NPL National Physical Laboratory

Electromagnetic *News*

A National Measurement Newsletter

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Securing signals for Europe's navigation system

A antenna measurement expertise at NPL has helped ensure the success of the first test satellite in Europe's ambitious new global navigation system.

GIOVE-A, the first satellite in the European Space Agency's (ESA) Galileo constellation, was launched in December 2005 and transmitted its first navigation signals on 12 January 2006. It orbits at an altitude of 23,260 km and makes a complete journey around the Earth in 14 hours and 22 minutes. Surrey Satellite Technology Ltd (SSTL) developed the Galileo System Test Bed satellite to validate key Galileo technologies and secure Europe's frequency allocation - the process by which radio frequency bands of the electromagnetic spectrum are regulated.

The ground station for reception of GIOVE-A's signals is the Chilbolton Observatory in Hampshire. Each time the satellite is visible the 25 m Chilbolton reflector antenna activates and tracks GIOVE-A to verify that the satellite's signals conform to the Galileo system design specification. ESA initially had concerns about the suitability of Chilbolton's feed antennas, particularly the port-to-port isolation. NPL worked with the developers of GIOVE-A, SSTL, to verify test results on new improved feed antennas in its new anechoic chamber.

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Safe radiation

All electronic devices give out a range of low-level electromagnetic radiation in the form of electromagnetic fields (EMF). Every new electronic device sold must carry a CE mark – this is a declaration by the manufacturer that the product meets all the appropriate provisions of the relevant legislation implementing certain European Directives, including that the EMF radiation is at a safe, low level.

Besides EMF from devices, we are exposed to broadcast signals all the time, such as those from radio, TV, emergency services, and mobile phones. Where there are a number of electronic devices close together the EMF produced by them will interact; it is possible that there will be constructive interference between them, and between broadcasts that increases the EMF at a given frequency, at a given moment in time. In April 2004 a new directive came into force setting safe levels of EMF radiation in the workplace. The directive sets out a duty of care on employers which becomes part of UK law in April 2008. All managers must ensure that their employees are working in a compliant environment.

Whilst it is cost effective to use field sensors (or probes) to detect the levels of EMF, these devices are unable to determine the frequency spectrum of the radiation. It is possible to distinguish field levels at different frequencies by using antennas and spectrum analysers. This gives a clear picture of where the highest levels of radiation are, allowing the sources to be pinpointed, as well as helping with the implementation of mitigation measures.

It is implicit in the requirements of the Directive that the measuring equipment used in any safety assessment is calibrated and that the measurement inaccuracies or uncertainties are taken into account. NPL has a long history of calibrating field probes and antenna used in the testing of EMF radiation and has built up significant expertise in this area. NPL's facilities cover the frequency range from DC to 45 GHz, easily encompassing the range required for the core of the Directive, which cites a minimum range of 100 Hz to 10 MHz .

Further information on the implementation and impact of the Directive can be found at

www.hse.gov.uk/radiation/nonionising/issues.htm

For more information on the calibration of EMF Probes, contact
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Improved electricity metering?

Domestic electricity meters have to measure electricity consumption even when there are highly distorted current waveforms on the supply. Current distortion is common because of the large number of non-linear power supplies that exist are in today's electrical appliances.

Provided the voltage sine wave of the mains has low distortion, the measured energy contribution of the harmonics associated with this highly distorted current is small. However, the distortion of the mains voltage waveform is increasing year-on-year, particularly at the 5th harmonic, due largely domestic appliances.

With the increase of domestic co-generation and other renewable energy sources, the quality of the mains voltage sinewave is likely to get worse leading to more harmonic power consumption.

Traditionally electricity meters have been assumed to measure sine wave power and calibrations of instrumentation ranging from primary standards to domestic meters are made on this basis. In response to the growing need for power measurement under non-sinusoidal conditions, NPL has developed a new facility for the calibration of wattmeters using distorted waveforms.

The new power standard builds on NPL expertise in digital sampling technology. A new Internet based waveform library will shortly be launched which will allow users of the NPL service to select from a set of real-world waveforms. The NPL calibration system will synthesise and apply the selected waveforms to calibrate the customer's wattmeter.

NPL is a world centre of excellence for power quality measurements and it is planned that the new calibration capability will address some of the requirements of emerging power quality standards such as IEC61000-4-30 and the requirements for traceable power measurements in the presence of distortion. The new standard will add to NPL's power quality capability that covers a full range of measurements in support of power measurements and low frequency EMC community.

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Coherent health

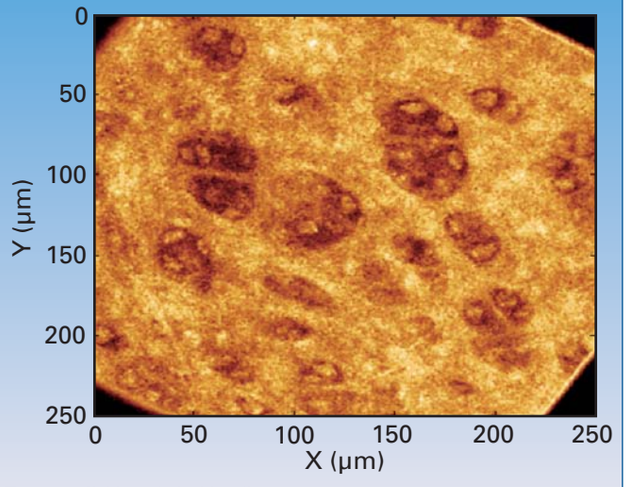
Optical Coherence Tomography (OCT) is a non-invasive technique for looking at the internal structure of biological tissue. NPL is working with industrial and academic partners to develop a better understanding of OCT and exploit new applications.

In the eye

When OCT is used to measure the human eye, the results are given in optical path lengths. If the refractive index of the sample is known then the geometric distance can be calculated. NPL is leading the development of an algorithm to separate the refractive index and the geometric depth. This may enable OCT to be used as a diagnostic tool to detect diseased tissue, and potentially as a replacement for biopsies.

Tissue scaffolds

NPL is using OCT to investigate the properties of tissue scaffolds. These are structures that are seeded with cells and used as a frame upon which to grow tissue formations, such as arterial tissue for vascular grafts. They are also used to distribute the nutrients that cells need to grow. NPL is using OCT to examine the complex fluid dynamics around the pores of the scaffold, and to measure the flow of cells and nutrients. Scientists are also creating images of the changes and deterioration in a scaffold while it is replaced by tissue as cells grow. This affects the movement of nutrients. Knowing how the wall thickness changes, and how this affects the structural and material properties, can ensure the most efficient design of new scaffolds.



Tissue scaffold seeded with cells.
Image provided by Professor Ricky Wang of Cranfield University

Get your teeth into this

OCT is also being examined as a potential tool for imaging teeth and dental compounds to monitor the health of teeth, the effectiveness of dental treatments and the curing of the compounds themselves. Having a better understanding of the internal structures of the teeth after treatment should lead to more effective treatments and less time spent in the dentist's chair!

NPL has launched up an OCT interest group. For further information contact
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Making magnets more attractive for electrical machines

NPL is helping aircraft manufacturers to replace high-maintenance hydraulics and pneumatics with electric systems that use less fuel and engine power, reduce maintenance costs and improve reliability.

For example, an electric environmental control system (ECS) - the system that provides air supply, temperature control and pressurization on aircraft - consumes 14 per cent less engine power than its pneumatic equivalent. Airbus achieved a 1,500 kg weight reduction on the A380 using more electric flight control systems.

However, many electric systems still have to be improved.

Electrical machines are often used in harsh environments, so considerable demand is placed on the materials they are made of. A joint prospect between NPL, Powdermatrix, Rolls-Royce, Goodrich and QinetiQ will model the performance of magnetic materials, characterise both soft and hard magnetic materials and look at the wire insulation of the systems.

The data will be used by modelling experts to develop new tools for predicting the performance of a device before expensive prototyping begins. NPL will guarantee the validity of data acquired during the programme.

This work, partly funded by the DTI's Technology Programme, will highlight the wider capabilities and opportunities for electrical machines, from transport to domestic appliances.

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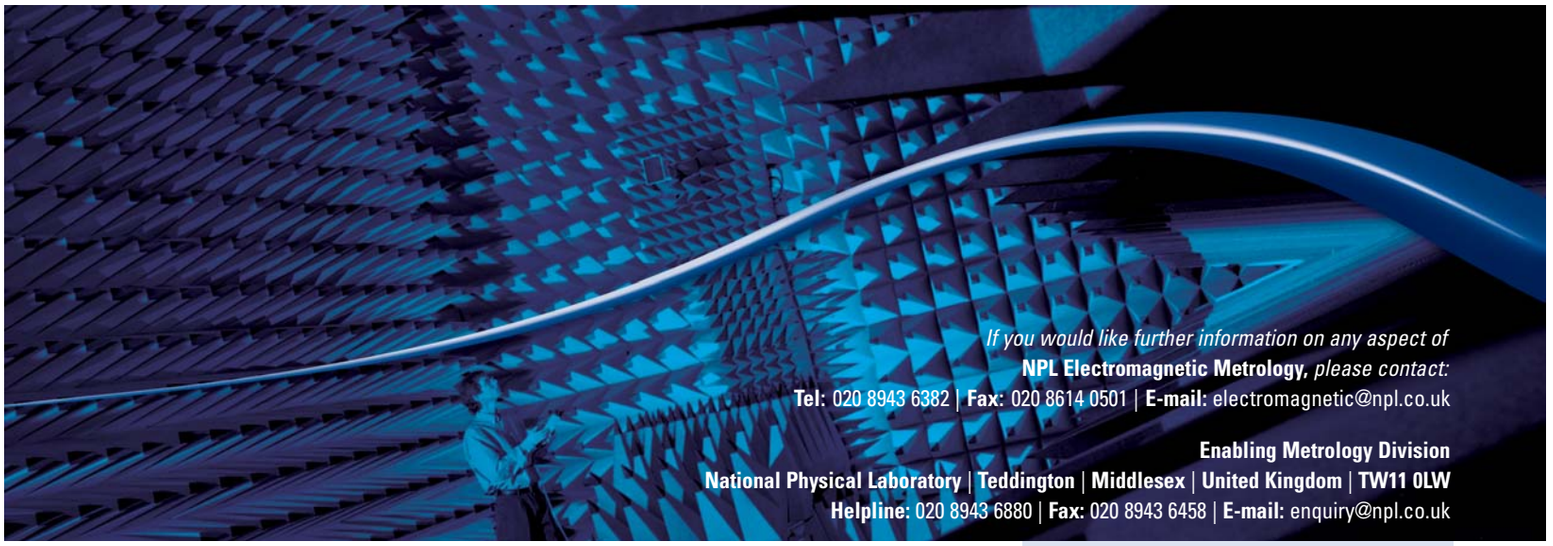

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Calibrating connectors

A technology child of the 1960s - the 7-16 coaxial connector - is enjoying increased use due to its suitability for high-performance military systems and cellular base station installations.

NPL has set up calibration services in response to growing demand for assurance of measurements of devices using the 7-16 connector.

The 7-16 connector is a precision connector with excellent electrical performance including low insertion and return loss, good connection repeatability and high power handling capability. It can cover a frequency range from DC to 7.5 GHz. The 7-16 connector is mechanically robust and exhibits low Passive Inter-Modulation (PIM).

High quality devices fitted with 7-16 connectors are available for use as standards for calibrating Vector Network Analysers (VNAs), reflection analysers and other similar measuring instruments.

Currently impedance and antenna measurements are available in this connector size, with attenuation and power measurement services coming soon. A service providing measurements of the characteristic impedance of precision air lines in this line size is also available.

For more information on measurement services relating to RF connectors, contact chris.eio@npl.co.uk 020 8943 6197

Forthcoming events

10-11 Octobet 2006
Understanding and Evaluating Measurement Uncertainty
www.npl.co.uk/ssfm/training/und_eval_meas_unc.html

02 November 2006
Laser Safety Workshop
www.npl.co.uk/photonics/training/laser_safety.html

15-16 November 2006
Developing Advanced Scientific Engineering Spreadsheet Applications
www.npl.co.uk/ssfm/training/dev_spread_apps_scieng.html

21-22 November 2006
Simulation of Experiments
www.npl.co.uk/ssfm/training/sim_exp.html

Spreadsheets for scientific engineering

Spreadsheets are a ubiquitous part of office and scientific life, however most people only use a small part of the available capabilities.

Of those who do use them in more depth, very few consider applying the rigours of programming to developing spreadsheet applications.

The Software Support for Metrology (SSfM) group at NPL run a two day course to highlight the need for proper design and testing of scientific spreadsheet applications, and to teach the attendees how to implement this.

The course shows how to apply software development techniques to spreadsheets using VBA, including: replacing formulas with functions, layout, coding conventions and review. The delegates work through exercises to understand the relationship between Excel and VBA.

Testing is a key component of software development. The SSfM team at NPL have developed a technology for testing spreadsheet applications based on unit testing technology. The second day of the course introduces delegates to NPL's spreadsheet testing technology.

The course will next be run on 15th and 16th November 2006.

The SSfM team has extensive expertise in spreadsheet development and testing; see the SSfM spreadsheet best practice guide (BPG7) - www.npl.co.uk/ssfm/download/bpg.html

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For further information, event details and contacts visit the website: www.npl.co.uk/electromagnetic/

6516/SEA/1.3k/0906