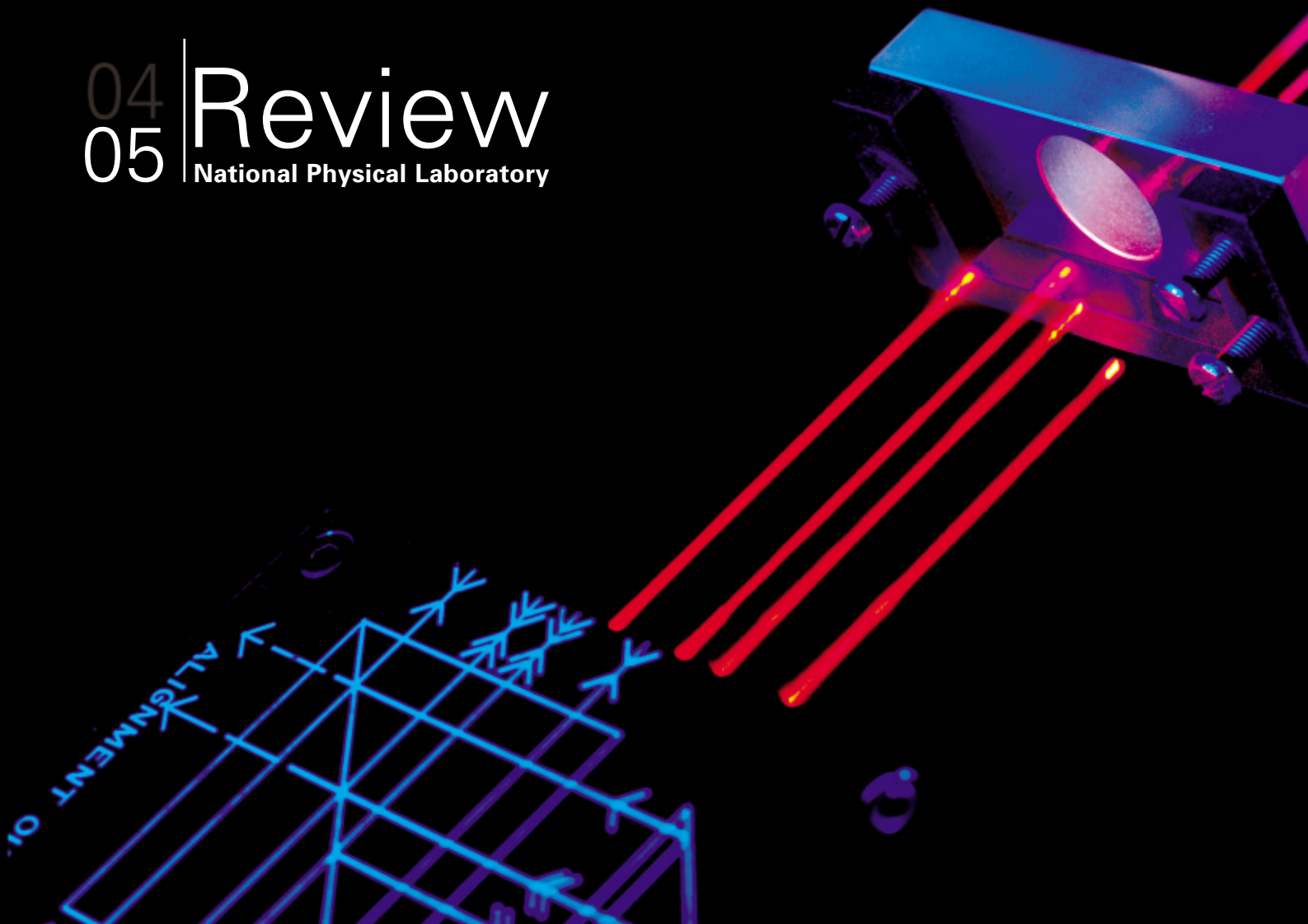
NPL
National Physical Laboratory

04
05

Review

National Physical Laboratory



Our vision for NPL is to be the national measurement institute that delivers the highest economic and social impact, through excellent and responsive science.

We will deliver this through:

- Excellence in science
- Increased exploitation of that science to boost UK competitiveness and quality of life
- Integrity and independence as a national asset
- Enhanced international standing

The National Physical Laboratory is operated on behalf of the DTI by NPL Management Limited, a wholly owned subsidiary of Serco Group plc

serco

[On the cover]

Custom-made indentation measuring system, a key part of NPL's hardness calibration facility. Within the last two years NPL has established a national standard for hardness in the UK and has seen a good take up of the measurement service by industry.

National Physical Laboratory | Hampton Road | Teddington | Middlesex | United Kingdom | TW11 0LW

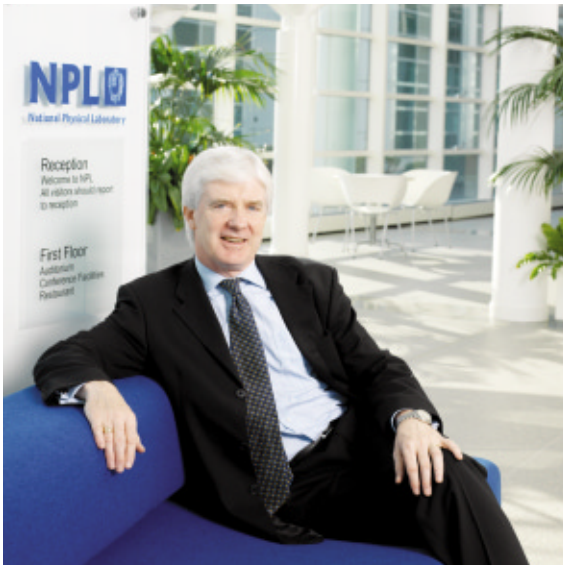
Switchboard 020 8977 3222 | **NPL Helpline** 020 8943 6880 | **Fax** 020 8943 6458 | **www.npl.co.uk**

04
05

Review

National Physical Laboratory

NPL's new laboratory at Teddington is among the world's most extensive and sophisticated measurement science buildings.



Welcome

NPL is proud to be one of the world's foremost national measurement institutes. We research, develop and partner with others to apply leading edge measurement science. Our work delivers levels of impact for the nation that can be measured in terms of billions of pounds and millions of improved lives.

We achieve these outcomes in close partnership with the Department of Trade and Industry, which funds the majority of our programmes; and with hundreds of other partners across business, government and academia.

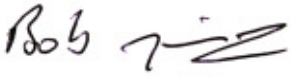
There is an adage that you cannot manage what you cannot measure. Measurement excellence is vital to innovation and the quality control upon which UK competitiveness depends, NPL's pioneering measurement science is primarily focused on the emerging technologies that will fuel our future economic growth. Microsystems, nanotechnology, biotechnology, advanced materials and new energy systems all feature highly in current programmes.

A commitment to quality of science underpins everything we strive for. Our scientists' achievements have been recognised by many awards, for outstanding scientific papers, for distinguished service to industry and through professorships and fellowships; and over the last three years we have doubled our rate of publication of scientific papers.

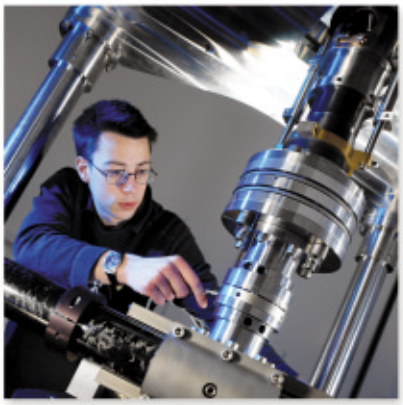
Today, NPL is on the threshold of an exciting new phase in its life as a national centre of scientific excellence. The New Science Contract that we have signed with DTI (for the period 2004-2014) coincides with the transfer of NPL into its new building and the emergence of new technologies which have the potential to revolutionise UK industry and which are highly dependent on NPL's core skills in metrology.

Our vision for NPL is to be the national measurement institute that delivers the highest economic and social impact, through excellent and responsive science.

Finally, I should stress that NPL's performance is not just about wealth creation. We help the government safeguard its citizens, whether through accurately measured radiotherapy for cancer treatment, the appropriate regulation of medical ultrasound or by monitoring air quality. NPL believes in public service. We have entered our second century determined to maximise the impact we have on the life of the nation.



[Bob McGuiness, Managing Director | bob.mcguiness@npl.co.uk]



NPL

The United Kingdom's national measurement institute

NPL is a world-leading centre of excellence in developing and applying the most accurate measurement standards, science and technology available to man.

For more than a century we have developed and maintained the nation's primary measurement standards. These standards support an infrastructure of traceable measurement through the UK and the world that ensures accuracy and consistency. The NPL mission affects many aspects of our life.

Good measurement improves productivity and quality; it underpins consumer confidence and trade, and is vital to innovation. We undertake research and share our expertise with thousands of organisations and individuals to help enhance economic performance and the quality of life.

Our services range from free technical advice, joint projects, training, secondments, problem solving consultancy, contract research to highly accurate UKAS accredited measurement services. For information on how you can access our expertise see page 29.

NPL is a UKAS-accredited calibration (0478) and testing (0002) Laboratory

Baptiste Lamarre, (left) and Marc Bailey, Biotechnology group, discuss a protein purity profile of a batch of recombinant proteins. NPL has invested to build capability in measurement techniques for proteins, and latterly in diagnostics and drug discovery.

Science and innovation

One of the challenges for a national measurement institute is to adapt its science to the rapidly changing demands on metrology. Emerging technologies, such as biotechnology and nanotechnology, will provide a foundation for much of the UK's future manufacturing. For industry to exploit these technologies innovatively, the UK needs a measurement infrastructure that meets the demands of new materials and new fabrication processes.

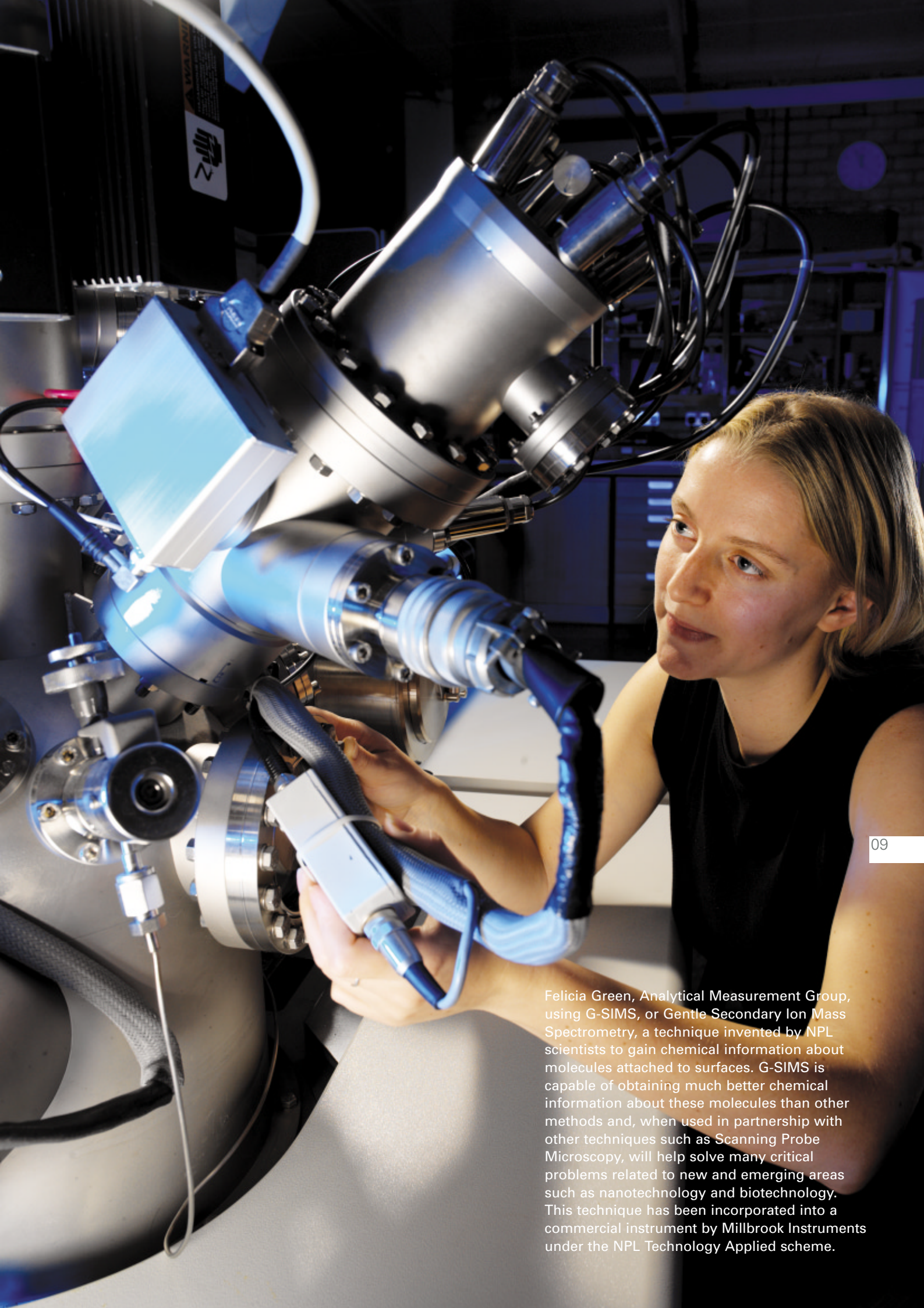
NPL's mission is to create and support the infrastructure, using the skills of multi-disciplinary teams and working with partner organisations best placed to understand the needs of new markets. As well as continual exploration of new science to improve existing standards, NPL tracks emerging technologies, supports appropriate regulation and generates innovative measurement methods in time for industry to develop new and improved products with confidence.

In biometrology, NPL aims to be the leading European national measurement institute in co-operation with LGC and others. Since 2000, NPL has built an impressive capability. Initial investment from its Strategic Research Programme built links with industry, government and other stakeholders. In 2001 the EC-funded Bioexpress Foresight study enabled NPL to examine the standards and measurement required in biotechnology, followed by a key role in the Metrology for Biotechnology (MfB) programme funded by the National Measurement System (NMS), which focused on biopharmaceutical product characterisation.

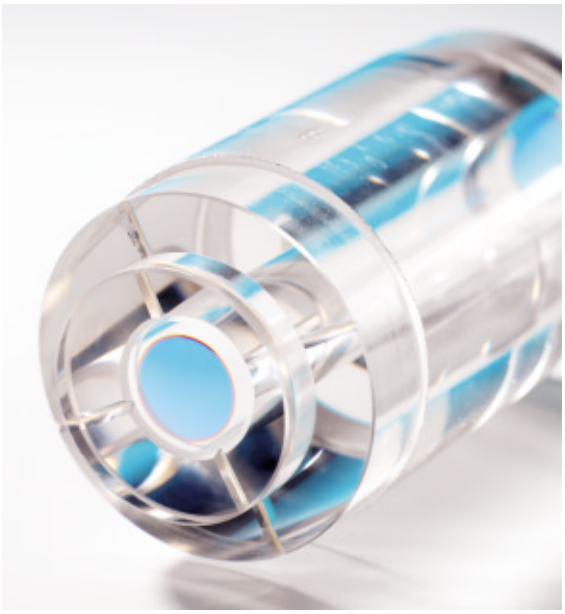
One of NPL's current biotechnology projects is improving fluorescence imaging techniques for analysing proteins. Single molecule analysis techniques enable the measurement of different molecules, which significantly improves the quality of data. This research could lead to diagnostic systems for the early detection of diseases.

NPL is also formulating the new NMS programme on Measurement for Emerging Technologies, which will include interdisciplinary work in the biosciences. Partnership has been key to NPL's success. Metrology for emerging technologies requires much larger budgets than any single organisation can fund. By joining forces, some 30 partners have been involved in developing this biometrology capability, helping the UK to gain a world leading position.

[Kamal Hossain, Director, Science and Technology | kamal.hossain@npl.co.uk]



Felicia Green, Analytical Measurement Group, using G-SIMS, or Gentle Secondary Ion Mass Spectrometry, a technique invented by NPL scientists to gain chemical information about molecules attached to surfaces. G-SIMS is capable of obtaining much better chemical information about these molecules than other methods and, when used in partnership with other techniques such as Scanning Probe Microscopy, will help solve many critical problems related to new and emerging areas such as nanotechnology and biotechnology. This technique has been incorporated into a commercial instrument by Millbrook Instruments under the NPL Technology Applied scheme.



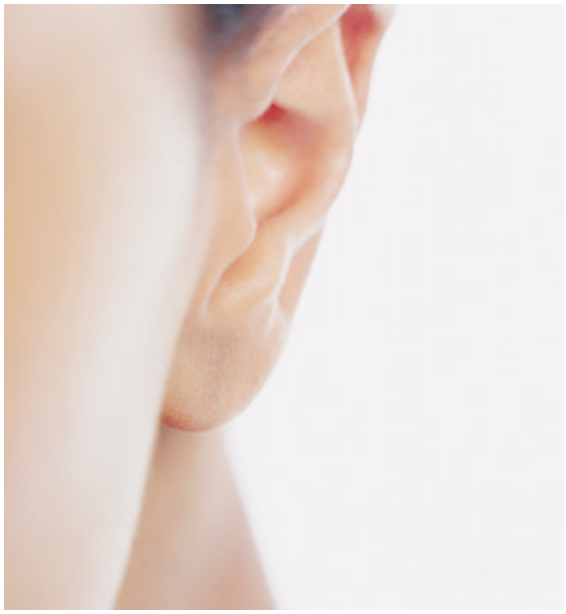
The ultra-low-expansion glass cavity used to stabilise the 674 nm "clock" laser used in the world's most accurate optical frequency measurement.

Nanotechnology is another emerging area which is central to NPL's science strategy. Measuring many quantities at the nanoscale (10^{-9}) is difficult. For example, the Analytical Measurement Group is looking at an atomic force microscope (AFM) to measure forces at surfaces. This could improve the understanding of how antigens bind to antibodies and explore how proteins bind to surfaces. In turn this could help prevent catheters and other medical implants binding to tissue, currently a serious problem.

The difficulty in measuring surface forces at nano level is to know how hard the tip of a cantilever is pressing down on a sample for a given deflection. This requires knowing the spring constant of the cantilever – how much it bends in response to a force. NPL's solution is a reference spring against which an AFM's cantilever can be compared. A capacitor of one tenth of a millimetre in diameter has a lower fixed plate and an upper plate that acts like a small spring carrying a small weight. A current applied to one of the plates causes the pair of plates to move up and down in relation to a fixed plate. By measuring the current leaking between the plates and monitoring the displacement using an optical interferometer, the spring constant can be calculated without needing to know details of the capacitor geometry. This will allow NPL to develop a new service, delivering optical calibrations at Teddington and making the technology available off-site for the calibration of AFM cantilevers.

The Time and Quantum Detection Group at NPL, working in conjunction with Cambridge University, is aiming to develop a new electrical standard with an accuracy of one part per million, based on the ability to produce, control and detect currents at the single electron level. This could lead to significant technological advances in quantum computing, communications and metrology.

NPL scientists have measured optical frequency with the lowest uncertainty ever achieved, whilst researching the use of single strontium ions confined in an electromagnetic trap as the latest generation of atomic clocks. The frequency of the light absorbed by these trapped ions is monitored and this allows measurement of time with an unprecedented accuracy.



In another healthcare-related breakthrough, NPL's materials scientists have proved the concept of a prototype piezoelectric device that mimics the cochlea in a human ear. It can be tuned to respond to different sound frequencies. A future miniature version of the device, with up to 100 sensors, may be positioned on sensory cells in the ear to feed signals down the auditory nerve to the brain, creating a revolutionary new wireless hearing aid. This work was carried out in partnership with Technology Transfer Ltd under a Scottish Enterprise Smart Award. Challenges faced by NPL scientists include the need to maintain detectable frequencies at a microscale and the selection of a biocompatible material to be moulded into the cochlea.

The technique involves the controlled transport of single electrons through one-dimensional channels etched in gallium arsenide devices. However, not all 'packets' of current travelling through the gallium arsenide contain just a single electron. NPL researchers have resolved this by inserting a 'quantum dot' in the channel. The dot acts as a barrier to packets trying to get more than one electron through – only one electron can squeeze through at a time. If this principle can be successfully demonstrated as a quantum standard of current, the work will feed into NPL's NMS programmes supporting calibration services for small currents, high value resistors and capacitance.

In radiotherapy, NPL has developed the world's first graphite calorimetry prototype standard for proton therapy. Radiotherapy commonly uses X-rays or electron beams. These are difficult to target precisely and are absorbed in areas of the body where they are not required. Protons offer much greater accuracy of treatment, but to date the technique has lacked reference standards. NPL's new prototype standard offers the prospect of accurately controlled proton therapy.

The science of measurement at NPL is both challenging and exciting, with major advances being made throughout 2004. These demonstrate the constant search required for metrology techniques and standards that will help industry to develop safe and effective products, and government to formulate regulations to protect the citizen.

Julia Pearce, Theory and High-energy Dosimetry group, positioning an ionisation chamber within a water phantom ready for calibration in an electron beam. In hospitals, ionisation chambers calibrated by NPL are used to measure dose. Complex simulations are needed to calculate corrections for these chambers, often taking weeks of effort. Computing expertise is being used to harness computers across the NPL network to complete simulations in three days instead of a year. This scale of improvement enables NPL to complete far more calculations for the NMS Ionising Radiation Programme than was previously possible.

Knowledge application

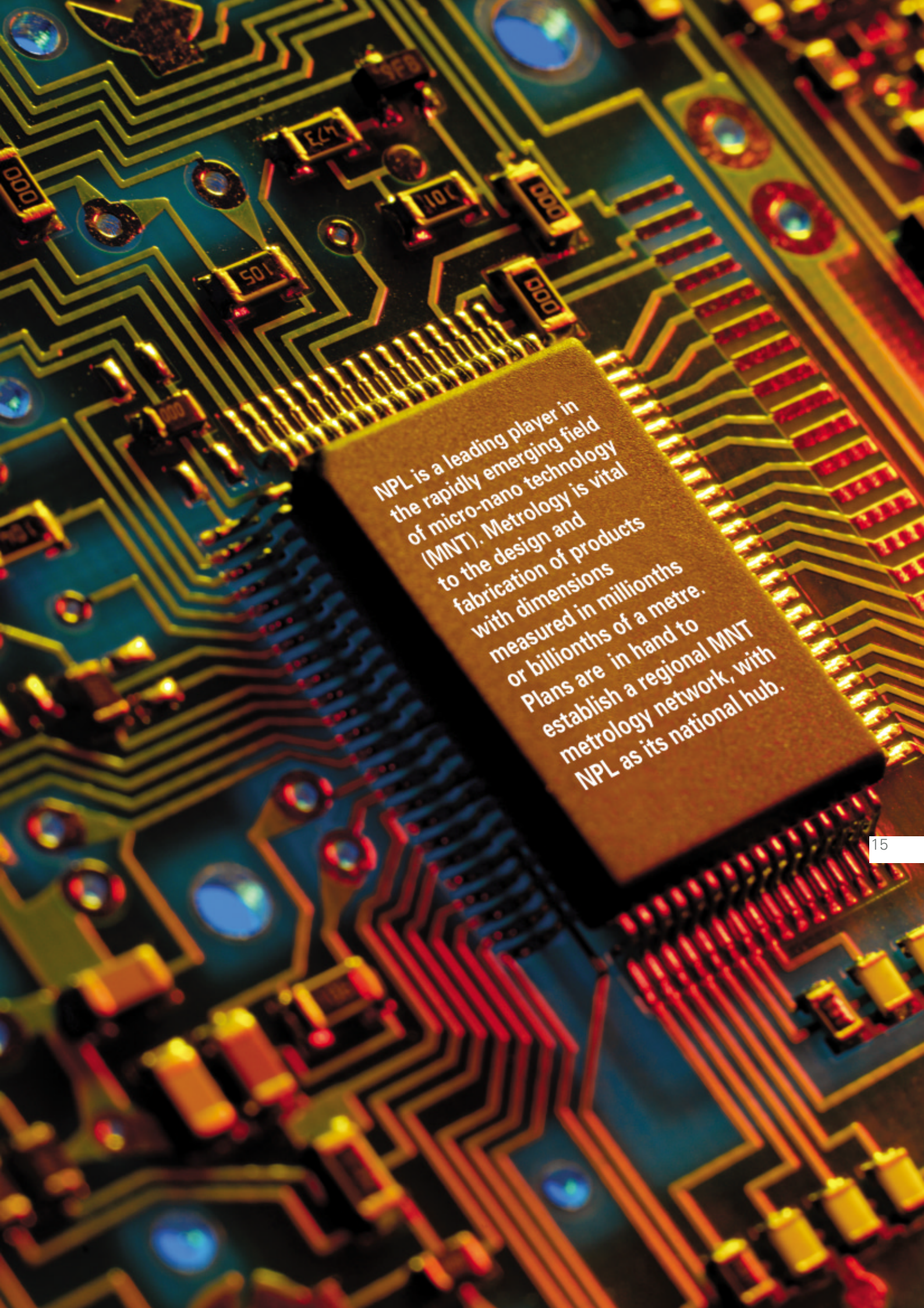
Scientific excellence is the lifeblood that flows through NPL's mission, but it is not its ultimate objective. NPL is an applied research and development organisation, focused on taking breakthroughs in metrology and making them valuable, by delivering economic and social impact for the nation.

NPL works closely with DTI in applying best practice in research programme design, running continuous detailed assessments of user requirements for measurement and keeping abreast of the emerging technologies that could help to meet them. NPL uses these foresight assessments to shape research programmes at their inception, routinely spending a year or more on programme design, so that investments can be made with confidence.

When programmes are formulated correctly, they create a direct link between ground breaking measurement research and its impact on industry and society. This generates knowledge products that translate NPL's scientific knowledge into a readily usable form. This is generally more than a research report, for example a new measurement service, best practice guide, software code or patented intellectual property (IP). Knowledge products are promoted into the potential user community, from which NPL will have engaged partners since programme inception.

NPL's approach to programme design is demonstrated in the introduction of micro electro mechanical systems (MEMS) into new NMS programmes. MEMS are mechanical components at the micrometre or millimetre scale. Their small size will enable different sensors to be combined on a single device and several variables to be measured simultaneously. Clearly this is a disruptive technology that offers users smaller, more versatile, low cost measurement devices.

When NPL began to advise DTI on the new Acoustic Metrology programme, it took account of Foresight work that had identified silicon-based MEMS as having the potential to revolutionise acoustical measurement practice and overcome the problems associated with current generation instruments. The thinking drew on work already under way with an automotive manufacturer to test multi-sensor acoustic MEMS. A group was assembled from the user community, instrument makers and academia to assist take-up by ensuring IP is quickly exploited in commercial instrumentation and by working to remove barriers associated with existing documentary standards.


NPL is a leading player in the rapidly emerging field of micro-nano technology (MNT). Metrology is vital to the design and fabrication of products with dimensions measured in millionths or billionths of a metre. Plans are in hand to establish a regional MNT metrology network, with NPL as its national hub.

ALEXANDER TSIARAS / SCIENCE PHOTO LIBRARY

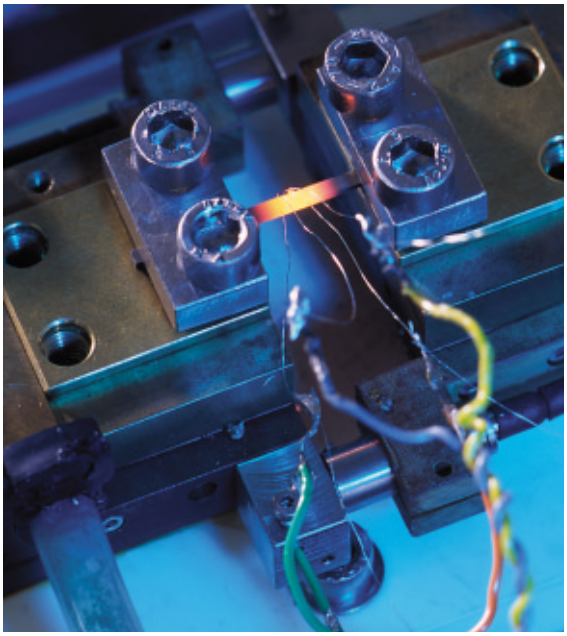
Among the varied inventions emerging from NPL in the last year is a novel technique for the controlled removal of radioactive contamination using high power ultrasound cavitation. A patent has been submitted and discussions are under way with potential partners in the nuclear industry.

Shown here (*left to right*) are Alan Dinsdale and Hugh Davies, Metal Performance Materials Group, with Hudai Kara of Johnson Matthey who took a one-year secondment with NPL to build specific expertise quickly. Development of pyro-metallurgical process simulation software has led to new expertise, the springboard for a commercial product offering cost reduction and improved competitiveness.

New knowledge products emerge from NPL's research programmes monthly. In the field of nuclear medicine, NPL's radioactivity and software teams have built a web-based system, where a database containing the results of calibrations for hospital ionisation chambers can be interrogated remotely, instead of relying on data transcribed from certificates. This removes a process potentially prone to error and safeguards patients. This system is currently in beta testing with three hospitals.

In another programme NPL is exploring how better measurement can make drug manufacturing more efficient and reduce time to market. A common testing technique, circular dichroism spectroscopy, is used to ensure the continuing quality of a drug and traceability to the version that passed extensive clinical trials. In a trial with 27 laboratories, NPL found that results varied widely. NPL isolated the aspects of the testing techniques causing the variation. A vast improvement in results was achieved by introducing simple best practice such as calibration of equipment.

[David Richardson, Director, Business Development | david.richardson@npl.co.uk]
[Glenis Tellett, Head of Knowledge Transfer | glenis.tellett@npl.co.uk]



NPL's Technology Applied scheme allows companies to promote NPL-generated intellectual property incorporated into their own products. NPL delivered its miniature thermo-mechanical test system as a market-ready product, together with valuable sales leads, to Instron, who are now marketing it worldwide.

Partnership is the key to success in knowledge exploitation. Joint Industry Projects (JIPs), secondments and consultancy for SMEs are all products being provided as part of NMS's commitment to implementing the DTI Innovation Review. In one JIP NPL, Arden Photonics and Halcyon Optical Services will be developing a new, fast measurement technique for laser beam characterisation. This work will underpin the transition from a research project to a validated technique for the laser manufacturing and associated user industries.

A feature of NPL's commitment to partnership is an increasing level of regional activity. NPL is already collaborating with several Regional Development Agencies, which is proving an effective way of establishing strategic partnerships to exploit knowledge, by embedding metrology into regional innovation centres.

NPL's work for and with industry – through contract research, measurement services, collaborations and partnerships - operates at many levels. These include small consultancy projects, clubs, calibration services and major research projects. By working with NPL, business has access not just to individual, world leading scientists, but also to a huge pool of knowledge and expertise funded for the national good and supported by professional managers who understand the science arena. NPL is a national resource readily available to any organisation in the UK.

NPL sells turnkey systems to other national measurement institutes looking to establish their own state of the art facilities. Malcolm White, Optical Detectors team, operating the UV-visible spectral responsivity facility. This is now used in laboratories in Greece, China, Norway and Singapore.

International

NPL's international standing depends upon its eminent scientists, its independence and its ability to contribute to and lead debate on international issues in metrology. NPL takes an active role in collaborating with national measurement institutes (NMIs) around the globe. Its experience in interfacing with governments and national laboratories alike provides UK users with access to unrivalled knowledge and expertise that helps to boost UK competitiveness in international markets. This experience enables NPL to answer many enquiries each year direct from UK businesses on the international acceptability of measurements.

NPL is committed to a pivotal role in Europe. EUROMET, the cooperative voluntary organisation between NMIs in 30 European countries is currently chaired by NPL's Deputy Director, Dr Seton Bennett. NPL is also leading iMERA, a proposal that will help national governments across Europe optimise their annual investment in metrology of around €400 million. Demand for metrology is growing from both emerging and existing technologies - biotechnology and nanotechnology; medicine and environmental science - while resources for metrology remain constrained. iMERA centres upon increasing collaboration between participating countries and will ensure the UK retains critical mass in metrology research, participates in multi-disciplinary initiatives and remains closely integrated in Europe.

NPL's international collaborations reach beyond Europe, reflecting its position as a top NMI. Building on the CIPM Mutual Recognition Agreement, NPL has concluded collaborative work with NIST in the USA relating to Federal Aviation Administration regulations and practices that disadvantaged UK and other non-US aircraft repair shops and instrument manufacturers. This will open up export opportunities for the UK.

Another important way in which the international team shares knowledge and experience is through exchange visits. Last year NPL exchanged staff with strategic laboratories worldwide including those in the USA, Australia, Canada, Italy, Austria, Finland, Germany and Japan.

[Seton Bennett, Director, International | seton.bennett@npl.co.uk]
[Andy Henson, Head of International Office | andy.henson@npl.co.uk]

Most regulations are either European or globally based; NPL helps regulators from government departments and public sector bodies to identify and apply measurement best practice. One example of metrology assisting regulation is in sports doping tests, where the natural level of a performance-enhancing substance must be taken into account. NPL mathematicians help to quantify the reliability of doping tests.

The mechanical testing facilities demonstrate the excellent working environment achieved in NPL's new laboratory, with improved use of space, equipment and better communication between teams.

Science management

NPL's ability to deliver its mission depends upon the calibre of its staff and how they perform. Drawing upon the extensive change management skills and experience of Serco Group, NPL has redefined the capabilities required to deliver relevant and affordable science that maintains NPL's international reputation. From this, a new structure has been established that creates a healthy tension between science, affordability and application. By balancing end user requirements with science objectives and commercial management, NPL will be better placed to deliver more relevant science that supports UK innovation and productivity.

At NPL, science is not just about research for its own sake: science is about effective use of the highest quality resources to generate the best possible outcomes for the UK. To manage that proposition, NPL has aligned its structure more closely with the needs of end users, focusing on Enabling Metrology, Quality of Life, and Engineering and Process Control.

This requires excellence in all the disciplines that contribute to NPL's mission, whether in science, knowledge transfer, business or project management. Through greater clarity, accountability and competencies in each job role, science will continue to be aligned to the needs of end users, yet compatible with the remit of a national measurement institute, maximising NPL's return to the economy and improving quality of life.

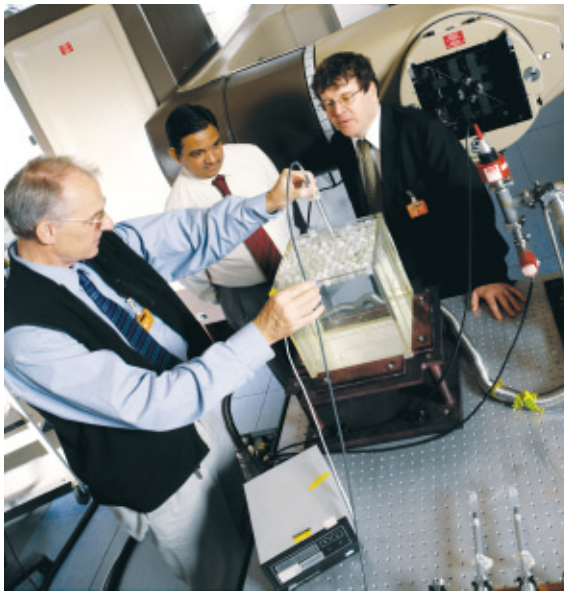
[Paul Gaskin, Director, Human Resources | paul.gaskin@npl.co.uk]
[Alan Mann, Director, Finance and Support | alan.mann@npl.co.uk]

The capabilities of NPL's staff can truly flourish when working in high quality facilities such as those in NPL's new laboratory at Teddington. The scientists must be supported by efficient processes, which in turn must be automated with good systems. During 2004, much of the emphasis on improving how NPL delivers its mission has focused on placing the right people in the right jobs with the right training.

Significant steps continue to be taken to improve NPL's business processes. For example, NPL partnered with BT Transact, Oracle and 10 key suppliers to implement its new electronic procurement system. By removing manual intervention from 60% of transactions, NPL has secured a more efficient supply chain with improved quality control and reduced costs.

NPL is also harnessing the power of its network of desktop PCs, by installing the United Devices Grid MP product on two hundred top-performing PCs NPL has established a site-wide distributed computing system that utilises the spare computing capacities of the machines to create a virtual supercomputer. NPL is now able to perform much larger calculations than was possible before, and to speed up the computation of many metrology applications saving scientist time.

NPL pursues continuous improvement in science operations. For example, recent changes in roles and accountabilities are intended to give staff total clarity about their personal contribution to operational performance.



NPL's world-class facility for Ionising Radiation measurement provides services for medical, environmental, power, defence and radiation protection applications. Simon Duane, Radiation Dosimetry Knowledge Leader, Ganesan Ramanathan, a research fellow from Bhabha Atomic Research Centre, India, and Martyn Sene, (*left to right*) with NPL's new theratron for radiotherapy.

Quality of life

The science and technology encompassed by the Quality of Life Division – Acoustics, Analytical Science, Biotechnology, Optical and Ionising Radiation – represent a massive investment by the DTI. The capability, both staff and facilities, constitutes a national resource covering areas of national and international skill shortage. The Division's five teams are focused on impacting, through world-class science and technology, on UK quality of life; health, safety, security and the environment. The Division's capability and the measurement infrastructure it provides are a platform on which UK industry and the public sector can rely and build, leveraging the DTI's investment.

In Ionising Radiation, the Division provides vital support for health, safety, security and the environment. In health, its work underpins the Department of Health for provision of diagnostic and therapeutic treatments such as radiotherapy, where NPL's world leading Ionising Radiation services are vital for accurate and consistent delivery of treatment to 200,000 patients each year.

The Analytical Science team uses its world-class expertise to impact a wide range of issues, particularly the environment. Recently the team has won contracts to support Defra, running two air monitoring networks measuring hydrocarbons such as benzene, and heavy metals such as lead, arsenic, cadmium, nickel and mercury. The team also contributes to the international effort to understand global warming, through earth observation data and measurements associated with the atmosphere. At present, in collaboration with Cambridge University and the Natural Environment Research Council the team is building a system to fly in a specially adapted aircraft, for the collection and interpretation of atmospheric data, using remote optical sensing technology.

[Martyn Sene, Director, Quality of Life Division | martyn.sene@npl.co.uk]

NPL's activities in biotechnology, focused on support for health-related applications, are described in more detail on pages 8.

In Acoustics, both sound in air and sound in water, the team makes an impact on security, health and the environment. The dynamic Ultrasonics team has a track record of working with partners such as Precision Acoustics to develop innovative products. The latest of these is a power meter for checking physiotherapy ultrasound equipment. The Acoustics team is also starting work on development of a new generation of acoustical measuring instruments based on MEMS – micro electro mechanical systems. These have the potential to revolutionise sound in air measurement, for example, enabling more accurate and extensive monitoring of environmental noise.

The Division also maintains an active programme of knowledge transfer activities to maximise two-way communication between NPL and those organisations and individuals who might benefit from its capability. NPL works with international standards committees, a range of active user groups, product best practice guidance and deliver training courses. These activities are complemented by NPL staff being available to work with other organisations on small or large projects.

The Optical Radiation Group leads the world in absolute radiation measurement and provides services that impact optical applications including health and safety. Conventional measurement capability is complemented by expertise in 'soft' metrology – developing a framework to quantify visual appearance, one of the most critical factors affecting consumer choice, via parameters such as colour, gloss, texture and translucency. NPL's work in this area is as diverse as measuring shoe polish, car paint and even feathers!

HANS HALBERSTADT / SCIENCE PHOTO LIBRARY

Stuart Pollitt (*left*) and Luk Arnaut, Ultrafast and Dielectric Materials Group in NPL's new reverberation chamber which will enable new methods to be researched for electromagnetic compatibility testing.

Enabling metrology

The Enabling Metrology Division provides the research, technologies and standards that underpin many of the measurements required by industry and government. It operates through multi-disciplinary teams spanning electrical, electromagnetics, time, and mathematical computing and software. These areas of research combine to address industry's immediate needs as well as laying the foundations for future measurement requirements and technologies. This unique national capability and pool of expertise is available to everyone in industry and government. Through NPL, organisations can benefit from the outcomes of National Measurement System research projects, accessing a vast pool of knowledge and infrastructure to support innovation and solve real life problems, large and small.

Accurate clocks are fundamental to science and technology, from international timekeeping to a new European satellite navigation system (Galileo). This programme has potential applications as diverse as supporting the justice system to helping blind people 'interpret' their surroundings. NPL has supported the development of Galileo and its precursors by providing accurate clock data to test-bed projects and contributing to system design.

In other pioneering work NPL has developed the most stable microwave frequency oscillators and lasers in Europe that will become the heart of new clock designs, allowing a new definition of the second and greater accuracy in time and position measurement.

NPL is also an internationally recognised centre for electrical and radio frequency, microwave and photonic measurements, with world leading capabilities. Twelve European national laboratories take traceability from NPL. Within the UK, electrical and electromagnetic calibrations conducted for accredited laboratories underpin more than 100,000 accredited calibrations annually for industry and other customers.

In the area of biometrics, where people can be distinguished through face, fingerprint and iris recognition, NPL is helping to develop international standards for certified biometric systems. These have security applications for Government and industry in identity cards, computer login and building access control.

[Stuart Pollitt, Director, Enabling Metrology Division | stuart.pollitt@npl.co.uk]

Contracts span a broad range of activities that potentially impact upon our daily lives. For Ofcom's Spectrum Efficiency Scheme, NPL has been researching how new techniques might help maximise use of the finite radio spectrum. NPL is examining whether frequency selective surfaces and windows can contain specific radio frequencies for wireless computer links within an office environment.

In health and safety NPL supports the £7million Mobile Telecommunications and Health Research Programme funded by industry and Government, providing the underpinning metrology that enables reliable interpretation of results. Here, NPL works with a broad range of research groups to transfer good measurement practice and techniques.

Transferring knowledge to the wider community is core to our mission. Dr Stuart Pollitt chaired the International Conference on Precision Electromagnetic Measurements which attracted 430 delegates to London. Good Practice Guides continue to provide practical assistance to those working in metrology. NPL's international reputation has been enhanced by staff secondments to other European national measurement institutes. In addition, instrumentation developed by NPL relating to electrical standards is being used by laboratories worldwide.

Clark Stacey, Thermophysical Properties Group, Jerry Benson and Graham Machin, Thermal Measurement Business leader, (*left to right*) discuss new European regulations that will limit the total energy output from new homes and buildings. NPL is supporting building materials manufacturers through appropriate regulation and testing methods.

Engineering and process control

Manufacturing industry contributes £150billion annually to the UK economy, representing 20% of GDP. NPL provides vital support to this sector, underpinning all calibrations and developing state of the art measurement capabilities for the emerging technologies that are essential for the future health of UK industry. Many of the metrology challenges lie in moving measurements from a laboratory environment into a real-world situation, from static to dynamic measurement conditions. To address these challenges, NPL works in close collaboration with businesses to identify and meet their key measurement needs.

The Engineering and Process Control Division has a strong relationship with the manufacturing sector. Its teams develop measurement and testing techniques to help characterise materials, quantify their performance, and improve their processing characteristics. The Division provides measurement standards and facilities in areas such as force, torque hardness, pressure and mass and is a world-leader in thermal measurement.

Modern manufacturing requires innovative and complex metrology. NPL must adopt new technologies such as nanoscience, bioscience and information and communication technologies to keep up with the challenges set by industry. For example, NPL is taking an international lead in metrology for functional and nanomaterials, developing novel measurement methods and models to assist the successful application of these new technologies. One exciting application for techniques developed at NPL in nano-materials is in 3D barcodes, which require a nano-scale 3D data encryption key for reading. This opens up the possibility for innovative developments in anti-counterfeiting, product security, ID cards and defence encryption.

[Jerry Benson, Director, Engineering and Process Control Division | jerry.benson@npl.co.uk]

In a transatlantic project, NPL is being supported by £2million from the DTI Cleaner Coal Technology Transfer Programme to increase the efficiency of power generation plants and reduce CO_2 and NO_x emissions. NPL will be taking a lead role in comparing testing standards in the UK with those in the US.

The Division is also active in many of the internationally important projects that support the realisation of SI units. One example is the thermodynamic realisation of the kelvin, which will use new techniques to redefine temperature. In future, temperature measurement will be linked to fundamental physical constants of nature. This will ultimately provide more accurate temperature measurement, an area of extreme importance to the processing industry.

In 2004 NPL completed its high-accuracy force measurement facility with the introduction of a new 120 kN deadweight force machine. This provides traceability to companies involved in materials testing, aerospace, manufacturing and power generation.

The Division has an active knowledge transfer programme. A new nano-science club was established in 2004 and the 70 members of the Materials Industry Advisory Groups ensure a lively two-way exchange of knowledge with industry. In twelve months the Division provided calibrations, research and development, and consultancy to over 1,000 organisations from industry, academia and government.

NPL has been instrumental in initiating the On-Machine Measurement programme, which provides on-site practical measurement advice to small businesses. Classic Cuisine found that automated, self-calibrating equipment dispensed correct portion control and led to savings of £60,000 a year.

NPL's international reputation is epitomised by its 15 Fellows and Senior Fellows. NPL Fellowships are awarded for outstanding contributions to science and all Fellows are recognised national and international leaders in their chosen fields. Shown here outside the new NPL building, left to right, are:

Maurice Cox
Mathematics and Scientific Computing

Alistair Forbes
Modelling and Numerical Analysis

Roy Preston
Mechanical and Acoustical Metrology

Ian Robinson
Electrical Metrology

Martin Milton
Chemical Metrology

Patrick Gill
Quantum and Frequency Metrology

Bryan Roebuck
Characterisation and Performance of Materials

Mark Gee
Surface Engineering and Tribology

Alan Turnbull
Aqueous Corrosion and Polymer Degradation

Neil McCartney
Materials Modelling

NPL fellows discussing a transducer under test in the new NPL 2 kN.m torque machine. The machine was built in response to the demands of UK industry and is currently being commissioned and will be ready to provide calibrations in the new year. The machine incorporates a number of innovative design features and makes extensive use of novel materials. Shown here, left to right, are:

Roger Morrell
Materials Science

Nigel Fox
Optical Radiometry

Graham Peggs
Dimensional and Optical Metrology

Martin Seah
Surface and Nano-Analysis

Peter Woods
Atmospheric Science and Gas Analysis

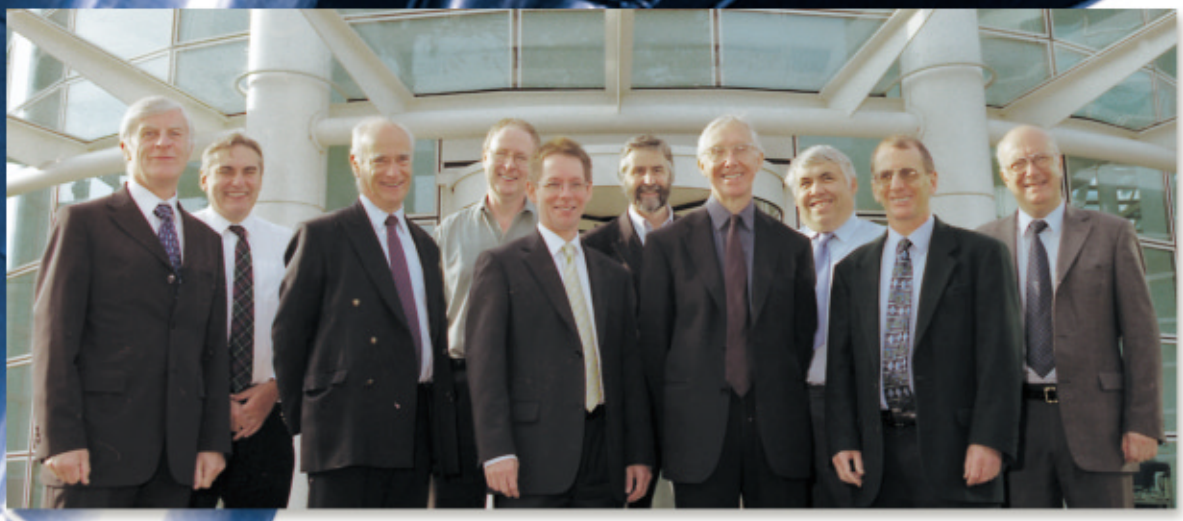
Graham Sims
Materials Systems

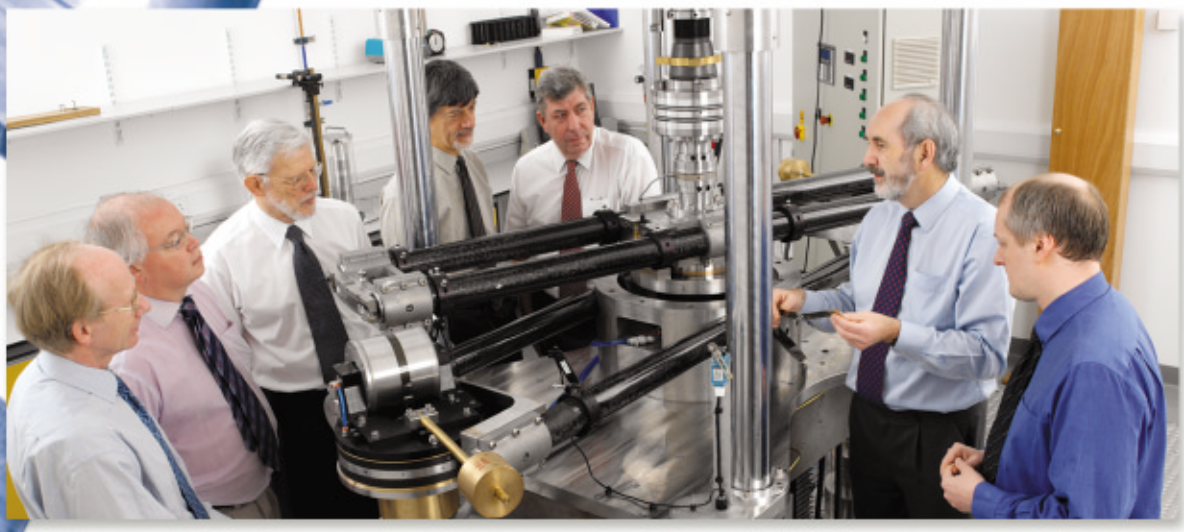
Peter Cumpson
Nano and surface analysis

Other Fellows not shown in the photographs are:

John Gallop
Quantum Metrology and Nanoscience

Stuart Saunders
Corrosion and Materials Analysis





Accessing NPL's expertise

As the UK's national measurement institute NPL makes its expertise available to all. Here are some of the ways that NPL supports businesses and other measurement users:

Advice from experts

The NPL Helpline takes over 600 enquiries every month. The Helpline staff and scientists provide expert assistance and can give up to two hours free advice, via the telephone or email. In some cases an additional two days consultancy can be given to small businesses. Contact the NPL Helpline, details on page 30 or **www.npl.co.uk/contact**

Measurement research and services

NPL provides a number of standard and tailored measurement services, research and development projects, training, and consultancy. Information and contacts are available at **www.npl.co.uk/measurement_solutions**

Working with our experts

NPL runs secondment programmes with academia, industry and others to promote the sharing of knowledge and skills. NPL also undertakes Joint Industry Projects, delivering measurement solutions with partner companies, sponsored by DTI. Information and contacts are available at **www.npl.co.uk/measurement_solutions**

Networking

Over 3,000 organisations are members of NPL's 30 clubs and user groups. These cover a wide range of technical and sectoral measurement topics. Club meetings, held two or three times a year, provide an opportunity to network with like minded individuals. Many clubs have newsletters and web forums; and organise joint research projects. Information and contacts are available at **www.npl.co.uk/metrology_clubs**

Publications

NPL shares its know-how through a large range of publications including educational materials; industry or technology focused newsletters; good practice guides and technical reports. A 1000 publications are downloaded free of charge from NPL's website every month. A full listing of these is available at **www.npl.co.uk/publications**

A Joint Industry Project is validating trials of stack sampling technology, required to meet new standards for emissions monitoring. This work is being undertaken in collaboration with ten co-funding partners, including the Society of Technical Analysts and a number of stack sampling companies, which are carrying out the field work. Manufacturers are supplying standard kit that meets the requirements for validation purposes. Other industrial partners, including Lafarge Cement, will supply field trial locations.

Contact NPL

The NPL Helpline is a first point of access. Our Helpline staff will discuss your enquiry or need and recommend the most suitable route or person to help you.

The Helpline will provide information from the NPL website for those not able to access this directly.

Helpline: 020 8943 6880 **Fax:** 020 8943 6458
Email: enquiry@npl.co.uk **Website:** www.npl.co.uk

Visiting NPL

In September 2004 NPL was delighted to open its new reception area. NPL's new building is accessed via Hampton Road, Teddington and not Queens Road, which is now closed to visitors. The map below can also be downloaded at **www.npl.co.uk/location**

National Physical Laboratory | Hampton Road | Teddington | Middlesex | TW11 0LW

NPL's Points of Contact

The enclosed booklet gives you a quick overview of NPL's structure and key contacts.

If this booklet is missing or you would like additional copies, please contact the NPL Helpline, details opposite.