ISSUE 1 • SPRING/SUMMER 2004

Electromagnetic News

Welcome to the first issue of Electromagnetic News. Produced under the National Measurement System's Electromagnetic Programme, this twice-yearly publication will provide you with information on many aspects of electromagnetic measurement. This issue contains a feature on the new Programme, as well as details of NMS technical clubs, upcoming events and workshops, services, and recent news.

Included with this issue is a questionnaire to enable you to tell us what you would like to see included in future issues. To encourage you to return this questionnaire we will place all forms into a prize draw. The winner will receive an electron tree and a copy of the illustrated guide to NPL, "A Century of Measurement". The winner will be announced in the next issue.

Emma Mulligan
KT Manager – Electromagnetic Measurement

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Inside this Issue:

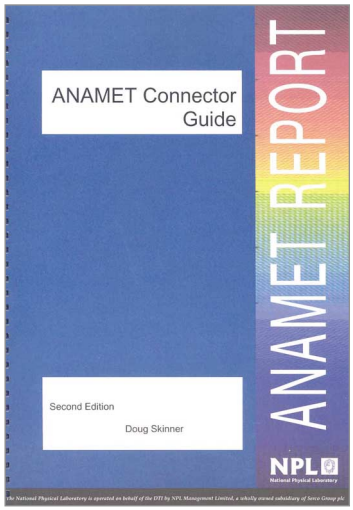
NPL
National Physical Laboratory

News

Caring for connectors to improve measurement

From DC and low frequency to microwave and radio, the condition of connectors can have a significant impact on experimental results. The ANAMET Connector Guide was produced in direct response to industry demand. It enables users to ensure that the coaxial connectors, they are using are "fit for purpose", to correctly handle and clean connectors to be able to identify when a connector has become damaged and to have confidence that the connectors are not adversely affecting the measurement. This can reduce uncertainty of measurement, improve quality, and prolong the life of the connectors.

The Guide is an evolving document, updated in response to industrial demand and when new connectors come on the market. The second issue is now available and contains extended data and additional information on new connectors.



This Guide is freely available electronically. For your copy please E-mail: **electromagnetic@npl.co.uk**

For more information on ANAMET please visit: ***www.npl.co.uk/anamet***

Confidence in every sensitive electrical measurement you make

- Are voltage, current or resistance measurements a key part of your work?
- Are you confident that you are getting the best from your measurements?
- Do you want a greater understanding of the factors affecting sensitive measurements?

NPL are running a course on making low frequency (<1 MHz) electrical measurements. It will show you how to configure equipment, for example digital voltmeters, and perform measurements to ensure that the result is fit for purpose. The topics covered will enable you to improve repair and diagnosis procedures for electronic systems, particularly remote sensing equipment.

The course will be held on 15 June 2004 at the Techno Centre in Coventry. The registration fee of £200 includes all training materials including a copy of NPL's Good Practice Guide on Voltage and Current Measurement. Delegates will also have the opportunity to discuss any specific problems with an expert in the field.

For further information or to register for the course contact:
Sara Fletcher
Ext: 6827
E-mail: sara.fletcher@npl.co.uk
To register online visit
www.npl.co.uk/electromagnetic/voltage_workshop.html

Taking dielectric good practice further

NPL will be holding a workshop on 20 September 2004 based upon its new Good Practice Guide 'Characterisation of Dielectric Materials'. The workshop will demonstrate to delegates how to put together an uncertainty budget and how to apply good measurement practice within their own organisation.

All attendees will receive a free copy of the Guide to the Characterisation of Dielectric Materials at RF and Microwave Frequencies, usually costing £45. The workshop will cost £65 to attend.

For further information and to tell us your views, contact:
Sara Fletcher
Ext: 6827
E-mail: electromagnetic@npl.co.uk

Quicker and better with cure monitoring

A one-day workshop on the benefits of cure monitoring will be held on Thursday 7 October 2004 at NPL. This is an ideal opportunity for companies as yet unfamiliar with the business potential of cure monitoring, as well as plastics processors, material suppliers, cure instrumentation manufacturers and researchers to meet and participate in discussions on the cost and quality benefits of cure monitoring within real industrial environments. The workshop is part of an on-going project (**www.npl.co.uk/materials/cure**) which has reviewed a range of currently available cure monitoring techniques, with the aim of encouraging the adoption of cure monitoring and highlighting the range of benefits to any company that processes materials undergoing cure reactions. The workshop, priced at £99 per delegate, will include presentations and demonstrations of cure monitoring technologies.

Two NPL Measurement Notes have been produced which provide general and practical guidance on the industrial application of established cure monitoring techniques to different materials and processes; one on the application of dielectric and fibre Bragg grating strain measurements to cure monitoring and the other on ultrasonic measurements for cure monitoring in polymeric material systems.

For copies of the Measurement Notes or to attend the workshop please contact:
Maria Lodeiro
Extension: 6034
E-mail: maria.lodeiro@npl.co.uk

The IEE measurement prize

Nominations are now being accepted for the 2004 IEE Measurement Prize. The IEE Measurement Prize, sponsored by NPL, aims to recognise and promote outstanding work in measurement. The Prize is awarded for a contribution to the science, art or practice of measurement using electrical, electronic or electromagnetic techniques. It is awarded annually, and may be given for a specific outstanding single contribution, or for a body of work over a period of time. The judges may take into account factors such as the level of innovation shown, the thoroughness with which ideas have been pursued, the economic or social benefits involved, or the degree to which the work has pioneered a significant new field or activity.

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measurementprize@iee.org.uk
www.iee.org/measurementprize

National measurement awards 2004

Following on from the success of the 2003 Awards, NPL and Beta Technology have launched this year's National Measurement Awards. The awards recognise outstanding achievement in the field of measurement and testing and highlight the crucial role that measurement plays in industry and sustaining quality of life.

The awards comprise five categories: Categories One, Two and Three acknowledge the development of new measurement solutions from initial concept through to prototype construction and actual application into industry; Category Four acknowledges the efforts of individuals or organisations that help promote measurement best practice, particularly within the UK; Category Five acknowledges advances in metrology that impact on the processing, properties, performance or characterisation of engineering materials. All categories can be applied for by manufacturing companies, engineering and R&D companies/departments, scientists and researchers from universities, institutes and measurement suppliers.

If you would like to participate in this year's awards contact:
Hannah Edmunds
Ext: 6260
E-mail:
hannah.edmunds@npl.co.uk
www.national-measurement-awards.co.uk

Clubs

Electrical programme clubs

An exciting programme of events has been put together for 2004, covering technologies and applications across the spectrum. The Electrical Programme Clubs are supported by the DTI's National Measurement System (NMS) and have the remit of reporting on research and development, developments in international standards, emerging technologies and relevant information on all areas of interest to measurement experts and anyone wanting to implement good measurement practice in their laboratory.

FREEMET Club members enjoying NPL's new conferencing facilities.

Club Events

Each club holds two meetings a year, often on a theme relating to a specific area of measurement or to an industrial sector. A list of current events is shown opposite. Club meetings provide an excellent opportunity for networking with other experts in the field, and an opportunity to discuss your measurement problems face-to-face with NPL scientists and other experts in the field. Not all club meetings are held at NPL, and visits to member organisations often provide delegates with the opportunity to view state-of-the-art laboratories for themselves.

In addition to club meetings, training courses and workshops are run according to industrial demand. Club members often provide guidance on topics they would like to see covered, and members often receive discount on delegate fees for these events.

The workshops provide a combination of theoretical explanation and hands-on training with the aim of enabling you to implement good practice in your company and reap the benefits of improved quality, and a better understanding of fundamental process behind your measurement.

Websites

Each club has a dedicated website containing presentations from previous meetings, and announcements of future club activities. ANAMET has an additional secure area for members only containing more detailed information, including a discussion forum.

Publications

ANAMET and the EMMA-Club both produce technical reports on special areas of interest. In addition, club members are invited to comment on documents such as Good Practice Guides, and receive a discount on certain publications.

Consultation – Have Your Say

An important club activity is consultation. Through the consultation process we have identified problems that are facing a wide community of measurement practitioners. The issues raised are addressed through a variety of mechanisms, including Good Practice Guides, training workshops and measurement comparisons.

Consultation with club members is also used to formulate the programme of research carried out through the National Measurement System, and in some cases influence standards development. For example ANAMET members played a role in the development of EA-10/12 "EA Guidelines on the evaluation of vector network analysers (VNA)", European co-operation for Accreditation, May 2000.

- **DC&LF Club** Is the forum for those involved in measuring DC and Low frequency electromagnetic measurements, typically up to 1 MHz.
  Next meeting – 10 November 2004.
- **FREEMET** – RF and microwave measurements in free field environments, including antenna measurement and EMC.
- **Microwave Measurement Forum** provides an opportunity for UKAS accredited laboratories to discuss measurement issues, consult on proposed standards and regulations, and highlight issues in new standards.

  Next Meeting – 15 July 2004
- **EMMA-Club** is for those with an interest in Electromagnetic Materials, Measurement and Applications. The EMMA-Club often co-hosts meetings with common interest groups such as the EPSRC Network and the Institute of Physics' Dielectrics Group. The group also produces technical reports, and club members receive a discount on the publication "A Guide to the characterisation of dielectric materials at RF and Microwave Frequencies
  Next Meeting – 21 September 2004
- **ANAMET** is the industry club for those carrying out measurements in the RF, Microwave, mm-wave and above, especially in guided wave environments. As well as meetings ANAMET members contribute and receive technical reports and take part in measurement comparisons. There is a members only web area and an e-mail forum, where you can instantly contact the ANAMET community.
  Next Meeting – 9 September 2004

Other relevant Clubs:

Time and Frequency Club address issues of importance to the UK timing community. The first club meeting of 2004 was held at NPL in Teddington, Middlesex on the 21 April. The agenda included an introduction and welcome to NPL, an outline of the NMS Time programme including opportunities for input from industry plus highlights of the benefits to the UK. We welcome your input into Club meetings, and are happy to host discussions based on suggested topics from club members.

More information can be found at: **http://www.npl.co.uk/time/userclub.html**

The UK Piezoelectric Club aims to bring together manufacturers, secondary processing specialists, end-user companies and academics in the field of electroceramics.

More information can be found at: **http://www.piezoclub.org/**

FOToN UK is organised by the Photonics team at NPL, but will also be of interest to readers. This club focuses on fibre-optic technologies, standards and applications.

More information can be found at: **http://www.npl.co.uk/photonics/clubs/**

Dates for your Diary

July
15 July 2004 – Measurement Forum

September
20 September 2004 – Dielectric Measurement Workshop

21 September 2004 EMMA-Club – Dielectric Measurements

October
6 October 2004 – Harmonic Measurement Workshop

November
10 November 2004 – DC&LF Club – Preparation for Accreditation

Technical Advances

Dielectrics support tissue ladders

In an expanding bio-market, tissue engineering has enormous potential to provide a low cost route to repairing damaged body tissues that is independent of material sourced from a cell or tissue bank. Healthy cells are taken from the patient, and cultured on a foam-like scaffold in a bioreactor. After a period of time a block of living viable tissue will form within the scaffold that can be implanted into the body to repair the damaged area, e.g. cartilage.

The scaffolds used to culture cells have to provide a network of pores that the cells can move through plus an infrastructure of smaller conduits to ensure the supply of nutrients and removal of waste products. Properties such as the size and distribution of pores, the surface morphology of the pores and the surface chemistry of the internal surfaces directly affect cell behaviour. Techniques currently used to assess the structure are limited by the length scale over which they apply and the stiffness of the material. Furthermore these techniques suffer from the limitations of not being able to generate real time data and not being cost-effective in terms of both time and capital investment. The latter are particularly relevant criteria for an SME based industry.

Dielectric Spectroscopy has been identified as a non-destructive approach that could overcome these limitations and also be used in the long-term to monitor real time cell growth.

Dielectric spectroscopy measures the complex permittivity of materials over a very wide band of frequencies – potentially from 10^{-5} Hz to 10^{10} Hz, usually over a range of temperatures. The technique has been successfully applied to complex biological systems, such as wood, but not to gel-like materials such as those used in tissue engineering. In conjunction with Leicester DeMontford University, NPL is involved in a Strategic Research project that is interpreting this complex permittivity data through modelling. The models will be used to assess the volume of open pores and the degree of tortuosity within the structure, i.e. how difficult it is for cells to progress along pores. This technique has the potential to generate information spanning a length scale ranging from nano- to sub millimetre, and offers a novel approach to non-invasive characterisation of biological materials.

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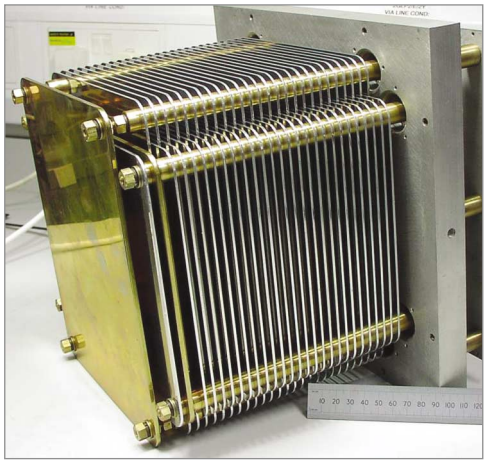
New calibration system for small dc currents



10 nF gas dielectric capacitor used for small current generation.

The ability to measure small currents is an increasingly important area in electrical metrology. Applications include dose measurement for medical applications and the production of ever-smaller semiconductors for the growing number of technical gadgets that pervade modern life. Commercial instruments already have sub-fA resolution, and as semiconductor devices continue to shrink to the nano-scale, so do the electrical currents involved. A current of 1 fA (10^{-15} A) corresponds to a flow of only 10,000 electrons per second. The traceability of these electrical measurements can be critical when, for example, the application is determining the dose level of a radiation source used in a hospital.

Currents in the μA region and above are most easily measured by recording the voltage drop across a calibrated resistor. For currents in the nA region and below, finding and calibrating suitable high value resistors becomes difficult, and a different approach is more suitable. If a constant dc current is used to charge a capacitor, a voltage which changes linearly with time is produced, and conversely if a constant voltage ramp is applied to a capacitor, a dc current can be generated. The non-ideal properties of a capacitor used in this way become very important, especially as the value of the capacitor can only be determined traceably by a conventional ac (typically 1 kHz) measurement.

A new system at NPL uses a selection of air-dielectric (parallel plate) capacitors in combination with low noise electronics to generate and measure currents from 1 nA to below 1 pA. The system can be used to calibrate commercial ammeters (commonly referred to as electrometers when optimised for small currents). The uncertainties offered will depend on the instrument, but at best will range from 10 ppm at 1 nA to 1000 ppm (0.1%) at 1 pA.

For further information contact:
Nick Fletcher
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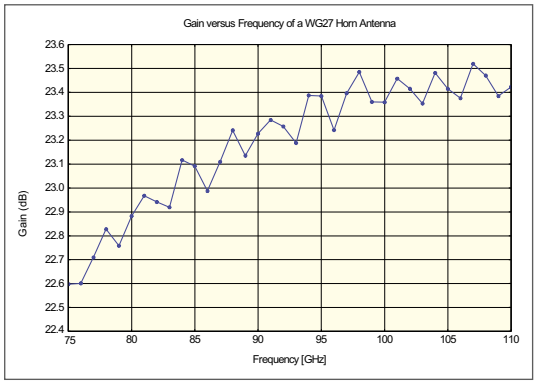
E-mail: nick.fletcher@npl.co.uk

Millimetre-wave antenna measurements

To address the demand for antenna calibrations at millimetre-wave frequencies, the frequency range of the NPL antenna extrapolation range has been extended to allow measurements up to 110 GHz. We are now able to perform gain, pattern and polarisation measurements in the following additional waveguide sizes: WG 23 (33 to 50 GHz), WG 24 (40 to 60 GHz), WG 25 (50 to 75 GHz) and WG 27 (75 to 110 GHz).



Millimetre-wave antenna measurements.

The measurement system uses frequency multipliers to provide the source signal and harmonic mixers to downconvert the signal to a 20 MHz intermediate frequency (IF). To minimise phase variations with temperature and flexure, the local oscillator (LO) cables supplying the reference and test mixers were carefully selected and their lengths equalised. The anechoic chamber also has very good temperature control and recent measurements have shown the resulting phase stability at 54 GHz to be better than ±1° over 16 hours.

For antenna measurements the linearity and dynamic range of the measurement system are critical parameters. These were assessed using switched coupler attenuation standards inserted between the transmitting and receiving waveguides. The incremental attenuation was measured as a function of the source power to detect where the compression of the mixers became significant and to evaluate the noise floor. The usable dynamic range is approximately 50 dB in the frequency range 75 GHz, to 110 GHz, if the effects of noise and compression are to be kept below ± 0.05 dB.

The graph (left) shows the measured gain of a WG 27 horn antenna having corrected for mismatches in the measurement system. The uncertainty in the gain is ± 0.1 dB for a coverage factor k=2. The oscillations in the gain as a function of frequency are typical of pyramidal horn antennas of moderately high gain.

For further information on the antenna measurement capabilities at NPL contact:
David Gentle
Ext: 6717
E-mail: david.gentle@npl.co.uk
Or visit our website at:
www.npl.co.uk/electromagnetic/rfmff/newcal/mwantenna.html

Antenna testing extends range

NPL is now able to test antennas with diameters up to 3 m using its new Spherical Near-Field Antenna test range. This facility, which replaces the Planar Antenna Test Range, can perform measurements from 0.5 GHz to 40 GHz, over a complete sphere, giving the system great flexibility. The system is suitable for a wide range of antenna from low gain beacons through to communication, small earth station, radar and satellite antennas

The range offers a number of standard interfaces for antenna mounting such as 8 x M12 bolts on either a 22 inch diameter or a 12 inch diameter ring. Adapters are also available for other interfaces.

The accuracy of the Spherical Near-Field Range is being assessed in detail to enable its use as a reference standard range. Customers will be able to have their antennas measured with a known accuracy for use as validation standards within their own facilities.

For further information contact:
Phil Miller
Ext: 6464
E-mail: phil.miller@npl.co.uk

Technical Advances

Is anyone listening?

In 2003-2004 Ofcom funded a project to investigate ways of improving spectrum efficiency, lead by Culham Electromagnetics and Lightning Ltd. in collaboration with NPL, Arup Communications, and Warwick University. The objectives were to demonstrate how Frequency Selective Structures (FSS) could facilitate frequency reuse between closely spaced wireless local area networks (WLANs) by creating Isolated Selective Spectrum Islands within a building. The wall screening and FSS required for this project allowed cellular telephone signals to enter but prevented WLAN signals leaving the building, thwarting eavesdropping.

The temporary office suite constructed at NPL

NPL's role in the project was to design, construct and assess a temporary office suite of three rooms with sufficient shielding to enable isolation of the WLAN transceivers. The transmission losses between the rooms and from the rooms to the outside world were measured to assess shielding for mobile phone communications at 900 MHz and the two IEEE 802 11 WLAN bands, 2.4 GHz and 5.2 GHz.

NPL measured the permittivity of various brick and concrete block samples in the WLAN frequency ranges, to facilitate the prediction of propagation through buildings; also some dielectric films were measured, which were used as substrates for the FSS patterns.

The reports on all Spectrum Efficiency Scheme projects will be available on the Ofcom web-site **www.ofcom.org.uk/research/industry_market_research/**

For more information contact:
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IEE European conference on reconfigurable systems

In November 2004 FREEMET will be joining with the Institute of Electrical Engineers (IEE) at Savoy Place, London, for the IEE European Conference on Reconfigurable Systems. This conference will be an opportunity to learn more about research carried out in this area from NPL and across Europe. For further information, or to suggest a paper, please contact Sara Fletcher. More information will be available from our website shortly.

www.npl.co.uk/freemet

New electromagnetic programme underway

Electricity pervades every aspect of modern life. From driving a car or using a computer through to manufacturing an aeroplane or launching a satellite. In all of these situations, and the myriad of others that rely on electricity, the ability to measure electrical quantities in a consistent and repeatable manner is vital to ensuring success.

The National Measurement Systems (NMS) provides the national framework within which primary standards are established. An unbroken chain from the standards through to industrial, commercial and domestic measurements ensures confidence in values with a known uncertainty.

The 2003 - 2006 Electromagnetic Programme covers the realisation, maintenance and development of measurement standards for electrical, magnetic and electromagnetic quantities in the frequency range DC to near optical. Work within the Programme will also develop new and improved measurement methods and facilitate appropriate routes for industrial uptake.

Technical Themes

DC and Low Frequency Electrical Standards

This theme supports the realisation and dissemination of standards for dc and low frequency quantities. Although the ampere is the base SI unit, and as such is used to express derived electrical units, it is the realisation of the volt and the ohm that underpin the metrology of electrical quantities. Physical effects based on quantum phenomena are now used to establish reference standards for voltage and resistance through the Josephson effect and quantum Hall effect respectively. Other parameters such as capacitance, inductance and power are derived from realisations of the volt and ohm.

Technical developments within the Programme will aim to generate ac voltages with the quantum accuracy of dc voltage as well as exploiting the metrological potential of manipulating and counting single electrons.

Radio Frequency and Microwave Electromagnetic Standards

This theme supports the realisation and dissemination of standards for the RF and Microwave guided wave quantities of attenuation, impedance, power and noise from a few kHz to 100 GHz. Work also aims to develop impedance measurements for lower uncertainties with an increased range.

Antenna Calibration and Characterisation

Work in this area covers the calibration and characterisation of a broad range of antenna types from 100 Hz to 100 GHz using the National Open Test Site (OATS), extrapolation range, spherical scanner and Fully Anechoic Room (FAR).

Electromagnetic Field Measurement and Mapping

Electromagnetic fields are widely used in industry for drying, food processing and blister packaging, and also diagnostic and therapeutic uses in medicine. In all these applications the measurement of field strength is critical to ensure correct quantities are administered. The National Radiological Protection Board (NRPB) has set exposure limits for field strength. Traceable measurements of electric field strength and power flux density are essential to ensure exposure levels are correctly measured and limits not exceeded.

Work in this area covers the calibration of probes used for measuring and mapping electromagnetic fields in both air and liquids. Developments will address pulsed fields, non-invasive field measurement and mapping techniques.

NMS Programmes

Electromagnetic Compatibility

The EMC Directive on Electromagnetic Compatibility, introduced in 1995, requires virtually all products manufactured and sold within the EU to be certified to have adequate immunity to electromagnetic fields and acceptable levels of emission.

Work in this area will continue to develop measurement standards and techniques to support such regulations for mains harmonics and electromagnetic emission and immunity. Specific topics covered will include magnetic flux density traceability for non-sinusoidal waveforms, calibration of harmonics analysers for waveforms with interharmonics and flicker and validation of alternative methods for EMC testing.

Waveform Measurements

Signal processing, computing and communications equipment produces and processes signals that are increasingly complex. Appropriate measurement techniques for these signals, supported by measurement standards, are required to demonstrate conformance to specifications across the electronics and telecommunications industries. Work in this area will enable measurements of single electrical pulses for a few picoseconds duration to the measurement of complex waveforms and related parameters.

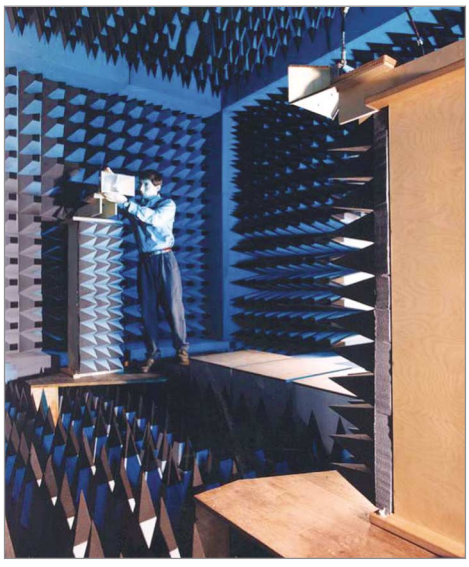
Electromagnetic Material Standards and Measurement

Knowledge of the dielectric properties of a material is used in many applications including food processing, pharmaceuticals, and the defence and telecommunications industries, for sensor and actuator technologies in the motor industry, magnetic media in IT and transformer cores. Additionally the dielectric properties of a material are vital to measure Specific Absorption rate (SAR) to ensure that safety guidelines on exposure to electromagnetic radiation can be followed and to support therapeutic use of electromagnetic radiation.

Work in this theme will provide traceable measurement techniques, supported by reference materials, for the measurement of dielectric materials, magnetic materials and structured electromagnetic materials.

Future Technologies Work within this theme will address technical areas believed to have an important impact on measurement capabilities over the next three to six years. Areas included are nanoscale electronic devices and microelectromechnical devices, which have significant potential to improve the accuracy with which electrical quantities are realised. They may also create their own requirements for measurement capabilities on a scale appropriate to the device. Work will also address the emerging requirements for electrical standards and measurement techniques within biotechnology and terahertz technologies.

Full articles on these areas of future technologies will be included in future issues of this newsletter.



Calibration of EMC horn antennas

For further information of any aspect of the new Programme, or on how you can become involved contact:
Electromagnetic Enquiry Point
Telephone: 020 8943 6880
Fax: 020 8943 6098
E-mail: electromagnetic@npl.co.uk

New SSfM programme set to support electromagnetic area

The third Software Support for Metrology (SSfM) programme began in April 2004. As with previous SSfM programmes it will provide mathematics, statistics and software engineering support to all measurement fields covered by the National Measurement System. In particular, it is well placed to give new forms of support to the electromagnetic metrology area.

EuroMetroS home on the web.

The SSfM emphasis on disseminating a range of best and good practice continues. However, the previous focus on provision of guides and training courses is to be complemented by technical advice services, an accredited software validation service, as well as case studies.

There are three areas of the new SSfM programme that are expected to be of particular relevance to the electromagnetic measurement field.

One is Signal Processing, in which SSfMwill develop a new Good Practice Guide, including material on such core SSfM topics as uncertainty evaluation, software validation and numerical correctness of algorithms. Another is Data Curation applied to calibration history data, which includes extracting information on equipment drift from calibration history data in order to improve uncertainty budgets. The third area is the validation of software embedded in measurement systems and instruments, for which SSfM will develop an accredited service.

Other areas that are also likely to be of relevance are data fitting, uncertainty evaluation and associated statistical modelling, data fusion, data visualisation, and the development of a Good Practice Guide for Internet-enabled calibration.

The home EuroMetroS website (www.eurometros.org), set up under a EUROMET project with SSfM funding, provides access to a wide range of software routines of relevance to metrologists. The content of this website will be expanded under the new SSfM programme and can be expected to contain many routines of relevance to the electromagnetic area.

For details of the new SSfM programme contact:
Bernard Chorley
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Current NMS Programmes

Acoustics
Biotechnology
Electrical Metrology
Flow Metrology
International
Ionising Radiation
Knowledge Transfer
Legal Metrology
Length Metrology
Mass Metrology
Measurement Technologies Research (MTR)
Optical Radiation
Photonics
Quantum
Thermal
Software Support for Metrology
Time Metrology
Valid Analytical Measurement (Chemical)
Valid Analytical Measurement (Physical)

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Fax: 020 7215 1978
E-mail:
enquiry.nms@dti.gsi.gov.uk

Conference on Precision Electromagnetic Measurements, 27 June - 2 July 2004 Queen Elizabeth II Conference Centre, London

NPL are proud to be hosting the 24th Conference on Precision Electromagnetic Measurements (CPEM 2004). This conference brings together experts in the field of electromagnetic measurements to report the results of latest research, and provides a forum for the exchange of ideas, knowledge and experience.

We are very please to announce that the following speakers have kindly agreed to talk at CPEM:

Lord David Sainsbury is the Parliamentary Under-Secretary of State for Science and will give the opening address.
Prof. Theodor W. Hänsch is the Director of the Max-Planck-Institut für Quantenoptik and will present on femtosecond laser frequency combs, which have firmly established their role as ultraprecise tools for optical frequency metrology over the last five years.
Prof Sir Peter Mansfield of the University of Nottingham was awarded the 2003 Nobel Prize for Medicine. He will speak about snap-shot MRI which speeded up the imaging process to enable the technique to be used practically as an invaluable diagnostic tool.
Prof Heikki Seppä is the Research Director for VTT Information Technology. At CPEM he will be discussing the applications of Microsystems in precision measurements. Micro Electro Mechanical System (MEMS) is a new potential technology to fabricate DC and AC voltage references, AC/DC converters and high frequency power sensors.
Prof Will Stewart (IEEE). Professor Stewart is expert to the Foresight project "Exploiting the Electromagnetic Spectrum" which has reviewed the applications most likely to give rise to major scientific innovations over the next ten to twenty years covering the whole spectrum from RF to X-ray including terahertz, infrared and visible. His talk at CPEM will describe the results of this study, the applications and technologies considered most promising and will review the implications for measurement needs and technology.
Prof Andrew Wallard is the director of the Bureau International des Poids et Mesures (BIPM). He will discuss the challenges and opportunities for metrology as the world of metrology is changing quickly and now extends far beyond its traditional boundaries in physics and engineering.
Dr Dave Wineland is currently a NIST fellow and Ion-Storage Group Leader in the time and frequency division at Boulder. At CPEM he will present a talk entitled "Quantum Computing and raising Schrödinger's cat" dealing with the physical systems currently being considered for building a quantum computer.
Prof Xi-Chen Zhang is Director of the Centre for Terahertz Research at the Rensselaer Polytechnic Institute and will talk at CPEM about the recent development of terahertz (THz) wave time-domain technology. It is believed that new T-ray capabilities will impact a range of interdisciplinary fields, including: communications, imaging, medical diagnosis, health monitoring, environmental control, and chemical and biological identification. Prof Zhang will also report how THz wave imaging contributes to NASA programs in the detection of defects in space shuttle insulating materials, which will be used before the next launch in September 2004

The CPEM programme will consist of poster and oral technical sessions plus an exhibition covering electrical and electromagnetic measuring equipment.

For more information, please visit our conference website at **www.cpem2004.npl.co.uk**.

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