NPL
National Physical Laboratory

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Annual Review

About us

The National Physical Laboratory (NPL) is the UK's National Measurement Institute and a world-leading centre of excellence in developing and applying the most accurate measurement standards, science and technology available to humanity.

As such, NPL occupies a unique position at the intersection between scientific discovery and real world application. Its expertise, original research and status as a world-leading measurement laboratory have underpinned quality of life, innovation and competitiveness for UK citizens and industry for more than a century:

- NPL provides businesses with access to world leading support and technical expertise, inspiring the absolute confidence required to realise competitive advantage from new materials, techniques and technologies;
- NPL expertise and services are crucial in a wide range of social applications - helping to save lives, protect the environment and enable citizens to feel safe and secure. Support in areas such as the development of advanced medical treatments and environmental monitoring helps secure a better quality of life for all.

Equipped for the future

I am confident that in years to come we will look back on 2007 as a very important year for the National Physical Laboratory. Sound financial performance coupled with new additions to the team and advances across all areas of measurement science and delivery served to further cement our reputation as one of the UK's foremost science institutions. Moreover, our ability to transform scientific discovery into real world, practical applications confirms our status as a vital resource for both government and industry.

Most importantly, this continued strong performance provides us with a platform on which to build for the future. A refreshed strategy and accompanying investment in people, facilities and infrastructure ensures we are ideally placed to meet a rapidly changing and expanding demand for measurement and knowledge based services.

For this reason, it seems appropriate that we should break with tradition this year, and use this Annual Review to look to the future as well as reflect on the year gone by.

Fresh challenges

NPL's core mission has not changed for over a hundred years. Our expertise and innovation as a National Measurement Institute (NMI) are vital to the economic prosperity of the UK. Without access to world leading measurement, UK industry's ability to innovate and compete would be severely compromised. Similarly, our contribution in areas such as healthcare and the environment is crucial to raising quality of life for people across the UK.

The world, however, has changed. The demand for measurement standards and services has seen huge proliferation over the last few decades. This has been driven by the emergence of new technologies, applications and markets. As a result, the demand for new measurement techniques and applications spans a far broader array of sectors than we have seen before – from alternative energy, environmental monitoring and national security to drug discovery, technology incubation and the services sector, where the use of modelling and telematics is increasingly driving product and service innovation.

New opportunities

The scope for measurement science to underpin these social and economic developments is huge. While our commitment to our core NMI operations remains as strong as ever, 2007 has seen a ground shift in the way we develop and deliver the government-driven and commercial measurement services that spring from it.

At the heart of our strategy for the coming years is a desire to deliver the highest social and economic impact as a leading NMI through excellent, responsive science and knowledge services. Our mission, however, is to deliver great science with impact. As a result of our strategic review we are now well placed to establish NPL as the obvious and preferred partner for R&D and technical services in our chosen areas of measurement science, as well as for knowledge transfer services in complex, scientifically driven markets.

Delivering against this strategy is all about relevance and engagement – working closely with government and industry to ensure that our measurement services continue to anticipate the needs of our diverse customer base and are more accessible than ever before.

This process has already started. For instance, an Innovation Centre to be established on site at NPL will provide technical incubator services for fledgling technologies and businesses, while joint ventures with organisations like IBM and St Thomas' Hospital are already underway. Equally, exciting additions to our management team bring new skills and perspectives and will provide even stronger leadership and direction as we expand beyond our traditional NMI heartland over time.

Alongside these developments, it is vital that we continue to play a leading role in the international metrology community, representing the measurement, social and economic interests of the UK. The lead role our international team played in establishing the European Metrology Research Programme again demonstrates our commitment to international collaboration.

An exciting future

As ever, I would like to offer my thanks to our exceptionally talented and committed workforce, on whose groundbreaking work the reputation of NPL is built, and to our customers, whose unerring faith in our ability to deliver again and again is fundamental to our financial success and our ability to invest for the future.

It promises to be an exciting future for us at NPL. There is no doubt in my mind that our role, as an NMI and as a science partner to industry and government, will only increase in importance over time. Thanks to the work we have started this year, these are challenges we are equipped to meet through excellent science coupled with valuable, relevant and innovative measurement solutions.

Steve McQuillan,
Managing Director

Open and independent

As chief scientific adviser at NPL my responsibility is to enhance NPL's science research capability. This means giving talented people the resources, support and encouragement they need to deliver research at the cutting edge.

The brief case studies set out in this review illustrate very well the quality and breadth of science research already underway at NPL, as well as its wider impact, so I will not dwell on it here. Instead, I want to set out a vision for the future of science at NPL, and how we are responding to the needs of government and industry. In essence, that is about expanding our public asset base of knowledge for the benefit of the UK as a whole and exploiting the commercial application of NPL science.

Independent, open and trusted

NPL sits at the interface between commerce, cutting edge science and government and plays a key role in creating an environment in which science and industry can flourish. It engages with government and industry to promote the open debate and discussion that must precede the development of standards and the use of science to generate genuine commercial advantage.

In establishing standards and pursuing long term scientific research of the highest quality, NPL provides its commercial and government partners with a level of confidence that comes from being an independent, open laboratory. To derive benefit and technical leverage from the world of science you have to be doing cutting edge, critical, published science – and NPL has a long track record of doing just that. NPL is a unique national asset because it can also provide the sustained and repeatable reference point needed for standards.

Government

Credibility and independence are particularly important issues for government, where public trust is vital. The Government cannot buy entirely unbiased, open technical advice and credibility from purely commercial entities. It should increasingly look to organisations like NPL to take up this role, because we can ensure that developments in a wide range of technical areas are informed by leading scientific research.

NPL is ideally placed to take on roles already played by similar national institutions overseas. For instance, we can provide scientific input and facilitate the open dialogue that is essential to establish public trust in security procedures and information handling by government. Or we can develop and assure the distributed sensor networks that will enable better, more accurate environmental monitoring, and which are required for proper carbon pricing and energy policy creation.

Industry

NPL provides a crucial halfway house between government and industry - strong science research coupled with involvement in the development of international standards helps to secure competitive advantage for UK businesses. Again, the fact that we are an independent organisation, backed to a significant degree by government funding means we are the right organisation to take on this role.

Government funding plays an important part in any research process, but is also a catalyst for commercial exploitation. It encourages smaller companies to get involved, because they are reassured that the research is credible and of high quality. Equally, for the interface between big technology businesses and science to work you have to be scientifically internationally competitive, and longer-term research is always linked to government support.

In the commercial area, world leading science is becoming relevant across an ever broader array of sectors. For instance, the emergence of flood mapping solutions and telematics-based products in the insurance sector brings with it a new set of measurement and data modelling challenges. These are not new techniques but the novel applications have a direct impact on products, customers and profitability, so getting them right, and understanding their inherent uncertainties, will increasingly become business imperatives.

Equally, new technologies and markets demand new approaches to the application of measurement standards. The alternative energy market is a hot-bed of innovation and must be supported by appropriate measurement applications if great ideas are to be transformed into sustainable energy sources and market leading products. The same is true for drug discovery, where new measurement techniques pioneered by NPL are being applied to HIV research and could significantly shorten the drug discovery process through sophisticated protein fragment analysis.

A strategic view

Supporting innovation and competitiveness via world leading science is a vital element of NPL's role, and we have chosen carefully the areas in which we should be involved.

We are focused on developing areas where we are close to the leading edge so we are ready as needs arise, and are also making strategic investments in areas where we believe critical need for our support will develop over time. NPL has refreshed its science strategy to focus our efforts in the areas where we can deliver the greatest value.

In the end, our ambition is to continue to increase the effectiveness of industry, to assist with the transfer of research and development into actual products and services, and to inform new standards and regulation. NPL now has in place the people, infrastructure and support we need to do that, and the strategic direction required to ensure that our efforts will continue to focus on the right areas and best new opportunities for years to come.

John Pethica,
Chief Scientist

Our people

In keeping with its strategy to deliver world class science, NPL continues to maintain and develop an environment in which some of the UK's most talented scientists can do their best work. Investments in infrastructure and facilities are only part of the picture. The last 12 months have seen the beginning of an ongoing process to provide people with greater opportunity to learn and develop, introducing a more dynamic people culture.

In particular, this has included concerted efforts to bring fresh perspectives into the organisation, both in terms of diversity and career background. During 2007, NPL recruited 70 new members of staff, all but 12 of whom were recruited externally. In addition, a focus on improving gender diversity saw the number of female recruits far outstripping the average for the science sector.

The new ideas and points of view these new people have added to NPL's strong base of talent is an extremely positive development, and is very much part of an overall desire to engage with a broader set of organisations and groups outside of the organisation. This engagement has been further enhanced by a renewed focus on international secondments, with 24 overseas colleagues bringing fresh ideas and new approaches to NPL during the course of the year. In addition, NPL strengthened its academic relationships during 2007, via significant collaboration with schools, colleges and universities, both in the UK and overseas.

Finding better ways to harness the ideas and drive of our people, to more closely involve them in the overall direction of NPL is a challenge related to our success in attracting a wider cross section of staff and broadening our engagement with the outside world.

This element of our people strategy has seen the implementation of a new approach to leadership across the organisation, based on empowerment. At any one time, between 30 and 90 people from all areas of the business are working on devising and implementing initiatives and programmes that will improve everything from our working environment and work life balance, to staff recognition schemes, employee communications and the protocols and processes that underpin our best work.

There is no doubt that these developments are helping to provide our people with a world class environment, and to be at the leading edge of research in their chosen fields. This is amply reflected by the continued quality of NPL science research and the independent recognition afforded to our people.

Sally Watson

Sally is NPL's resourcing manager and plays a vital role in ensuring that NPL can attract the talented people required to deliver its long term strategy. Her focus is on identifying present and future recruitment needs, based on NPL's core remit and key growth areas, then finding and hiring people who excel in their fields; be they science, commercial or support staff. Sally is also developing a pipeline of world class talent, working with schools and universities to identify, encourage and attract exceptional candidates.

Angela Dawson

Working in partnership with industry to ensure groundbreaking measurement science delivers competitive advantage, is central to our mission. In 2007 Angela Dawson received the James S. Walker Award from the Institute of Materials, Minerals and Mining for her work on thermal conductivity in amorphous polymers. Her research could lead to more accurate modelling of polymer processors and, in turn, faster processing with less wastage.

Ian Gilmore

Ian Gilmore has been appointed an NPL Fellow in recognition of his international leadership in surface analysis and his research in the analysis of organic molecules at surface, which delivered a step-change in our ability to identify and analyse the structure of complex molecules. His work is of enormous importance across a wide range of industry sectors, from organic semiconductors to pharmaceuticals and personal care.

Laurie Winkless

Following a rigorous selection process Laurie has been invited to take up the role of ambassador to the Institute of Physics' NOISEmakers programme. NOISEmakers aims to encourage young people to study science and engineering at school, college or university, with a view to pursuing careers in these subjects. Laurie was invited to become an ambassador based on her science outreach experience, a presentation of her work and following her demonstration of centripetal acceleration using a simple, do-it-yourself experiment.

Graham Machin

In recognition of his international reputation as a leader in temperature metrology, Graham Machin has been appointed an NPL Fellow. His work to re-determine the Boltzmann constant by acoustic methods, and deliver step-change improvement in thermometry above 1000 °C, is having a positive impact in challenging temperature measurement areas as diverse as energy efficiency in gas turbines and clinical practice using thermal imaging.

Our science

Drug delivery

NPL has paved the way for more accurate measurements of controlled drug release systems, with the development of innovative layered organic films.

Created by NPL's nanoanalysis team, the films are critical to depth profiling techniques that measure the distribution of a drug more accurately than ever before.

Controlled release drug systems contain therapeutic agents with a material that can be broken down gradually by the body. The drug is released bit by bit as the material breaks down. Designers of these drug delivery systems need to measure the distribution of drugs within the material to ensure that the correct release rate is maintained over time.

NPL's novel, layered films make it possible to use secondary ion mass spectroscopy combined with cluster ion beam sputtering as an imaging spectroscopy to develop three-dimensional reconstructions of drug-dispersal within the film. In particular, this reconstruction is vital to enabling drug designers to confirm that predicted distributions have been achieved, and determine the cause of poor function or failure.

Ultimately, this breakthrough will enable scientists to improve the way drugs are delivered, to ensure that patients consistently receive drugs at their optimum dosage.

For more information on Nanoscience

Pollution monitoring

Twenty-five years of air pollution and air quality monitoring using a system operated and managed by NPL has helped to demonstrate cuts in pollution by heavy metals by 70%.

Air pollution has been recognised as a danger to public health for over 200 years but it is only since 1980 that supporting data for metals has been widely available. Disparate air monitoring sites were brought together, under the umbrella of the UK Heavy Metals Monitoring Network in 2003. Data from the network is vital to understanding the impact of a wide range of factors – both industrial and household – on air quality and provides the evidence required to frame effective regulation designed to improve air quality.

This year, a report from NPL highlighted the real impact of this work. Monitoring at 17 testing sites around the UK shows a fall of 70% in the presence of harmful heavy metals such as lead, iron and copper in the air we breathe - total average concentrations have fallen from 1873 nanograms per cubic metre of air in 1980 to just 568 ng/m^3 in 2006. Lead has seen a particularly sharp decline falling from 556 ng/m^3 in 1980 to 20 ng/m^3 last year. A reduction of 96.5%.

An air quality report is produced each month based on the analysis of filters provided to the participating sites by NPL. These filters are returned each week to NPL where the results are analysed and collated.

For more information on Environmental measurement

Our science

Efficient engines

NPL's world beating accuracy in thermal metrology brings highly efficient, low emission aircraft engines a step closer.

One of the ways to make aircraft engines more efficient, and reduce carbon emissions, is to run them at higher temperatures. To do so safely demands that engine-part alloys are heat treated at very specific temperatures above 1300 °C, using sensors called thermocouples, to ensure they can withstand higher temperatures without being damaged.

Previously, the process thermocouples only offered an uncertainty of ±3 °C at temperatures above 1300 °C, not good enough to use in the heat treatment of the next generation of aircraft engine parts.

NPL has solved this problem by developing novel metal-carbon eutectic fixed points to calibrate thermocouples with world-beating uncertainties of less than ±1 °C. As a result, alloys can now be accurately heat treated at temperatures above 1300 °C.

With this added confidence in temperature sensors, aircraft engine part manufacturers and processors will be able to heat treat their products more accurately than ever before. This in turn means less waste, increased safety, and ultimately the production of more efficient engines.

For more information on Thermal

On-the-spot diagnosis

NPL has developed and patented a novel, sensitive immuno assay platform which generates a digital read out.

The technique is quantitative, highly sensitive, and can use less refined samples such as whole blood. It enables the identification of different blood markers from an unfiltered sample, providing the ability to carry out on-the-spot testing without compromising on sensitivity or the delivery of quantitative data. For instance, the platform will allow paramedics to quickly and reliably identify the cardiac markers that signal a heart attack.

This technology can bring significant advantages in point-of-care, microbiology and other immuno assay products. NPL is currently seeking to understand the requirements of those who may be interested in future licensing in order to inform its development of the technology.

Our science

Structural health monitoring

NPL is taking the lead in the development of systems to provide reliable early warning of structural health issues in everything from bridges to aeroplanes.

There is a wide industrial need for structural health monitoring systems that can be applied to everything from bridges and aircraft to power and chemical plants. NPL's work is seen as a first step in the development of a system as simple to understand as traffic lights, and is currently focused on the development of industrial demonstrators for transport and civil engineering structures, including renewable energy production. The selection of demonstrators has been chosen to include different material systems, such as metallic, composite, and concrete materials.

The largest specimen ever created at NPL, a 20 metre, 14 tonne bridge is being used as a test bed to try out different techniques for monitoring structures. The bridge will undergo accelerated ageing and will then be loaded until it cracks, repaired using new composite repair methods and then re-tested. Work on the bridge will provide a unique opportunity to gain experimental evidence for the cost and safety benefits of structural health monitoring.

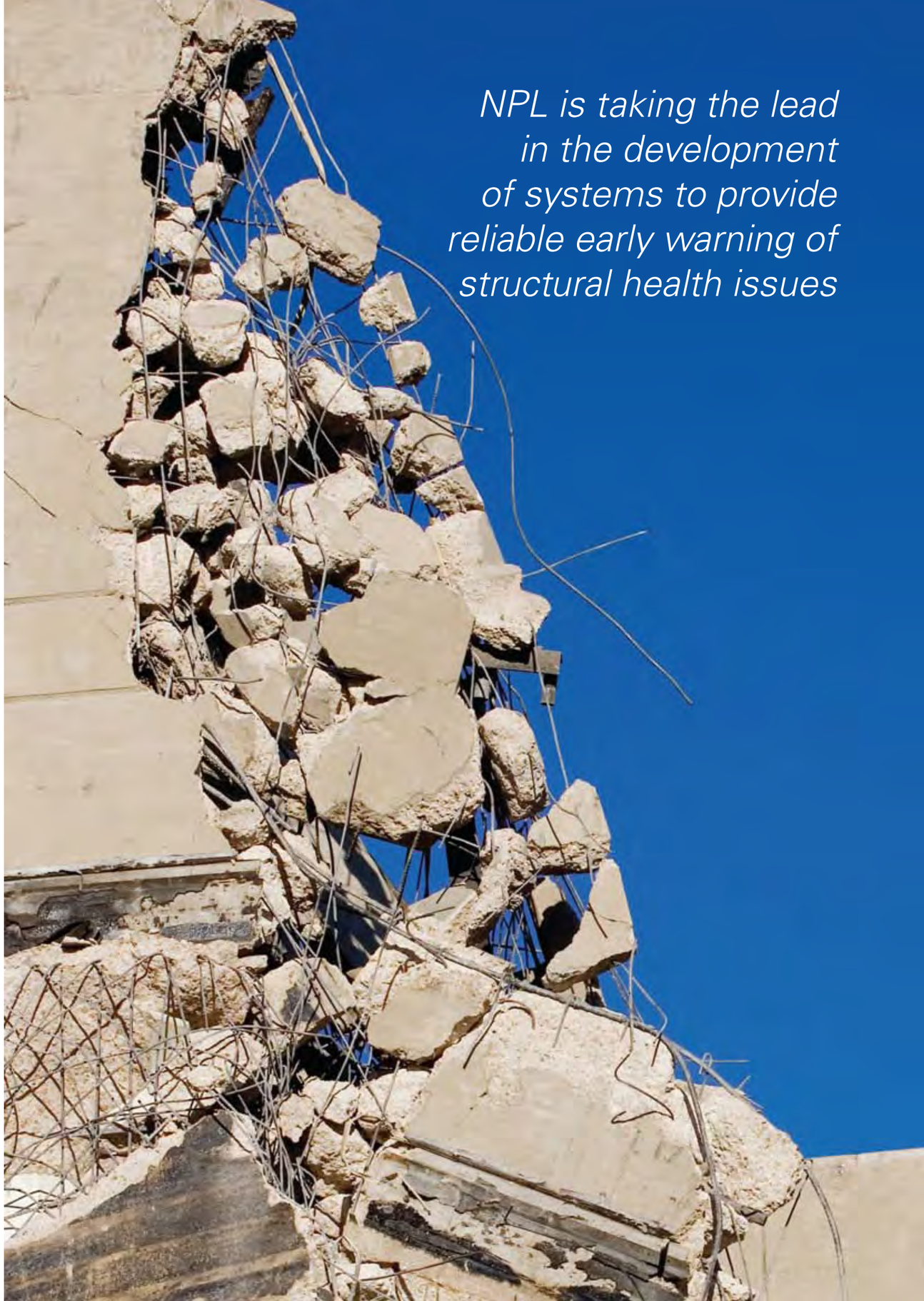
In a related piece of work, NPL collaborated with BAE Systems, Insensys and Smart Fibres Ltd on the development of a robust set of rules to enable the consistent, reliable use of fibre-optic Bragg sensors to measure strain. These rules will enable better monitoring of industrial structures such as bridges and oil rigs, while enabling the use of Bragg sensors across a far wider range of industries.

Data storage

Breakthrough research carried out by NPL's materials scientists will revolutionise data storage, making faster, more energy efficient, and ultra-high capacity storage devices a reality.

NPL scientists have found a way to use the magneto-electric (ME) effect rather than the conventional magneto-resistance (MR) effect to access recorded files. The paper, '*A new recording read head technology based on the magneto electric effect'* published in the Journal of Physics D: Applied Physics, detailed how storage devices using the ME effect would consume far less energy and be of simpler design than current devices. It is estimated that about 100 stages within the production line would no longer be necessary. As a result, ME devices would save time, money, and energy during both production and use.

Despite its simpler design, the device would not compromise on performance. It would enable the storage of more data than current models, while allowing data to be accessed and read more quickly.



Our science

Natural gas safety

A collaborative project to improve the accuracy with which the hydrocarbon dew point of natural gas is measured, helps to underpin the safety of the UK's gas network.

The hydrocarbon dew point (HCDP) is the temperature, at a given pressure, at which the hydrocarbon components of natural gas start to condense out. It is vital to the safety of the UK's natural gas transmission network that the conditions within the pipeline are such that this dangerous condensate is prevented from forming. Achieving this consistently relies on accurate measurement of the HCDP.

NPL, three UK SMEs, and National Grid undertook a project to compare the different dew point measurement techniques currently in use. The work provided a valuable insight into how different instruments operated and performed in relation to each other and led to the development of improved and innovative analytical methods for dew point measurements.

Together these developments will help to underpin the safety of the UK natural gas network, and ensure that stringent safety standards are consistently met.

For more information on Gas Standards

Cleaning the kilogram

NPL has developed a novel technique for cleaning primary mass standards and is collaborating with the Bureau International des Poids et Mesures (BIPM) to evaluate its effectiveness compared with the current cleaning method.

Every so often the UK's primary mass standard (the kilogram) is sent back to the BIPM for reverification. This process includes cleaning the kilogram by manually rubbing it with alcohol soaked chamois leather and washing it in a jet of steam (nettoyage-lavage). However, whilst this process is effective in removing the organic contamination that builds up on all mass standards, it relies on the skill of the operator and has proved difficult to replicate at other National Measurement Institutes.

The new technique, pioneered by NPL, is just as effective as the traditional method but far more reproducible. It uses ultra violet light in an ozone rich atmosphere to create atomic oxygen which reacts with the carbonaceous and hydrocarbon contamination on the surface of the mass standard to produce CO_2 and H_2O. Both of these by-products can be easily desorbed from the surface.

The process can be applied to mass standards composed of most materials (e.g. platinum-iridium, stainless steel and silicon) and is extremely controllable, simply by varying the UV intensity, ozone concentration and exposure time. Preliminary test results have been encouraging, and the technique will now undergo direct comparison with the nettoyage-lavage cleaning procedure.

For more information on Mass

Our science

Laser TRACER

NPL has developed a revolutionary measurement system that brings laboratory-level standards to the shop floor, to significantly reduce machine downtime.

The Laser TRACER, developed by NPL and partner ETALON, is a portable system delivering rapid, highly-accurate calibration and verification of coordinate-measuring machines (CMM), CNC machine tools, and other leading-edge measurement applications. It uses a highly stable laser source and an NPL-patented precision internal design that is mechanically and thermally decoupled from the tracking mechanism, to deliver market leading stability and accuracy.

Measurement routines can be performed without the need for highly skilled technicians and are significantly quicker than existing traditional methods – machines can be calibrated in less than three hours. The availability of standards laboratory quality of measurement on the factory floor will reduce manufacturing waste and significantly increase productivity for businesses using the system.

For more information on Laser TRACER

Sellafield monitoring

NPL is playing a vital role in improving the understanding of small radioactive objects and particles found on beaches close to the Sellafield nuclear site.

In partnership with Serco Assurance and Sellafield Ltd, NPL is providing detailed analysis of radioactive particles found on beaches, to help identify their source and better understand their potential environmental or health impacts.

The beaches around the site are being monitored using improved and more effective radiation detection equipment mounted on a small tractor-like vehicle. Following removal from the beach a selection of the radioactive particles is being brought to NPL for analysis.

In the laboratory they are subjected to a range of analyses, including γ-ray spectrometry to isolate and quantify radioactive particles and scanning electron microscopy to determine their elemental composition and size. Finally the particles are dissolved in leaching solutions to enable α- and β- emitting radionuclides to be identified in conditions that are comparable to sea water and the human digestive tract.

NPL's work in this area is vital to providing a better understanding of the risk the particles pose and their possible sources. The accurate analysis of the radionuclides present on beaches, the radiation doses arising from them and their behaviour in sea water and the human body ensures that any environmental and public health risks can be identified and managed more effectively.

For more information on Ionising radiation

NPL has developed a revolutionary measurement system that brings laboratory-level standards to the shop floor

Our science

Ultrasound cancer treatments

NPL has developed a range of new measurement techniques that will underpin the wider adoption and more effective use of High Intensity Focused Ultrasound (HIFU) cancer treatments.

HIFU is a non-invasive treatment that uses the power of ultrasound to destroy deep-seated malignant tissue with pinpoint accuracy. It reduces the need for treatments that impact the entire body, like chemotherapy, lowering recovery times and patient discomfort.

However the lack of standards to enable accurate measurement of the ultrasonic fields produced has hindered understanding of dosage and the effect of HIFU treatments on tissue, as well as the development and adoption of efficient HIFU systems.

The Acoustics group at NPL, in collaboration with ICR, Royal Marsden Hospital, the Churchill Hospital, Oxford, and St Thomas's Hospital, has now developed a means by which to measure ultrasonic output power in strongly focused fields. The technique has been tested successfully at power levels in excess of 300 W and overcomes the limitations of existing measurement methods. The group is now working on ways of rapidly mapping the distribution of ultrasound energy in the field to enable more accurate and safer targeting of treatment within the body.

These advances are vital to the effective and efficient calibration of HIFU equipment and to its wider adoption as an innovative cancer therapy.

For more information on Ultrasound

Closer European collaboration

NPL has led the way in establishing the European Metrology Research Programme (EMRP) that addresses the most pressing needs of european metrology identified by stakeholders. The EMRP aims to increase collaboration between national measurement systems, creating synergy, reducing duplication between institutes, and accelerating the development of vital research capabilities - to enhance competitiveness, improve quality of life, and provide essential tools for industry and the science community.

Currently, the EC has provided €21 million to partially fund four selected areas of the EMRP over the next three years. Following independent evaluation of the proposed projects, funding has been allocated to 17 EU member states, one pre-accession state, two EFTA countries, and the EC's Joint Research Centre. Around €4 million funding was won by NPL.

NPL is working with the Commission to provide longer term support to the EMRP utilising Article 169 of the European Treaty. Subject to adoption by the European Commission (scheduled for late 2008) the initiative will be put before the Council of Ministers and European Parliament in 2009 for formal approval. The Metrology Article 169 is likely to be a 7 year €400 million programme, jointly funded by the participating countries and the European Commission. So far 21 European countries, including the UK, have already committed funds to this Metrology Article 169.

For more information on NPL's International activities

Our science

Thermal performance measurements

NPL's state of the art apparatus for measuring the thermal performance of building materials and structures, including traditional and innovative insulation materials, pipe insulation, walls, windows, roofs and doors, provides a vital resource in the development of low energy buildings.

The Code for Sustainable Homes and the draft Climate Change Bill create a legal framework aimed at minimizing energy use in new buildings. As a result, everyone from manufacturers, regulatory authorities and builders to architects and designers must prove that their products and designs meet stringent guidelines for thermal performance.

Most importantly, those measurements must be accurate, and traceable to accepted measurement standards. NPL's apparatus is capable of accurately measuring the thermal performance of insulation materials from -170 °C through room temperature and on up to 800 °C, and includes the UK's only pipe insulation thermal performance measurement facility. NPL is also home to one of very few 'Hot Box' facilities for measuring the thermal performance of structures ranging from masonry walls to windows, doors, roofs, wall and floor structures.

These resources provide a level of accuracy and confidence that will be vital to the certification of low energy construction materials and products and, ultimately, to the industry's ability to compete in an increasingly regulated market.

For more information on Thermal

VOC standards

NPL has collaborated with the Institute for the Environment and Sustainability at the EU Joint Research Centre to develop two multi-component standards that enable more consistent monitoring of volatile organic compounds (VOC) in ambient air.

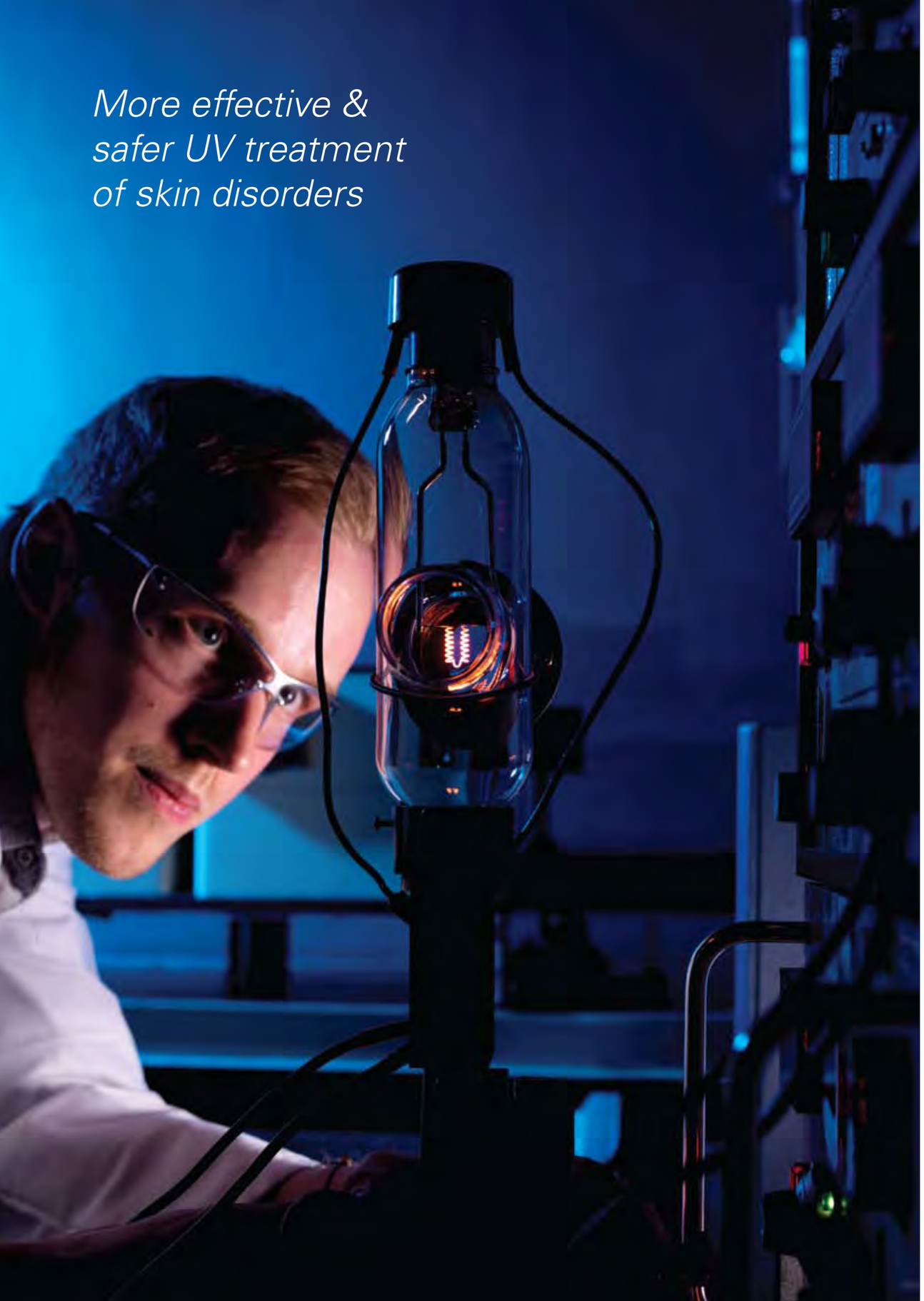
Monitoring atmospheric VOC levels accurately is difficult because these compounds exist at very low levels and are extremely reactive. As a result, stable and accurate standards are needed to ensure that measurements taken in different countries are good enough to identify region-wide or global trends.

NPL addressed this issue by carrying out a comparative study of measurement laboratories in 17 EU states and two further countries across the world. This led to the development of two new measurement standards that will improve the equivalence of measurements from country to country.

The first suite of standards was prepared according to the methods developed for NPL's world-leading synthetic multi-component standards. The second suite has required the development of a novel method involving combining parts-per-billion levels of VOC species into samples of real air taken in Bushy Park, Teddington.

The standards will play a vital role in supporting the European Ozone Directive that requires all EU member states to monitor and reduce levels of ozone depleting chemicals in the atmosphere. They will also be important to the World Meteorology Organisation's Global Atmospheric Watch (GAW) Programme.

For more information on Analytical science



Our science

A dose of UV

NPL is carrying out a systematic study into UV treatment dosimeters in an effort to increase the quality and effectiveness of UV treatments in the UK.

Many people in the UK suffer from skin disorders such as eczema, psoriasis, dermatitis and vitiligo, which are treated by exposure to UV light at specialist phototherapy centres. UV doses must be optimised to ensure treatment is effective while protecting against skin burns and cancer, which requires accurate calibration of the measurement devices used to monitor dosage.

However, a recent comparison found the calibration factors for UV dosimeters varied significantly between different treatment centres. As a result, doctors cannot be confident how much UV radiation a patient is exposed to during treatment, making it impossible to ensure continuity in treatment regimes if a patient has to move to another phototherapy centre. It also makes it difficult to assess any increased skin cancer risk, or to reliably evaluate the effectiveness of new UV light treatments.

NPL's study will identify the cause of the variations between treatment centres and enable the development of a Best Practice Guide to provide help and guidance on how best to characterise UV measurement devices and UV sources. In turn this will lead to more effective and safer UV treatment of skin disorders.

For more information on Optical radiation

VAMAS

The Versailles Project on Advanced Materials and Standards, originally signed by Prime Ministers and based on a need identified by NPL, returned to France in 2007 to celebrate 25 years of international collaboration and standards achievement.

A recent highlight of the project was the development and publication of standards covering instrumented indentation measurement – a development that came as a direct result of an NPL-led intercomparison project to scope the issues surrounding measurement of hardness and elastic modules of thin films and coatings. Data from over fifty laboratories enabled the publication of standards for instrumented indentation measurement BS EN ISO14577 Parts 1-3 in 2002. A specific standard covering coatings measurement, BS EN ISO14577 Part 4, was published in 2007.

To celebrate the 25th anniversary, NPL organised a seminar reviewing the past work and future needs, which was followed by a dinner in the Musée des Arts et Métiers organised by the French hosts, LNE. NPL made three presentations on the increasing importance of materials metrology, and on future developments in the nano- and bio-material fields.

During the concurrent Annual Steering Committee meeting a new VAMAS Memorandum of Understanding (MoU) and by-laws were agreed. The new MoU will allow expansion of the VAMAS Steering Committee membership outside the founding G7 and EC providing a wider global participation. Countries likely to join include Brazil, China, India, Korea, Mexico and South Africa. These are countries of increasing economic importance with the scientific capability to support VAMAS work on international pre-normalisation activities in the materials field.

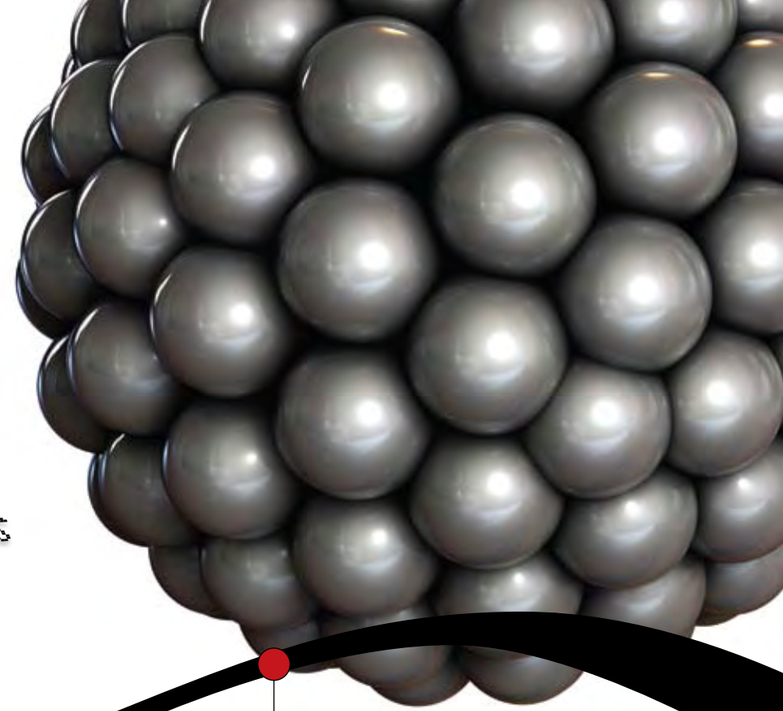
Our impact - nano

The research

In 2002 the UK government decided that it needed to do more to provide the best possible conditions in the UK for the nanotechnology industry to innovate and grow. A critical element of that work is the development of terminology, international standards and measurement infrastructure to support the innovative and effective use of nanotechnologies and to assess the possible implications of nanoparticles on public health and the environment.

Since that time, NPL has played a lead role in international efforts to develop nanostandards, terminology and measurement techniques. NPL provides expert UK representation on ISO, BSI and CEN technical committees and leads a range of related research projects. To date NPL's involvement has been vital to the development of standard terminology and classifications covering everything from nanoparticles, carbon nanostructures and nanomaterials to common nanoscale measurement terms, medical and consumer applications of nanotechnologies.

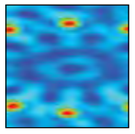
This work represents an important first step in the development of internationally accepted standards for the safe, effective and innovative use of nanotechnologies and materials – and NPL's lead role represents a clear competitive advantage for UK industry.



For more information on Nanoscience

Second Life

In 2007, NPL established NanoLands in the 3D virtual world, Second Life. The development established a real-time, interactive environment where the global nanotechnology community can come together to discuss key ideas, issues and research. NanoLands also provides resources and mentoring to help nanotechnology researchers and businesses to get started.



UK standards

In 2007, the British Standards Institute published nine documents on nanotechnology terminology and guidance for UK industry, all of which were developed with strong support from nanotechnology specialists at NPL.

These developments help to equip the UK to take up a market leading position in a global nanotechnology market that is expected to grow to well over £500 million by 2015. Future applications could include smart drug delivery systems, hydrogen storage, energy efficient systems, plastic electronics and conductive composites, self-repairing or self-sensing materials and even photovoltaic particles for use in paints.

Nanoanalysis

NPL is developing sophisticated nanoscale surface analysis techniques based on atomic force microscopy, secondary ion mass spectroscopy and x-ray photoelectron spectroscopy. This work, through the development of new analytical methods, will provide robust and powerful methods by which to obtain physiochemical properties of fibre surfaces at the nanoscale.

Joanna Lee

Joanna Lee, from our Surface and Nanoanalysis Group, was this year recognised in the Institute of Physics Early Career Woman Physicist of the Year award. Her outstanding work on time-of-flight secondary ion mass spectrometry has applications in many innovative technologies such as drug delivery systems, bio-molecular engineering for diagnostics, and personal care products. She has also designed a range of interactive educational exhibits for NanoLands.

Nanoparticles

The NPL nanomaterials team has developed the metrology expertise required to measure nanoparticles less than 1 nm. The work represents an important breakthrough in a wider effort to develop traceable standards for nanoparticles of less than 50 nm. The team is now leading a European project to provide traceable standards and procedures to determine the size, shape and distribution of nanoparticles, with an accuracy of better than 1 nm.

Surface area

The increased surface area to volume ratio of nanoparticles boosts the efficiency of existing catalysts or powder-based products. NPL's leading role in the development of international standards for the measurement and application of nano particles is vital to their commercial exploitation – for instance in the form of highly concentrated ink suspensions, drug delivery agents or novel composite materials for the transport industry.

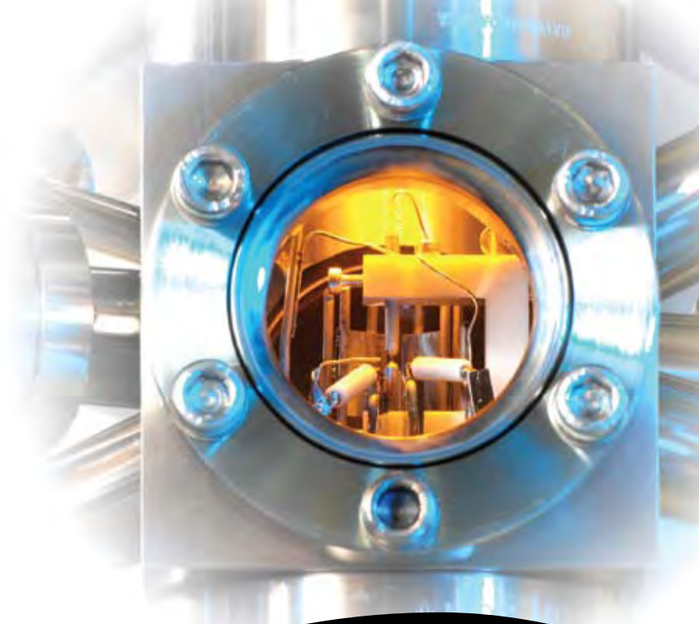
Our impact - time

The research

The first working atomic clock was operated by Dr Louis Essen at NPL in 1955. Based on the absorption of microwaves by caesium atoms it promised to keep time with unprecedented accuracy, demonstrating one part in ten billion accuracy at the time.
In 1967 the atomic clock, was accepted as the basis for the international definition of time by the General Conference on Weights and Measures.

In 1985, the optical frequency standards research group at NPL achieved the UK's first demonstration of laser cooling, a critical requirement in the quest for highly accurate optical atomic clocks. This led, in the late 90s, to the group's observation of the octupole transition in a single cold ytterbium ion – an ultra-narrow optical atomic clock transition due to its extremely long-lived excited state. This development was cited by The American Physical Society as one of the 'discoveries of the year'.

In 2004, the use of femtosecond frequency combs led to the measurement of an optical atomic clock frequency based on a single cold strontium ion optical transition at a level approaching the caesium microwave atomic clock uncertainty. That result was the first of a number of measurements at standards laboratories and research institutes worldwide that have increasingly demonstrated the capability of optical clocks to surpass the accuracy of microwave atomic clocks in use today.



For more information on Time & Frequency

Patrick Gill

NPL's optical frequency standards research head Patrick Gill is recognised as a foremost expert on optical frequency metrology. In 2007, Patrick's work was rewarded with the IEEE Frequency Control's Rabi award for 'profound and continuing contributions to time and frequency metrology' and the Institute of Physics Thomas Young Medal for 'distinguished research in optics'.

Pervasive

The international definition of the unit of time, the second, in terms of a caesium microwave frequency has been in place since 1967. It underpins a wide range of applications such as the movement of information over the internet and billions of pounds of financial transactions, electricity distribution and regulation of power grids, and the synchronisation of television broadcasts and global satellite navigation.

Satellite navigation

Satellite navigation is limited by the accuracy of the atomic clock on each satellite. Currently, those clocks only allow the position of moving objects (like an aeroplane or car) to be determined with accuracy to the nearest few metres. Highly accurate optical atomic clocks promise to underpin highly innovative applications of satellite navigation technology – ranging from increased system autonomy and safety-critical integrity, wider implementation of GNSS-controlled transport applications, through to improved geodesy and geoscience.

Deep space exploration

A team of NPL scientists has recently completed studies for the European Space Agency (ESA) to assess the suitability of optical atomic clocks for use in deep-space ground stations and on-board satellites and space probes. Following those studies, there is significant interest in the increased stability and accuracy that optical atomic clocks could deliver in future space missions with application to science, earth observation and navigation. As a result, NPL is well placed to take a leading role in the development of optical atomic clock technology for future ESA missions.

Physical laws

An enhanced time standard may also provide a vastly more powerful tool with which to test the laws of physics. For instance optical atomic clocks could help scientists to determine whether the physical constants are really constant or whether they change over time.

Laser precision

The femtosecond optical frequency comb, based on Nobel Prize winning research, is central to the development of the next generation of optical atomic clocks.

NPL has now developed a transportable femtosecond comb system, which opens the door to a wealth of applications such as dimensional metrology and molecular spectroscopy. NPL's transportable system enables the frequency of a test laser to be related to the SI second through the use of an on-board GPS-disciplined oscillator, providing robust traceability at any location capable of receiving a GPS signal.

Our partnerships

As the UK's measurement standards laboratory, NPL is one of the UK's leading independent scientific research organisations. It sits at the pinnacle of a framework of standards and measurement infrastructure that has underpinned UK innovation and competitiveness for more than a century.

This unique position at the intersection between scientific discovery, industrial and social application means NPL's commercial and government customers are first to realise the full commercial benefit of new materials, techniques and technologies.

Experienced project managers combine industry and public sector know-how with world leading scientific research to deliver real-world solutions that enable innovation and competitive advantage, whilst enhancing quality of life for UK citizens.

As a result, NPL is the partner of choice for market leaders in aerospace, telecommunications, healthcare, security, transport, defence and energy, and is a key science resource for the public sector.

For more information about working with NPL

United States Pharmacopoeia

NPL is working closely with the United States Pharmacopoeia (USP) on two strategically important collaborations. NPL's work on UK interlaboratory comparison in glycan analysis has seen it invited to join the USP's advisory group for writing glycan analysis chapters. Meanwhile, a recent study and report to the USP on validating Protein A ELISA measurements has demonstrated NPL's leading capability in ELISA and immunoassay measurement. As a result, NPL is now a key contributor and sits on the editorship panel of the USP's immunoassay chapter.

IP exploitation

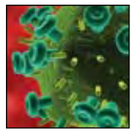
NPL is working with Imperial Innovations to extend its IP offering. Imperial is providing commercialisation services based on NPL's extensive research activities, with the aim of developing spin out companies and licence deals based on a combination of innovative NPL technologies and those in Imperial's own portfolio.

"NPL has world-leading measurement standards and an extensive pipeline of quality IP."

Susan Searle, CEO,
Imperial Innovations

Quantum leap

NPL worked closely with the UK's Technology Strategy Board to research and develop an action plan to support emerging products and markets based on quantum technologies. The action plan sets out a national strategy for quantum technologies, identifying niches where government investment in infrastructure and support for technology commercialisation would deliver the greatest value and setting out a clear pathway for the development of common definitions, standards and accreditation.



HIV drug design

A collaboration between the University of Edinburgh, the IBM TJ Watson Research Center in New York and NPL is using powerful computing technology, sophisticated algorithms and experimental techniques to design improved molecular therapies that could inhibit infection by the HIV virus. Researchers are examining a fragment of the surface protein of the virus, known as a peptide – understanding its structure and behaviour will enable the development of new drugs to target the infection process.

NPL signs Memorandum of Understanding with Surrey University

During 2007, NPL signed a Memorandum of Understanding (MoU) with Surrey University. In addition to its proximity, Surrey's reputation as a centre of excellence in areas such as advanced materials, nanotechnology, electrical metrology, radiation science and communication aligns well with NPL's science strategy. The MoU will facilitate future research collaborations, secondments, teaching courses, access to each others specialist facilities, training, graduate projects and jointly promoted PhDs amongst other benefits.

Guiding the way

During 2007, best practice guides developed by the Dimensional Measurement group at NPL were downloaded from the NPL website more than 3,600 times. The guides, designed to help people working within the metrology industry keep pace with technological advances, are available free of charge and are complemented by a detailed training programme.

"It is proving beneficial to use NPL as our independent point of reference. Notable examples include the use of its training modules in dimensional measurement and its best practice guides, which are well designed, instructional and easy to use."

Mike O'Sullivan, Airbus UK

Bajram Zeqiri

Bajram Zeqiri is one of the world's leading experts in ultrasound metrology and has been responsible for a number of novel developments that will have a strong impact on the way we measure and apply ultrasonic radiation. His work with NPL's commercial partners has been vital to the development of products that improve healthcare through more precise and safe use of medical ultrasound, and enhance the accuracy of acoustic measurements in the defence, oil and gas industries.

Community science outreach

NPL also plays a vital role in promoting science amongst young people, helping to encourage the next generation of scientists.

The Richmond Borough Science Film Festival was a joint venture between NPL, Richmond Borough Council and the borough's schools. More than 200 children across nine local schools developed 26 short films explaining different aspects of science, to be shown at an Oscars-style awards evening.

"I was delighted to see so many young people showing a real passion for science."

Councillor Malcom Eady,
Cabinet Member for Children's Services and Education - Richmond Council

Measurement for Innovators

NPL plays a lead role in a Department for Innovation, Universities and Skills programme designed to provide industry with simple access to the expertise and resources required to bring innovative products and services to market.

Innovation leading to new product development is the lifeblood of industry – reaching new markets, launching new products, adapting existing products. But even the best products and ideas can fail in the design stage. Sometimes an individual company lacks the particular expertise that will overcome some of the development barriers, or they may lack the correct approvals or calibrations.

The 'Measurement for Innovators Programme', provides companies with cost effective access to expertise and facilities contained in the National Measurement System (NMS) – NPL, LGC, NEL and NWML. This expertise can be crucial in helping innovators solve measurement issues, for instance by providing access to specialist equipment, or by having experts troubleshoot on-site measurement problems.

This support is available in three ways:

Joint industry projects

The NMS and industry work together in a multi-partner project to solve common measurement issues that block the route to commercialisation of a novel technology, product or service. The programme is designed to support in-product development and improvement by providing access to capital-intensive test equipment and offering a route to match funding.

Secondments

Specialist NMS staff are seconded to organisations with measurement needs, or staff from those organisations are seconded to the NMS, where they can access NMS facilities. Secondments are for a minimum of one week and can be on a full or part-time basis.

Consultancy

Designed to provide SMEs with up to four days free advice on a measurement issue and can include face-to-face meetings, inspection of parts and site visits.

For more information about Measurement Innovators

Viking swords

Access to consultancy and NPL's Camscan Scanning Electron Microscope helped The Wallace Collection to determine the origin of steel used to create the Viking Swords that were on loan from the Germanic National Museum, Nuremberg.

Precision voltmeter

A joint industry project involving NPL and Metron Designs has enabled the development and credible evaluation of a printed circuit board digital voltmeter that delivers improved accuracy and greater flexibility of application at reduced unit cost.

Thin films

NPL, Nightingale-EOS and Lombard Medical collaborated on a joint industry project to validate the accuracy of a bench-top instrument that uses beam profile reflectometry to measure the thickness of polymer coating used on medical implants. The instrument will enable better control of anti-rejection drugs used in conjunction with these implants.

Display performance

The secondment of a Sharp Laboratories research scientist to NPL's Display Metrology Group underpinned close collaboration on a series of tests assessing the effect of ambient illumination on the performance of large format displays. The results provide a better understanding of display performance and move a prototype display closer towards commercialisation.

Gas detection

A secondment to NPL's Environmental Measurements Group gave Cascade Technologies Limited cost effective access to NPL's state-of-the-art test facilities. A ten day testing period provided the company with an array of data that has been invaluable in the development of an innovative gas sensor.

Acoustic sensors

Consultancy from NPL has provided Valeport Ltd with extra confidence in the performance and accuracy of its system of acoustic sensors for the offshore industry. An NPL study demonstrated that the use of high frequency sound velocimeters in conjunction with lower frequency acoustic positioning systems is based on solid scientific foundations and has the potential to deliver greater accuracy than traditional methods.

Contact us

We help all UK industry, research organisations, institutions and government departments to use our knowledge to support their business. Working with NPL opens the door to 500 passionate scientists and world-class facilities through the Department for Innovation, Universities and Skills backed research programmes. NPL provides a range of services to solve your problems by applying measurement advice to lever and complement your skill base. NPL experts give up to two hours of free advice and have many guides and dissemination events available.

Contact the NPL Helpline staff, who will be happy to advise you and find the correct person with the right know-how for your enquiry.

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UKAS TESTING 0002 UKAS CALIBRATION 0478 UKAS REFERENCE MATERIALS 4002

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