionospheric refraction, there may also be time-delayed scattered returns. This is particularly noticeable in equatorial and high-latitude regions, especially during spread-F conditions.

For predicting the performance of digital HF radio transmissions, it is important to know the relative power and time delay between the specular and scattered components of the received signals. A recent model for time and frequency spreading of ionospherically propagated HF signals in the equatorial region suggests that the scattered power is at least 6dB below the specular power and the standard deviation of the time spread of scatter is 1ms. This document presents a method for obtaining quantitative information on these two parameters to test this hypothesis.

FEDSAT OBSERVATIONS OF THE TOPSIDE IONOSPHERIC AND PLASMASPHERIC RESPONSE TO THE MAJOR MAGNETIC STORM OF 15 MAY 2005

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During the most disturbed period of the May 15 storm, FedSat obtained GPS measurements of TEC over Eastern Europe during daytime. The onset of the magnetic storm was seen to produce an enhancement of TEC compared to the quiet time TEC values. It is well known that during magnetic storms the location of auroral phenomena move equatorward and the FedSat observations show that related, distinct structures in plasma density occur in the topside an ionosphere plasmasphere at about 800 - 1200 km altitude. The FedSat TEC observations also show unusually large horizontal gradients, particularly in longitude. This paper will present and discuss these observations.

Simulation of a Novel Photonic Transmission System Using M-Ary Amplitude-Phase Differential Shift Keying Modulation Format

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We propose a photonic transmission system based on 16-ary multi-level amplitude-differential phase shift keying (MADPSK) format and its generation using a dual-drive interferometric electro-optic modulator. The modulation scheme is bandwidth efficient with an effective transmission bit rate equal to only ¼ of the bit rate. The photonic transmitter structure is very simple as the modulator can be simultaneously operated in both amplitude and phase modulation modes. Simulation models are developed for evaluation of the system transmission performance. The multi-level optical signal spectra, eye diagrams and bit-error-rates are obtained to demonstrate the lightwave-modulated multi-level scheme transmission over the dispersive single optical fibres.

A CLASS OF MULTI-ARM MONOPOLE ANTENNAS FOR MULTI-BAND WIRELESS/MOBILE APPLICATIONS

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This paper presents several multi-band, compact, lightweight and low-cost monopole antennas suitable for applications in the wireless local area network (WLAN) and mobile communications. These antennas are two-arm microstrip-fed antenna, two-arm antenna fed by a co-planar waveguide (CPW) line, three-arm microstrip-fed antenna and a diversity antenna pair composed of two two-arm microstrip-fed antennas. Antennas to cover *1.8*, *2.4*, *4.9*, *5.2* and *5.8 GHz* bands have been successfully designed. Theoretical and measured results are presented.

OCEANOGRAPHIC RESEARCH: A NEW APPLICATION FOR SUPERDARN RADARS

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Large military HF over-the-horizon radars (OTHRs) can measure ocean wave heights, surface currents, and surface wind directions over vast, remote regions. This paper will demonstrate the potential for relatively compact Super Dual Auroral Radar Network (SuperDARN) radars to acquire valuable sea state information. Detection of Bragg backscatter from the Southern Ocean was made possible by a new radar operating system permitting the acquisition of coherent, long time series data at great ranges without range aliasing. The detection of large, illegal fishing vessels in the remote Southern Ocean may become possible with planned advances in radar hardware, operation, and data analysis.

Australian Roadmap from NTD to SKA

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CSIRO has developed a large and well-planned roadmap with the goal of ensuring that Australia plays a major role in the next-generation radio telescope development and also remains at the forefront of astronomy research. The Australian astronomical community views participation in the SKA as a most important long-term priority for astromomy. Australia is well poised to play a major role; it has proposed a very attractive site in WA for the central 50% of the SKA; with the rest of SKA distributed as "stations" at selected sites across the Australian continent and in NZ. Australia has a 2-stage technology development plan, leading to its technology demonstrator:

NTD (New Technology Demonstrator); funded from MNRF, 2002 – 2007, provides for initial R&D to exploit use of focal plane arrays with fully digital beamforming. The erection of two 13.7m antennas at Marsfield is part of NTD.

xNTD (Extended NTD) exploits the deliverables from NTD, with substantial extra funding from CSIRO and the WA Gov to provide a world-class scientific instrument, consisting of 20 antennas at Mileura in WA. To be completed in 2009, it is intended to influence the technology choice for the next stages of SKA development. SKA could consist of hundreds of stations; the xNTD would be an example of one of these stations.

Prototyping Dual-band Artificial Magnetic Conductors With Laser Micromachining

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In this paper we describe a laser micromachining process for prototyping dual-band artificial magnetic conductors (AMCs) with narrow slots in the order of (~*mil*2*m*μ50) or even narrower. Because these narrow slots cannot be correctly fabricated using standard milling machine, we explore laser micromachining. Although these AMCs can be made inexpensively using mass production processes, prototyping them is difficult. Considering that the period of the dual-band AMC surface is much smaller than the wavelength, we explored the use of a waveguide to measure the reflection coefficient of fabricated prototypes.

The Dynamics of the Low-Latitude Ionosphere

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This is a single scientist company which acts as a contractor to DSTO on background ionospheric research in support of Over the Horizon Radar and HF communications. As well, private research is conducted. In both cases, research is directed primarily to identifying experimentally the dynamics of the low latitude ionosphere and those common features which extend into Australia. The objective is to obtain a complete and detailed observationally determined picture of ionospheric variability.

Development of a Propagation Prediction Software Tool for VHF/UHF Terrestrial Wireless Communications Systems.

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This paper describes the development of a propagation prediction software tool, for VHF/UHF terrestrial wireless communications systems. An essential input to the software is a Digital Elevation Model (DEM) for information on terrain heights and obstructions in applying empirical propagation and semi-deterministic diffraction models for initial pathloss estimates. Calculations for field strength, signal-to-noise ratio and coverage area can then be performed, incorporating full antenna gain pattern effects. As accurate co-ordinate, mapping and visualization features are required, Geographical Information System (GIS) issues and the usage of raster image techniques needed to be developed. Having a reliable physical layer model paves the way to incorporate more advanced network modeling components of a wireless communication system, which is the intended direction of this project. Simulation results are compared to estimates available from TV broadcast transmitters.

An analysis of Oblique Ionograms collected in the USA in November 2005.

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In November 2005, DSTO researchers collected almost two weeks of daytime oblique ionograms between sites in California and New Mexico, a 1260km baseline.

We calculate the best working frequencies from these ionograms and compare them to predictions based on the IPS tool ASAPS. We also test the persistence of ionospheric behaviour by comparing the measured ionogram parameters across days, and test the rule of thumb that if day X starts off similar to day Y, then the rest of day X will follow that trend.

What will the ionosphere be like in mid-2006 for the same propagation path?

A 77 – 117 GHz RADIOASTRONOMY RECEIVER FREQUENCY CONVERSION AND LOCAL OSCILLATOR SYSTEM

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A cryogenically cooled millimetre-wave receiver system was recently installed in an antenna located at Mopra near Coonabarabran as part of the Major National Research Facility (MNRF) funded project to extend the frequency coverage of the Australia Telescope National Facility receiver systems. The frequency down-conversion and local oscillator systems for the new dual-band, 16 – 26 GHz (12mm band) and 77 – 117 GHz (3mm band), receiver will be described. The system design and active components required to down-convert the very wide, 77 – 117 GHz, frequency range will be highlighted.

Do substorms need a solar wind trigger?

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Evidence is present in the literature for both triggered and untriggered substorms. Previous attempts to evaluate the likelihood of solar wind triggers being associated with substorm onsets by chance have presented compelling evidence for the external triggering of substorms. However, these studies have used a null hypothesis that substorms are unrelated to a signature which comprises both a trigger and a growth phase requirement. We test the association between substorm onsets and substorm triggers, with and without growth phase requirements, to determine whether substorms and solar wind trigger signatures are related.

Digital Beamforming for Parabolic Reflector Focal Plane Phased Arrays

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Wide field imaging in radioastronomy is becoming an important driver for next generation radio telescopes. An emerging concept to achieve wide fields of view is an antenna system with a phased array at the focus of a parabolic reflector to extend the field of view. The signals from the phased array elements are beamformed to generate multiple independent beams. Digital beamforming allows the correction of a number of frequency dependant errors and also provides flexibility in calibration procedures. A digital beamformer for the concept is currently being designed for the xNTD, Australia's SKA demonstrator project. The beamformer for each of 20 antennas processes one Terabit/sec of data requiring a computation capacity of ~10 Tera operations/sec.

A Simple Model for the Deposition of ULF Wave Energy on the Ionosphere.

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One dimensional (1-D) computational and analytic models for the propagation of ultra low frequency (ULF; 1-100 mHz) wave fields from the Earth's magnetosphere through the ionosphere, atmosphere and into the ground are presented. The models are formulated to include solutions for high latitudes where the Earth's magnetic field, B_0, is near vertical to oblique magnetic fields at low latitudes. The models are used to investigate the partitioning of energy deposition associated with ULF wave interaction with the ionosphere. The results show an asymmetry in the energy deposition in the ionosphere. It is found that the dip angle of the background magnetic field as well as the arrival angle of the incident ULF wave has a significant effect on how the energy from incident ULF wave are reflected back into the magnetosphere or converted into joule heating of the ionosphere. Significantly more Joule heating occurs for waves that propagate in the north-south compared with the east-west direction.

FADING OF HIGH FREQUENCY RADIO SIGNALS PROPAGATING IN THE IONOSPHERE - RESULTS FROM THE JINDALEE RADAR EXPERIMENT

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The use of High-Frequency (HF) radio-wave propagation in the ionosphere is still prevalent. The ability to acquire the behaviour of the channel and the knowledge of how the channel will a®ect the propagating signals is imperative to ensure the reliability, and maintain adequate performance, of modern wide-bandwidth HF systems. An experiment to study the fading of HF signals propagating in the ionosphere has been conducted. Using the Jindalee Over-The-Horizon (OTH) radar, the behaviour of the ionospheric channel and wide bandwidth fading signal observations were captured. In this paper, results from the experiment will be presented, and the potential uses for the set of experimental data will be discussed.

Modelling electron trapping effects on gate lag in Field Effect Devices

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Traps at the surface of devices cause delayed response of drain current to a step change of gate voltage. This is known as gate lag. Gate lag is usually caused by surface hole trapping. Traps at the surface are charged negatively during turn-off of the device. The negative charge turns the device further off. After turn-on, these negative charges decay by means of capturing holes, which turns the device further on. However, measurements have shown that electron trapping also occurs during gate pulsing which causes drain current to decrease after turn-on pulse. This paper aims to model this electron trapping effect and combine it with a previously developed hole trapping model.

Session 3 : Thursday PM

CSIRO 4.5m MultiBeam Antennas for the New Danish Radio Multimedia Building in Copenhagen

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The manufacture, installation, test and delivery by CSIRO of two 4.5m MultiBeam earth station antennas for the new multimedia building of Danish Radio in Copenhagen is described. These antennas at the Danish Radio complex are the world's first multibeam antennas providing both transmit and receive services into commercial satellite networks.

A CRYOGENICALLY COOLED, SEVEN BEAM, 21 CM WAVELENGTH RECEIVER FRONT END FOR THE ARECIBO RADIO TELESCOPE

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A 7-beam receiver, using a cryogenically cooled front end for maximum sensitivity, has been developed by the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Australia Telescope National Facility (ATNF) Engineering and Development Group and is almost wholly fabricated using the facilities of the ATNF and Australian industry. This new receiver system was recently installed in an antenna situated in Puerto Rico. This paper highlights various design and construction details of the front end, and reports the results of laboratory and telescope testing of the front end cryogenic and electronic systems. This paper also describes measures to minimise self-generated electromagnetic interference (EMI) and shield the receiver from high power radar in close proximity to it's location in the receiver room of the Gregorian dome.

xNTD — A Parallel Radio Telescope

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Provoked by the desire to increase sensitivity vastly beyond that available with today's highly optimized radio telescopes, radio astronomers are adopting parallel architectures at the very front end of the telescope. Over the last decade, multiple feed arrays have been used in the Parkes single dish radio telescope to increase the speed of observing. The next step is to use focal plane arrays in synthesis radio telescopes. The extended New Technology Demonstrator (xNTD) currently being designed by CSIRO will have 50 to 100 pixels in the focal plane of each of twenty antennas. Thus each focal plane pixel can be imaged using traditional radio interferometric techniques. This design has excellent speed but brings new challenges and opportunities in both data processing techniques and computation approaches. New techniques will be needed for calibration of the telescope, as well as for image formation. All of this must be implemented on a large parallel computer system - probably about 10,000 processors. If successful in the xNTD, this same technique may be adopted for the next decade's Square Kilometre Array, which is expected to be equivalent to about 100 xNTDs.

Coupling of the Sun's internal oscillations to the solar wind

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Spectral analysis was performed on upstream solar wind data obtained from the ACE and WIND satellites in order to investigate the possible existence of periodic variations in the solar wind due to coupling from internal oscillations of the Sun. The solar wind proton density, proton temperature and velocity, and the interplanetary magnetic field (IMF) north-south component were examined. No consistent spectral peaks were found over different years or from different instruments at the same time, indicating that internal solar modes are unlikely to affect these solar wind parameters in a periodic fashion.

Receiver Design for the NTD Focal Plane Array

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The New Technology Demonstrator (NTD) requirement of down-converting the 800-1700 MHz RF input to a fixed Intermediate Frequency (IF), which will be the input to the NTD DSP module, has led to the conception and design of the dual-conversion down-converter described in this paper. A total of 24 down-converters are required to take the signals from the LNAs located with the array of feeds at the focal plane of a 13.7 m diameter parabolic dish reflector antenna. The useful input to each receiver is a very weak signal from distant radio sources. This signal needs to be extracted from a much larger thermal noise signal, typically 100K, picked up by the array of receptors, and a still much larger level of interference (tens of dB greater) created by local broadcast stations, mobile phone towers and other transmitters in this frequency band. This unwanted noise and interference is spread over most of the band, with decreasing energy above 1400 MHz. The challenge NTD faces is doing radio astronomy in a frequency band that is adjacent to powerful local interferers.

GPS Carrier Phase and TWSTFT comparisons of clock ensembles based at UWA and NMI

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The Frequency Standards and Metrology research group at the School of Physics, the University of Western Australia (UWA) and the Time and Frequency group of the National Measurement Institute (NMI) are developing apparatus and analysis to compare clocks across the continental baseline of Australia, using both GPS carrier phase as well as two way satellite time and frequency transfer (TWSTFT) techniques. The UWA group has purchased a Hydrogen Maser, which will complement an existing Cesium beam clock. The group is continuing the development of an in-house cold atom Calcium optical clock as well as a liquid-helium cooled ultra-stable Whispering Gallery (WG) mode sapphire cryogenic oscillator (CSO) and a solid Nitrogen cooled dual WG mode CSO. A microwave synthesis chain is currently under development that combines the output of the Cs clock, the hydrogen Maser and the sapphire oscillator to generate signals across the RF and microwave domain that exhibit the best properties of each of the reference oscillators. The synthesizer will provide a stable 10 MHz reference for our ongoing experiments. The NMI group has an ensemble of H-Masers and Cesium clocks, a high accuracy (10^{-15}) Ytterbium cold ion clock that is still under redevelopment, as well as a liquid-helium cooled ultra-stable WG mode CSO. NMI has substantial experience of both two-way satellite and GPS time and frequency transfer, and currently operates the SYDN node of the IGS network in partnership with Geoscience Australia. Independent GPS carrier phase and TWSTFT time and frequency transfer between UWA and NMI will allow not only the ensembles but also the techniques to be compared for short, medium and long timescales over a baseline of 3300 km. The experience gained from this collaboration will assist the UWA-NMI team to be ready for the Atomic Clock Ensemble in Space (ACES) mission. UWA and NMI have formed an official ACES user group and are Southern hemisphere laboratories preparing for ACES clock comparisons to support ACES science goals. An update on our progress in achieving these goals will be given at the workshop.

THREE DIMENSIONAL MODEL FOR PROPAGATION IN THE TROPOSPHERE AND INVERSE DIFFRACTION

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The parabolic wave equation model (PEM) can be applied to model the propagation of electromagnetic signals in the troposphere and electromagnetic scattering. In this paper the concept of inverse diffraction is investigated for the case of the three dimensional (3D) PEM. Inverse diffraction is an algorithm that produces field convergence by inverting the PEM diffraction term and can be applied to find the transmitter location. The inverse diffraction radiolocation algorithm can be related to existing, standard radiolocation methods and is an efficient method for locating a transmitter using intercepted emissions. The 3D PEM presented in this paper gives correct spatial phase. Correct spatial phase for the PEM is essential for the inverse diffraction algorithm to process observed data correctly. Examples are discussed for propagation with atmospheric refraction and over irregular terrain.

PHASE RETRIEVAL OF SCATTERED FIELDS

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This paper describes an initial investigation of the problem of phase retrieval of fields which have been disturbed by a scatterer. The two techniques of successive projections and conjugate gradients are taken from the research area of near field antenna characterisation and adapted for the problem at hand. Both techniques are discussed and then implemented and compared in a quantitative fashion.

NTD and xNTD Technology Demonstrators for SKA

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The xNTD (extended NTD) uses deliverables from the NTD project, and facilitated by additional funds from CSIRO and the Western Australian Government, will further develop the technologies required and enable a powerful demonstrator to be built at Australia's chosen SKA site. This project is being undertaken by the ATNF in collaboration with the ICT Centre and several Australian universities, plus groups in the USA, EU, India, and South Africa.

The xNTD will be an array of innovative, low-cost parabolic dishes, each fed by a focal plane array (FPA); a small phased array (eg 10 x 10 elements) at the focus of the dish. The signals from the FPA are combined digitally, using specially developed FPGA-based (Field Programmable Gate Arrays) digital processors for beam-forming and correlation. Multiple beams on the sky give the telescope unprecedented field-of-view and flexibility.

The xNTD will showcase technologies such as low-cost dishes, highly-integrated array antennas, digital beam forming, optical signal transport, LNAs and integrated receivers, calibration and offline software.

Australian Industry Engagement in R&D for the xNTD

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CSIRO's extended New Technology Demonstrator (xNTD) project is being led by the ATNF. It will build a new radio telescope based on an array of 20 antennas, each equipped with a focal plane array (FPA). The xNTD will be based at Mileura in Western Australia. It is an ambitious project with a challenging specification: Many of the technologies developed for the xNTD are critical to the realisation of the Square Kilometre Array (SKA) - International Project: www.skatelescope.org Here we illustrate how CSIRO is engaging with Australian-based industry for xNTD and SKA R&D.

The Australian Electronics Industry Action Agenda (EIAA) Implementation group has endorsed the SKA project. With advice from industry groups and support from AEEMA we have developed the "SKA cluster mapping project" to determine capability, gaps and strategic goals within Australian-based electronics and ICT industry. The initial mapping project is expected to foster the development of industry-led SKA R&D projects in the future, offering global exposure to potential new astronomy markets, as well as the exploitation of SKA technologies beyond radio astronomy.

PHASE AND AMPLITUDE MODULATION FORMATS FOR HYBRID 40GB/S AND 10GB/S DWDM PHOTONIC LONG-HAUL TRANSMISSION

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Amplitude and phase shift keying modulation and pulse sequence formats are employed to demonstrate their effectiveness in optical fibre transmission systems at a bit rate of 40Gb/s over the dense wavelength multiplexed 10Gb/s channels. The impacts of optical filters are studied for 40Gb/s 320 km standard single mode optical fibre optically amplified and dispersion compensated transmission system employing RZ/ NRZ/CS-RZ amplitude shift keying and differential phase shift keying modulation formats. For 0.5 nm passband multiplexers and demultiplexers for wavelength channels multiplexing and separation, the receiver sensitivities are insignificantly affected.

Identification and implication of multiple flow channels in the TIGER data

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Westward flow channels are latitudinally narrow regions with enhanced F-region convection near magnetic midnight seen by the most equatorward radars in the SuperDARN array of paired HF radars. A newly deployed TIGER radar near Invercargill, New Zealand (46.51°S, 168.38°E) often observes double or triple flow channels at magnetic latitudes (MLAT) of 59°-65°S. Most equatorward channels are difficult to identify in the data simultaneously collected by the TIGER Bruny Island radar (43.38°S, 147.23°E) as these latitudes typically refer to the scatter from the E region so that this radar typically observes only the main flow channel at 61°-63°S MLAT. In this study we develop a method of the flow channel identification and tracking using the TIGER F-region velocity data. We examine flow speed and direction within each channel as determined by fitting cosine law curve to the maxima in the velocity profiles for all radar beams. Several cases of possible identification of westward flow channels in the E-region velocity data are presented and analysed. Implications of the multiple flow channel observations for convection models are discussed.

A 77 – 117 GHZ CRYOGENICALLY COOLED RECEIVER FOR RADIOASTRONOMY

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A new receiver system was recently installed in a radioastronomy antenna, situated near Coonabarabran, NSW, as part of the Major National Research Facility (MNRF) funded project to extend the frequency coverage of the Australia Telescope National Facility antennas. The cryogenically cooled receiver and the active and waveguide components required to achieve the very wide, 77 to 117 GHz, frequency coverage will be described. An early observation from this receiver system will be presented.

Combined geostationary, low-Earth orbit and ground-based observations of electromagnetic ion-cyclotron waves.

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Coordinated observations from GOES-9, DMSP F-13 and Chokurdakh (CHD) have shown Pc1-2 band wave activity in the late afternoon sector. The left-hand polarization of the waves indicates that these are electromagnetic ion-cyclotron (EMIC) waves. These are the ¯rst observations of Pc1-2 waves at three points along a geomagnetic ¯eld line. In the region of ¯eld-line conjunction DMSP also observed high-energy ion precipitation. The extent of the associated precipitation is latitudinally narrow.

Optimisation of a Luneburg Lens Fed by a Corrugated Horn Antenna

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Low profile Luneburg lenses (LL) fed by a horn antenna have been recently used for a variety of airborne applications. To achieve the required gain for some specific applications, usually an array of the hemispherical lenses is used. The hemispherical lenses, mounted on a conducting ground plane, are fed by the horn sources which can be pivoted about the lenses. The combination of the rotating ground plane and the pivoting sources provides a substantial 3-D coverage that can be used to track the position of the targeted communications satellite. So far, the standard circular horns were used to feed the lens [1]. In this paper, we describe a theoretical method which may be used for optimisation of the lens-horn system.

Development of an Australian regional TEC model and the study of ionospheric TEC variability in the sub-equatorial Australian region

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This information paper details current work being undertaken at IPS Radio and Space Services in the development of an Australian regional ionospheric TEC model with near real time capability and the related study of TEC variability in the Northern Australia (sub equatorial) region.

TEC may be derived from dual-frequency GPS satellite signals by one of a range of techniques. Furthermore, spatial mapping of TEC over a region using multiple GPS receivers requires the adoption of a mapping function, kriging or tomographic technique, as well as algorithms for the accurate estimation of GPS satellite and receiver interfrequency bias and corrections for cycle slip, phase ambiguity and multipath.

Real-time ionospheric TEC modelling can be used to monitor the ionosphere for both ionospheric research and practical applications and also provide calibration information for GPS users and for other space geodesy techniques. A near real-time ionospheric TEC model is being developed at IPS, driven by hourly GPS data from the Geosciences Australia ARGN network of GPS receivers. The model uses a grid-based algorithm and Kalman filter to estimate vertical TEC values. As part of the efforts to develop a near real-time ionospheric model, an assessment of the errors associated with interfrequency bias estimation using various techniques has been undertaken.

Further related work involves the study of TEC variability and TEC gradients in the sub-equatorial Australian region. Large TEC gradients cause simple model assumptions to break down. As a result, most TEC models have their greatest errors in the equatorial anomaly region which shows high TEC variability and where large TEC gradients are a daily occurrence. This study aims to understand the source of ionospheric variability and improve modelling of TEC gradients in this region.

Session 4 : Friday AM

SYMMETRIC HEMT DRAIN CURRENT MODEL FOR INTERMODULATION DISTORTION PREDICTION

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A new large-signal HEMT drain current model is presented that accurately describes not only the AC gain and resistance of the device, but also their derivatives with respect to bias. This allows the accurate simulation of linear and nonlinear performance over bias. The model is scalable, and is shown to predict S-parameters, power compression characteristics and intermodulation distortion of devices and circuits over a range of frequencies, biases and device sizes.

SOLAR TERRESTRIAL AND SPACE PHYSICS RESEARCH AT THE UNIVERSITY OF SYDNEY

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Space physics is a major research strength of the School of Physics, University of Sydney. A group of approximately 15 people study fundamental plasma physics and space phenomena ranging from Earth's ionosphere to the Sun's surface to the outer boundaries of the heliosphere and solar system, where the Sun's ``solar wind'' interacts with the local interstellar medium (see http://www.physics.usyd.edu.au/space-solar.html). Interests include the acceleration and heating of particles in magnetic reconnection regions and by shocks, generation and propagation of plasma waves and radiation, development and testing of theories for solar (type II and III) and heliospheric radio emissions, the SWAVES instrument on NASA's STEREO spacecraft (launch scheduled for late June 2006), and prediction of space weather based on solar radio bursts. A brief summary of the research interests and analysis techniques used will be given.

DESIGN OF A PRIME-FOCUS DUAL-BAND FEED FOR THE GIANT METRE-WAVE RADIO TELESCOPE IN INDIA

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The design of a dual band VHF/UHF prime focus horn for a 45m-diameter antenna is showcased. The design has been made difficult due to the compactness necessary to meet the stringent weight-limits. The paper highlights the engineering challenges and the results obtained after optimization.

Radio Wave Propagation Algorithms Based on the Reciprocity Principle

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The reciprocity principle is best known as a result concerning the interchangeability of antennas. In its general form, however, it can be used to derive a large number of integral results that include the better known integral equations of electromagnetism. Furthermore, numerous extensions form the basis of some quite general approaches to problems in radio wave propagation. The current paper describes some recent developments in this area and discusses the extension of these ideas to non isotropic propagation media through the concept of pseudo-reciprocity.

SPACE PHYSICS RESEARCH AT LA TROBE UNIVERSITY

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The La Trobe Space Physics Research Group [http://www.latrobe.edu.au/www/physics/space/space.htm] includes staff from the Departments of Physics and Electronic Engineering. The group studies the basic physical causes of space weather phenomena in geospace, the interface between Earth and interplanetary space. The investigations are based primarily on three experimental techniques: the Tasman International Geospace Environment Radar (TIGER) dual HF radar system; optical spectrometers used to study auroral and airglow emissions; and GPS tomography using the Australian satellite FedSat. Theoretical studies include radio wave scattering theory and the development of ray tracing and inversion techniques applicable to research sounders and radars and, to applications in surveillance techniques and radio communications. This poster presents an overview of the research program.

Research in the University of Newcastle Space Physics Group

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Research within the Space Physics Group is primarily concerned with studying solar-terrestrial physics in relation to space weather impact. With instrumentation located in Australia and Antarctica it is possible to monitor the dynamics of the ionosphere, plasmasphere, and magnetosphere. Magnetometer arrays monitor plasma densities in the plasmasphere and magnetosphere using ULF wave diagnostic techniques. High latitude studies of magnetosphere-ionosphere coupling utilize HF SuperDARN radars in Tasmania and New Zealand (TIGER and Unwin) and riometers, while the spatial and temporal variability of the current systems and convection are studies using satellites and ground data. The Group was a core partner in the Cooperative Research Center for Satellite Systems (CRCSS) and responsible for the NewMag fluxgate magnetometer experiment onboard FedSat, Australia's scientific and engineering research microsatellite launched in December 2002.

ATLAS: Australia Telescope Large Area SurveyA8C Deep Radio Observations of the CDFS-SWIRE field.

Ray Norris, José Afonso, Phil Appleton, Brian Boyle, Paolo Ciliegi, Scott Croom, Minh Huynh, Carole Jackson, Anton Koekemoer, Carol Lonsdale, Enno Middelberg, Bahram Mobasher, Seb Oliver, Mari Polletta, Brian Siana, Ian Smail, Gene Smith, Jason Surace, Maxim Voronkov

We present the first results of a deep radio survey of a region surrounding the Chandra Deep Field South (CDF-S), which has also been imaged by the Spitzer-Space-Telescope Wide-area Infrared Extragalactic Survey (SWIRE). Combining radio data with other wavelengths will help us understand the formation and evolution of early galaxies. When finished, this will be the widest (6 sq. deg.) deep (10 - 15 μJy) radio survey ever. We expect this large survey to uncover rare classes of object, and show obscured large-scale structure. In this interim report, we identify a class of radio sources with surprisingly little infra-red emission.

FedSat: Three Years of Space Science and Technology

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FedSat is a small satellite developed by the Cooperative Research Centre for Satellite Systems (CRCSS) and launched on 14 December 2002 by what is now the Japan Aerospace Exploration Agency (JAXA). Carrying a range of scientific and engineering test payloads, FedSat reached the end of its three year primary mission in December 2005. That mission has seen the gathering of a significant set of instrument data as well as the demonstration of some new technologies for space systems. The research associated with FedSat has been conducted by the partners of the CRCSS, which include CSIRO, The University of South Australia, QUT, UTS, The University of Newcastle, Auspace Ltd, VIPAC Engineers & Scientists Ltd, LaTrobe University, DSpace Ltd and DSTO. In addition FedSat has allowed researchers to participate in significant international space science and technology programs.

CHARACTERISING MICROWAVE TRANSISTOR DYNAMICS WITH SMALL-SIGNAL MEASUREMENTS

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Small-signal microwave transistor characteristics are used to construct and fit a comprehensive model of their dynamic behaviour. The model includes thermal effects and trap-related effects, which influences such a large range of frequencies that they are not well characterized by large-signal or pulse measurements alone. Correlation of the model with small signal characteristics demonstrates the region of influence of specific dynamic effects. The model extrapolates beyond the measurement space to quantify the very significant impact that transistor dispersion has on microwave circuit performance. The results question the adequacy of conventional transistor characterization techniques for accurate circuit design.

WHY DO WE NEED "DIGIDARN" – A GLOBAL NETWORK OF DIGITAL SUPERDARN RADARS?

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The Super Dual Auroral Radar Network (SuperDARN) is an international network of oblique HF over-the-horizon radars dedicated to the study of ionospheric convection. This paper argues why a fully digital redesign of SuperDARN needs to be developed. A network of "DigiDARN" radars will help to solve data consistency and quality problems, and greatly increase the amount of ionospheric echoes recorded across extended spatial regions through a combination of time and frequency multiplexing, and enhanced, adaptive beam forming. The use of field programmable gate array (FPGA) technology will enable flexible experimental research at the cutting edge of modern space physics.

On the spectral width of HF echoes from high latitudes

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The sharp latitudinal gradient in spectral width from the Super Dual Auroral Radar Network (SuperDARN) has been used to identify the ionosphere footprints of various magnetosphere boundaries. The large spectral width values above 200 m/s observed poleward from the boundary still lack comprehensive physical interpretation. In this work we applied multi-frequency sounding of the ionosphere in an attempt to clarify the dependence of spectral width magnitude on the scale size of the ionospheric irregularities. The observed spectral width values decrease with transmitter frequency contrary to theoretical predictions. A possible explanation may be connected with the effect of electron precipitations on the generation and/or lifetime of the irregularities.

Radio Quiet Zone in support of Australia's Bid to Host the SKA

Dr Michelle Storey – Australian SKA Planning Office Leader, ATNF, CSIRO
Dr Tasso Tzioumis – Spectrum Management Coordinator, ATNF, CSIRO
Erik Lensson – Manager, Spectrum Engineering, ACMA
Andrew Stewart, Alex Seneta, Vaughan Barry – RQZ Project, ACMA

What is the origin of our universe? And how did it evolve? It is these fundamental questions which the Square Kilometre Array (SKA) project aims to address. Expected to be built by 2020, the SKA will be the best imaging radio telescope array in the world. It will be more sensitive and able to survey the sky faster, than any other imaging radio telescope array.

A number of countries are bidding to host the SKA. A site ranking decision will be made by the International SKA Steering Committee this year. Australia's bid is being led by the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

One factor affecting the site ranking decision is radio quietness, in support of which the Australian Communications and Media Authority (ACMA) has been assisting CSIRO by working on a regulatory framework for a radio quiet zone (RQZ) at the proposed SKA site in Western Australia. The design of this regulatory framework merges technical and legal expertise, and involves consultation with both the public and other agencies. This poster introduces the SKA, sets out the regulatory options available to establish an RQZ, and flags the challenges for ACMA in designing this proposed zone.

The effects of polar magnetic field aligned currents on the attitude control system of low earth orbit satellite FEDSAT

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Attitude accuracy is a significant issue for satellites carrying scientific magnetometry payloads. At Low Earth Orbit (LEO), an error in pointing accuracy of 0.5 degrees can translate to an error in measured magnetic field components of up to 350nT. Whilst slow variations in attitude error can be relatively easily removed when studying smaller scale features of the geomagnetic field, removal of the effects of more rapid variations in attitude error present a considerable challenge.

As part of quality and performance checks in the commissioning phase of the Fedsat LEO satellite, a statistical study was undertaken into the occurrence of Fedsat Attitude Control System (ACS) pointing errors, and their occurrence in relation to various scale field-aligned current (FAC) structures. FACs manifest as large perturbations to the geomagnetic field in the polar regions, and are one of the main research objectives of the NewMag magnetometer onboard Fedsat.

This study found a strong coincidence of ACS pointing errors with the locations of persistent large-scale FAC in the polar regions. It also found little obvious effect on the ACS from intense small-scale FAC structures below spatial scales of ~20km. The effect of large-scale FAC regions is enhanced during periods of high geomagnetic activity when the FACs are significantly strengthened.

This study has implications for the design of attitude control systems for small satellites carrying payloads with high attitude accuracy constraints, and their reliability in regions such as near the poles where large magnetic field gradients exist.

Using precision oscillators to test fundamental physics

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Cryogenic sapphire oscillators at microwave frequencies have been constructed in the laboratories of the Frequency Standards and Metrology Research Group since 1990, with frequency instabilities of parts in 10^{15} , and a decade latter with instabilities of parts in 10^{16} . Due to this innovation, sapphire oscillators have become important tools for testing some fundamental principles of physics. For example, the technology has been used for highly sensitive transducers for gravitational wave detectors , to pump the transitions of atomic frequency standards with improved signal to noise ratio, and for tests of Lorentz Invariance, such as Kennedy Thorndike and Michelson-Morley experiments, as well as tests in the photon sector of particle physics. In this work we present results of a continuously rotating cryogenic microwave oscillator constructed to test Local Lorentz Invariance (LLI). Initial results from this experiment improve limits set by previous non-rotating experiments by more than a factor of 7 with only 3 months of data. Now, with over 12 months of data, we have reduced the noise floor by a factor of 2. Also, we present experiments that are sensitive to the scalar and parity-odd coefficients for Lorentz violation in the photon sector of the Standard Model Extension (SME) of particle physics. We are developing a high precision microwave interferometer experiment with different electromagnetic properties in the two arms. With present technology we estimate that the scalar and parity odd coefficients may be measured at sensitivity better than parts in 10^{11} and 10^{15} respectively, which represents six orders of magnitude improvement in the former and four orders for the latter.

SPATIAL AND TEMPORAL IONOSPHERIC MAPPING WITH OUTLIER AND MISSING SAMPLES

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Accurate ionospheric mapping has application in real time coordinate transformation of HF skywave radar targets to ground coordinates. Typically Kriging methods are used to spatially interpolate derived parameters from a sparse network of ionospheric sounder observations. Here we modify the model by making use of the current sounder observations to form a sample spatial covariance matrix. A statistical non-homogeneity detection test is introduced for selecting robust stationary and homogenous observations. In this way spatial and temporal outliers are rejected. The formulation also provides a means to handle missing observations.

Telluric currents induced in a North Queensland gas pipeline by geomagnetic variations

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The geomagnetic field varies with time, generating electric fields and currents in power transmission systems and pipelines (oil, gas, water). Geomagnetically induced currents (GIC) and their effects on technological systems have been studied at high latitudes where the effects of geomagnetic disturbances can be large. There have been no reports of GIC effects in pipelines at low latitudes. Australia has the majority of its population distributed along the coastal regions. Pipelines are essential for transporting resources to these centres. Enertrade is responsible for the gas pipeline in north Queensland which runs from Townsville, south east to Moranbah which is located south west of Mackay. The pipeline has a cathode protection system that maintains the pipe to soil voltage in order to inhibit corrosion.

Pipeline voltage measurements have been compared with the magnetometer data located at Townsville. In this study the pipeline data were provided at a sample interval of 60 sec. Two data intervals are presented. The first is for geomagnetic quiet conditions while the second is for data recorded during a geomagnetic disturbed interval. Following a similar approach to high latitude data, we found a moderate correlation between the time varying magnetic field and the pipeline voltage (correlation coefficient ~0.4). However, we also show that there is a diurnal variation in the pipeline voltage data which is in phase with the magnetometer signature of the Sq currents that are routinely detected at low latitudes.

Ku BAND ELECTROMAGNETIC BANDGAP ANTENNAS

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Electromagnetic bandgap (EBG) materials, also known as photonic crystals, have created new innovative methods for controlling the electromagnetic behaviour of antennas and other electronic devices. Created from periodic dielectric and/or metallic structures these materials are characterized by a band of frequencies where no propagating modes exist, known as the EBG. In different implementations, the EBG properties may be used to guide, filter, store, reflect or collimate electromagnetic waves. In this paper we provide a brief review of several EBG antenna designs from our research, describe their operation, and highlight the advantages and potential applications of each device.