Department for Business, Energy & Industrial Strategy

National Measurement System

Annual Highlights 2018

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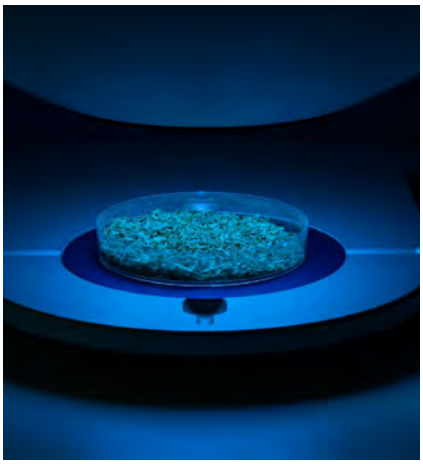


Cover image: Effective sampling and analysis is crucial to fight food adulteration and for food authenticity, quality and safety testing. Multispectral imaging (MSI) represents an innovative, rapid and non-destructive technique that provides true non-targeted multi-analyte capability.

UK National Measurement System

Annual Highlights 2018

Executive Summary

Measurement is critical to our business and personal lives, allowing us to trade effectively and develop capabilities to meet new and changing demands from government and industry.

The Department for Business, Energy and Industrial Strategy (BEIS) invests approximately £65M annually in the National Measurement System (NMS), funding metrology research to support developments in the advanced manufacturing, life sciences, health, energy, environment, security and digital sectors.

This report provides highlights of the work from 2018, which include:

- **Assisting the battle against resistant bacteria by engineering an artificial virus that kills bacteria on contact**
- **Improving environmental monitoring of methane emissions, used by industry and the National Gas Grid to monitor fugitive leaks**
- **Continuing to build presence and impact in the regions**
- **Launching a new curriculum for Metrology Apprenticeships, enabling businesses to secure world-class measurement skills to unlock productivity and efficiency gains**
- **Supporting innovative companies to overcome measurement problems through the Analysis for Innovators programme**

This report also outlines how the NMS laboratories continue to invest in future capability and ensure the UK is at the leading edge of research, such as the new Advanced Multiphase Facility, which will be able to evaluate high flow rate production systems at subsea conditions.

Investing in a world-leading measurement infrastructure

Ensuring good policy, standards and regulations

Our vision is for the UK to capitalise on its world-leading National Measurement System to be the best place to live and do business

Providing confidence in the intelligent and effective use of data

Getting better connected to our end-users to deliver impact

Improving the UK's measurement skills

Measurement matters – an introduction

Measurement is critical to our business and personal lives, although most of us don't notice it.

Measurement enables us to trade effectively as most goods and many services are specified in ways in which you measure them, such as a weight, a specific material or performance criteria.

Measurement enables us to innovate – to understand how to improve a process or validate a new idea. This can be from the use of new materials to make aircraft more efficient, to the better targeting of cancer treatments to tumours. All require a highly interlinked and complex measurement infrastructure.

The vision for the UK Measurement Strategy, published in March 2017, is that:

"The UK must capitalise on its world-leading National Measurement System to be the best place to live and do business."

The UK Measurement Strategy sets out five strategic themes which provide a framework to deliver this national ambition:

- **Investing in a world-leading measurement infrastructure**
- **Ensuring good policy, standards and regulations**
- **Getting better connected to our end-users to deliver impact**
- **Improving the UK's measurement skills**
- **Providing confidence in the intelligent and effective use of data**

The UK Measurement Strategy Delivery Plan, published in June 2018, sets out how the Department for Business, Energy & Industrial Strategy (BEIS) will invest £65M annually into a National Measurement System (NMS) to deliver the outcomes from the UK Measurement Strategy (UKMS) and advance measurement capability in the UK in the advanced manufacturing, life sciences and health, energy, environment and digital sectors.

The NMS's activities support UK government's priorities, such as:

- **the Industrial Strategy, for example by helping people develop new skills and providing services to businesses developing new technologies**
- **the Grand Challenges such as Clean Growth and Artificial Intelligence & Data, for example by developing metrology to support improvements in battery reliability and safety**
- **the Life Sciences Industrial Strategy, for example by giving clinical leaders opportunities to work with the NMS to improve healthcare measurement capability**
- **the Clean Air Strategy, for example by developing a near real-time methodology for monitoring of methane emissions**
- **UK government's commitment to raise investment in R&D to 2.4% of Gross Domestic Product by 2027**

The NMS also enables the UK to compete in global trade and manufacturing by ensuring consistency and recognition of measurement units and standards throughout the world.

The work programmes of the NMS are delivered by a core infrastructure of measurement laboratories (see page 30 for details). These laboratories are connected to a wider community throughout academia, industry and others such as regulators, standards bodies, calibration laboratories and innovation support organisations, to deliver the benefits of measurement to the UK end-users. Their work is reported quarterly to panels of independent experts to ensure quality and value for money.

This documents presents some of the highlights of the work from 2018.

Publication of **77** new or revised standards with an NMS contribution

429 active measurement services and reference materials

Income of **£14.9M** from measurement services and reference materials

613 business collaborations

18 new active measurement services and reference materials

£25.1M of leveraged income from collaborative **R&D** and consultancy

World-class measurement in the UK

The National Measurement System (NMS) provides the measurement infrastructure that is critical to business, science, government and the regulatory community.

519 academic collaborators

404 peer-reviewed papers

2,672 people accessing measurement training through web resources

962 participants in face-to-face training

Measurement infrastructure

Policy, standards and regulation

Delivering impact

Measurement skills

National Measurement System

Statistics are for the year 2017

Investing in a world-leading measurement infrastructure

The NMS underpins measurement traceability and quality in the UK, ensuring manufacturers and their customers can be confident that products meet specifications, and business and trade can be conducted on fair and transparent terms – all of which deliver economic value and social benefit to UK plc.

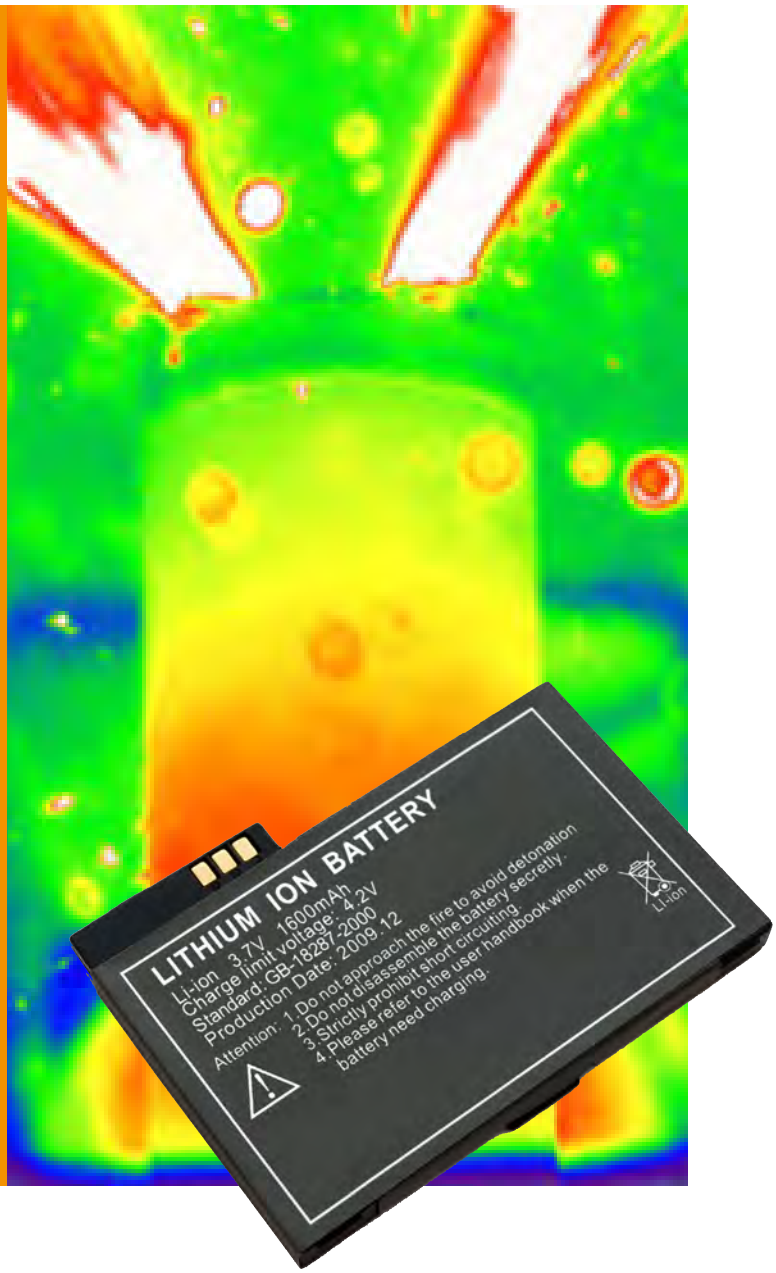
The NMS maintains and improves existing essential measurement capability, as well as developing new capabilities to meet new and changing demands from government and industry. This enables industry to improve the quality of manufactured products and helps bring innovations to market, thereby supporting the aims of the Industrial Strategy and its Grand Challenges, and UK government's commitment to raise total R&D investment to 2.4% of GDP by 2027.

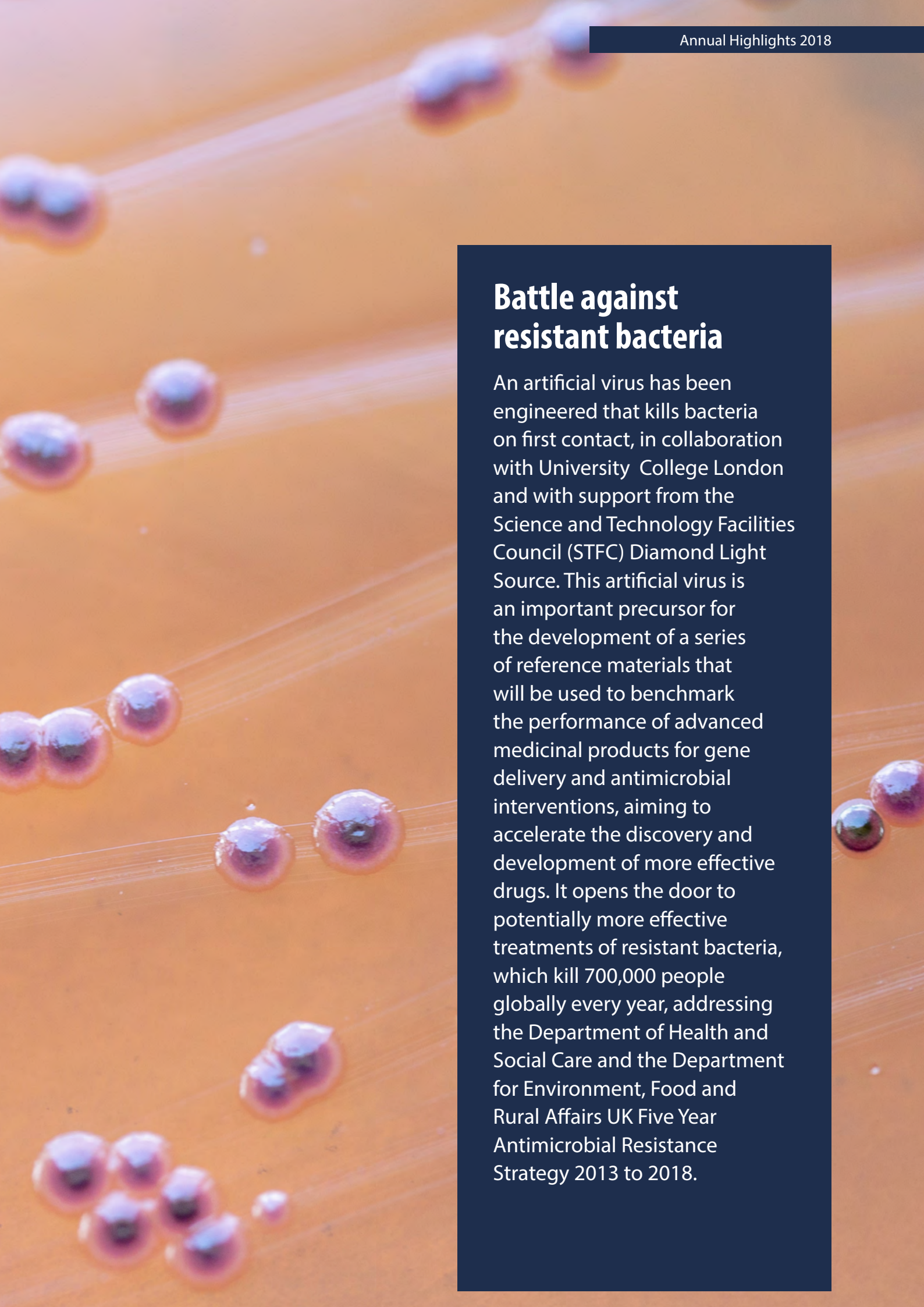
Improving lithium-ion battery safety for clean growth

Novel *in situ* 3D imaging techniques have been developed to understand thermal runaway of lithium-ion batteries – work which won *The Engineer's* 2017 Collaborate to Innovate Award in the Safety & Security category with the citation:

"Important pioneering research that has advanced our understanding of lithium battery failure."

These ground-breaking X-ray and thermal (infra-red) imaging techniques were used to simultaneously measure changes in temperature and internal structure of battery cells under very fast (explosive) short-circuit conditions, as part of a collaborative research project that included UCL and the European Synchrotron Research Facility. This work will support improvements in battery reliability and safety, which could help avoid disastrous failures such as those experienced by Samsung's Galaxy Note 7, supporting both the Clean Growth Strategy and the Industrial Strategy's Faraday Battery Challenge.





Battle against resistant bacteria

An artificial virus has been engineered that kills bacteria on first contact, in collaboration with University College London and with support from the Science and Technology Facilities Council (STFC) Diamond Light Source. This artificial virus is an important precursor for the development of a series of reference materials that will be used to benchmark the performance of advanced medicinal products for gene delivery and antimicrobial interventions, aiming to accelerate the discovery and development of more effective drugs. It opens the door to potentially more effective treatments of resistant bacteria, which kill 700,000 people globally every year, addressing the Department of Health and Social Care and the Department for Environment, Food and Rural Affairs UK Five Year Antimicrobial Resistance Strategy 2013 to 2018.

Investing in state-of-the-art flow facilities

The NMS established an elevated pressure and temperature (EPAT) oil flow facility, providing for the first time traceable flow measurement at field conditions. The new facility is providing the platform to improve standards for Coriolis flow meters and has contributed significantly to improving density measurement at elevated pressures. The facility will also underpin the traceability of the new high pressure multiphase flow facility (AMF) – see page 29. Together, these are significant steps forward in addressing the agenda of maximising economic recovery from the North Sea and UK Continental Shelf, one of the key recommendations of the 2014 Wood Review.

World-leading innovative measurement science

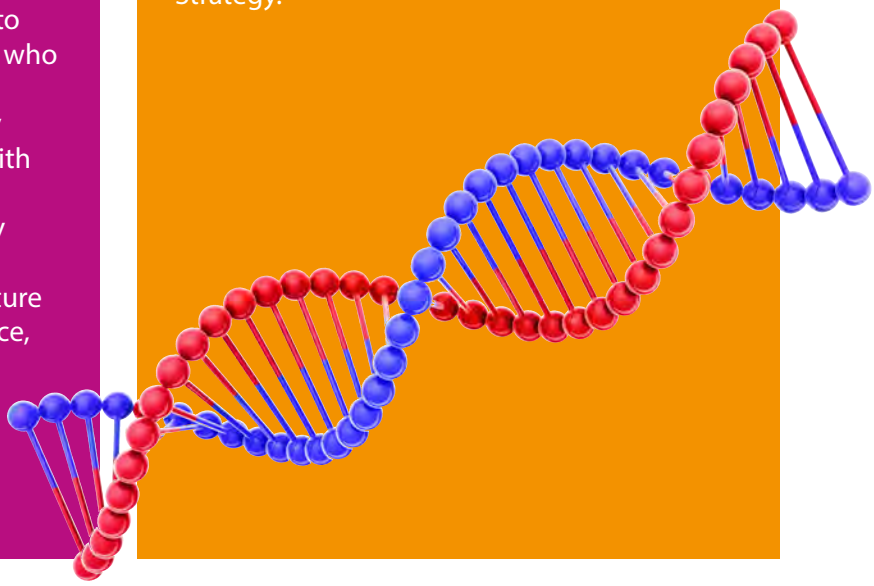
The NMS's Kibble balance, currently under development, could provide one of the first practical realisations of mass measurement using the new definition of the kilogram which relates the kilogram to the Planck constant, *h*. The NMS is also investigating the application of micro-Kibble balances to improve traceability for very small mass and force measurements in areas such as pharmaceutical research, healthcare and biotechnology, supporting the Life Sciences Industrial Strategy.

Atomic clocks get smaller

The NMS has developed a prototype miniature caesium atomic clock, to support applications in defence and security, space and aerospace, oil and gas, and energy distribution; industries that require accurate timing but currently rely on GPS signals that could be easily disrupted. This work is in partnership with Teledyne e2v, the Compound Semiconductor Centre and Compound Semiconductor Technologies Global.

Accreditation of DNA measurement supports regulatory compliance

The NMS laboratory LGC became one of the few laboratories worldwide to gain ISO 17025 accreditation for measuring DNA using digital polymerase chain reaction (PCR). This new measurement facility provides customers across the diagnostics, therapeutics, agricultural biotechnology and food sectors with a route to providing evidence for regulatory compliance (e.g. with EU In Vitro Diagnostics Regulation (IVDR 2017/746)) and supports the development of innovative, new technologies and products, helping to deliver the Life Sciences Industrial Strategy.



World-leading measurement capability leads to successful UK innovation

NMS research and development has contributed to a Queen's Award for Innovation for the 'microK', an instrument for establishing and disseminating the International Temperature Scale. The award was made to two UK companies, Metrosol and Isotech, who co-developed the instrument using novel analogue-to-digital converter technology developed by the NMS in collaboration with Metron Designs. The microk is now used by the world's leading National Metrology Institutes as well as providing highly accurate research and industrial temperature measurements in oceanography, aerospace, medicine and astrophysics.

Ensuring good policy, standards and regulations

Good measurements, and with them good data, bring confidence to decision-making. Government and its agencies rely on the trusted expertise of the NMS to provide advice on technical aspects of policies in health, security, energy and the environment, as well as for emergency responses. The NMS ensures good measurement and standards are at the heart of evidence-based policy and regulation.

Measurement, and the associated standards, enable trusted trade between suppliers and customers. Supporting this are around 1,500 calibration and testing laboratories in the UK which verify that products meet relevant standards, delivering certainty to buyers and sellers. These calibration and testing laboratories are underpinned by the NMS through traceability to the International System of Units (SI), attained through the NMS's measurement services and reference materials.

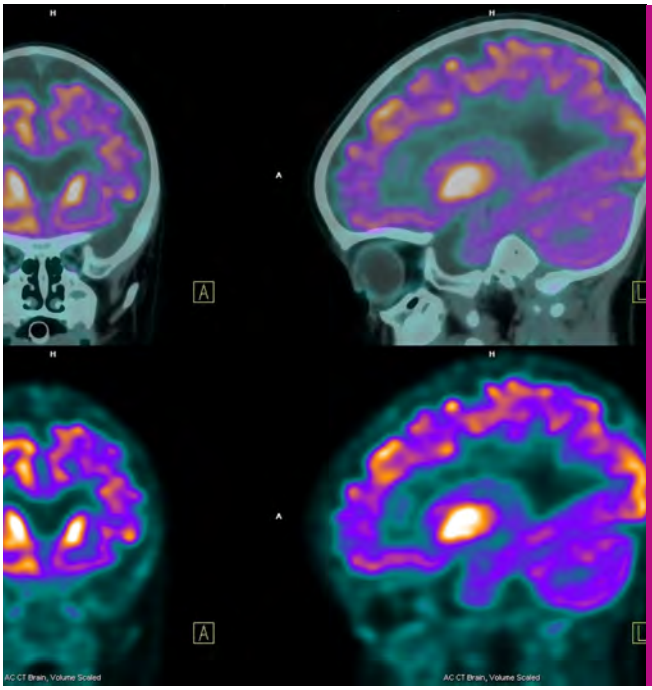
Standardisation, accreditation and conformity assessment will be a key element of any new trading arrangements following the UK's exit from the European Union.

Improving environmental monitoring of methane emissions

The NMS has developed a new methodology based on distributed sensing and reverse dispersion modelling for near real-time and more informative monitoring of methane emissions, used to locate emissions leaks. This is now being used by industrial facilities such as the national gas grid to monitor for fugitive leaks, helping to improve safety and save money by implementing improved maintenance processes. In addition, such capability enables compliance with environmental regulations and supports delivery of the Clean Growth Strategy.

Supporting 5G policy

NMS expertise is embedded in the Department for Digital, Culture, Media and Sport (DCMS) 5G Testbeds and Trials programme, providing technical and policy advice across a range of activities. This is helping to ensure that government programmes are aligned to foster innovation and help grow and sustain the UK 5G ecosystem.



Leading-edge healthcare – Improving cancer diagnosis and treatment

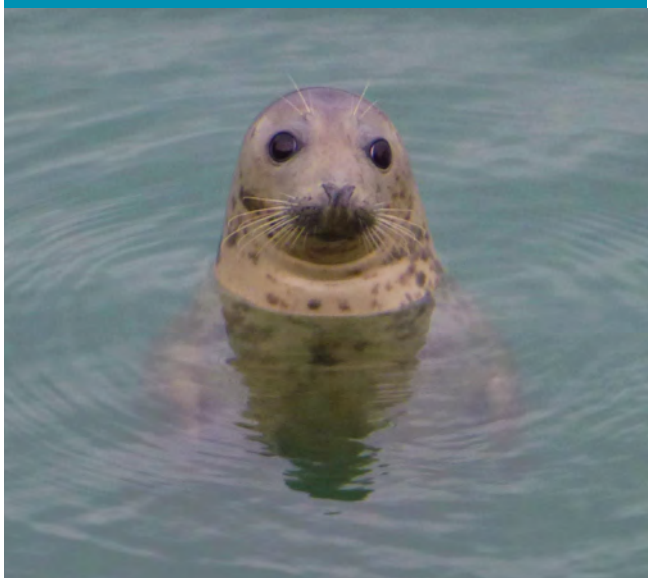
The NMS has performed the first primary standardisation of the radionuclide terbium-155. This is an essential step in the translation of new radioisotopes into clinical trials for cancer diagnosis and treatment, and supporting compliance with the Ionising Radiation (Medical Exposure) Regulations. This work, a collaboration with the European Organization for Nuclear Research (CERN), aims to provide unique medical strategies which combine cancer therapy with diagnostic imaging, and aligns with the Leading-Edge Healthcare Industrial Challenge identified by the Industrial Strategy Challenge Fund (ISCF).

Underpinning environmental policy on greenhouse gases

The NMS produced a report, commissioned by the Committee on Climate Change, assessing how the UK's Greenhouse Gas Inventory is calculated and the implications of uncertainty. Underpinned by extensive NMS capability, the report draws out key insights around issues such as robustness, reliability and uncertainty of the inventory data, and provides reassurance that UK Government and international community can have confidence in the UK Greenhouse Gas inventory. The Inventory is used to track progress against emission reduction policies, including the Kyoto Protocol.

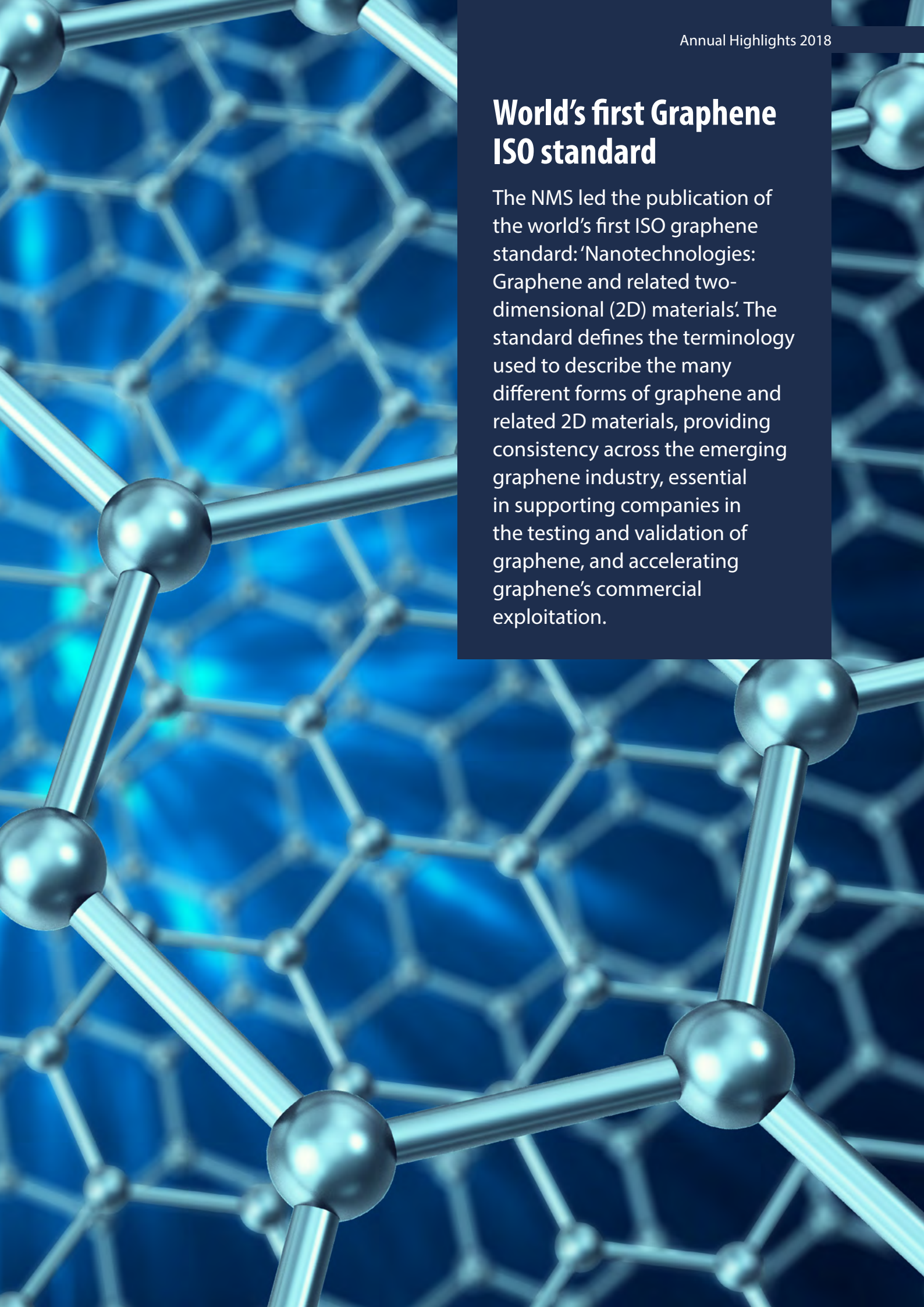
Enabling compliance with EU Directives

The EU Marine Strategy Framework Directive requires member states to monitor noise levels in their oceans. The NMS is supporting compliance with this Directive by providing underpinning metrological capability, including guidance on instrument performance, calibration and deployment, and benchmarking for data analysis and acoustic propagation modelling on ambient noise monitoring in the North Sea, as part of a collaborative EU project.



World's first Graphene ISO standard

The NMS led the publication of the world's first ISO graphene standard: 'Nanotechnologies: Graphene and related two-dimensional (2D) materials'. The standard defines the terminology used to describe the many different forms of graphene and related 2D materials, providing consistency across the emerging graphene industry, essential in supporting companies in the testing and validation of graphene, and accelerating graphene's commercial exploitation.



Improving counterfeit detection

The UK exported £4.36bn of Scotch whisky in 2017, accounting for 20% of all food exports, which makes this high value product susceptible to counterfeiting. A collaboration with the Scotch Whisky Research Institute and King's College London demonstrated the feasibility of new portable and fast mass spectrometry technology to provide an identifying 'fingerprint' for various types of Scotch whisky, aiding the detection of counterfeit and adulterated whiskies.

Supporting regulation through standards

The NMS represents UK interests in international standards committees to ensure the UK can successfully trade and compete globally. These standards support innovation and address global challenges by bringing measurement certainty to complex new procedures and help to provide the framework for accreditation and regulation. In the field of health technology innovation, standardisation activity has covered, for example:

- *In vitro diagnostic medical devices.*
- *Nucleic acid quantification and examination procedures.*
- *Characterisation and assessment of homogeneity and stability of reference materials.*
- *Estimation of measurement uncertainty for medical laboratories.*
- *Detection and characterisation of nanoparticles.*

Supporting regulation through reference materials

In the area of medical innovation the NMS has produced, for example:

- *A reference material to support therapeutic drug monitoring for transplant patients, providing validation for routine analytical methods and establishing traceability in support of the European In Vitro Diagnostic Regulation (IVDR).*
- *A metagenomic control material for pathogen detection, containing DNA of bacteria observed in clinical infections including organisms resistant to antibiotics. It will help improve analytical precision of novel diagnostic approaches for detecting and monitoring common diseases.*
- *Multiple reference materials on behalf of the World Health Organisation (WHO), including a standard for measurement of teriparatide, a protein used to treat osteoporosis, and a standard for mutations of the KRAS gene used in cancer genomic diagnosis.*

Getting better connected to our end-users to deliver impact

To ensure measurement best practice is utilised by all who can benefit from it, the NMS must be well connected across business, government, academia, and measurement and standards communities. We are driven by understanding our end-user requirements and ensuring easy access to our measurement capability, knowledge, products and services. To do this, we have created a range of mechanisms for users to engage with the NMS, as illustrated below and also through the Analysis for Innovators programme (see page 26).

Time stamping for the financial sector

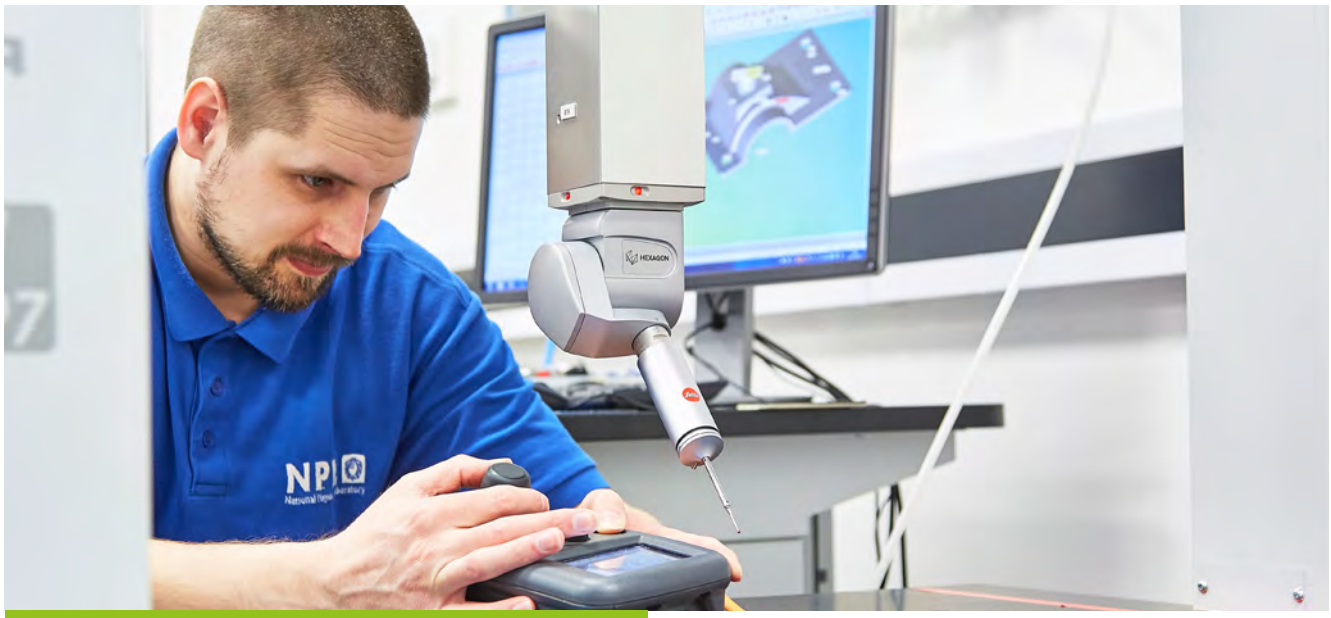
The NMS has expanded its precise timing service, NPL*Time*®, through distribution agreements with QuantHouse, Intergence Systems, NexGen Networks and the Intercontinental Exchange (NYSE: ICE). This provides the UK and global financial sectors with a certified precise time signal which underpins computer-based high-frequency trading. NPL*Time*® delivered against a surge in demand for the service ahead of the Markets in Financial Instruments Directive and associated Regulation (MiFID II) implemented in January 2018, which imposed timing traceability requirements on financial institutions, and supports the Industrial Strategy in putting the UK at the forefront of the data revolution.

Collaboration with the NHS, academia and industry to drive innovation in healthcare

The NMS has launched the Metrology for Medical Physics (MEMPHYS) Centre, working closely with the NHS, academia and industry, including The Christie, Royal Marsden, University College London Hospitals and the Institute of Cancer Research. MEMPHYS will support the development and implementation of innovative early diagnostic and therapeutic technologies for conditions such as cancer, dementia and heart disease into clinical practice. As part of the launch, the new clinical PET/SPECT/CT (Positron Emission Tomography / Single Photon Emission Computed Tomography / Computerised Tomography) camera was officially opened and is to be used to develop clinical quantitative nuclear medicine imaging with direct traceability to standards. These collaborative activities contribute to the Industrial Strategy's Grand Challenge of utilising innovation to help meet the needs of an ageing society.

Getting connected

The NMS holds a wide range of events for industry, academia and the measurement and standards communities, aimed at developing collaborations and increasing the impact of the NMS, from conferences, exhibitions and workshops, to industrial advisory groups and international standards meetings.



Regional presence

In support of the Industrial Strategy, building on local strengths across the country, the NMS is continuing to build its presence and impact in the regions, with new hubs being developed in the East of England (focused on data science, agritech and the life sciences), and the Midlands (focused on quantum technologies).

Innovation in electronics and optical devices

The NMS has worked with Oxford Instruments to develop a technique for measuring 2D semiconducting material, molybdenum disulphide, which could pave the way for a new generation of electronics and optical devices, addressing UK government's emerging quantum technologies agenda within the UK's Industrial Strategy.

Increasing manufacturing productivity

The NMS has provided a product verification service to a range of companies to improve product quality and productivity – a cornerstone of the Industrial Strategy. One beneficiary, Precision Products UK (PPUK), manufactures piston rings and metallic seals for a wide range of applications, offering chrome plating as part of its distinctive capability. The NMS worked with PPUK to measure and understand the variables involved in the plating process, helping them to significantly reduce cycle times and increase capacity.

Improving the UK's measurement skills

Skills are an important priority for the UK government and a key pillar in the Industrial Strategy. Investment in innovative technologies and processes is vital for improving efficiency and developing new products, as is investment in technical skills for operating such leading-edge equipment. Organisations large and small are realising that a lack of measurement skills is an issue for their success; keeping up with the speed of technological change and empowering an innovative workforce to drive productivity. To address this, the NMS is developing new tools, training programmes and initiatives to disseminate best practice to industry, as illustrated below.

Improving newborn screening programme

The NMS and NHS England announced the winners of first Chief Scientific Officer's Knowledge Transfer Partnership (KTP) programme, which gives clinical leaders in healthcare science the opportunity to create, test and implement innovative ideas and accelerate access to new technologies to improve patient care. Dr Rachel Carling, Guy's & St Thomas' NHS Foundation Trust, one of the first recipients, is working with the NMS to investigate measurement improvements to the Newborn Blood Spot Screening programme that identifies babies who may have rare but serious conditions. Through the KTP, the NMS is helping to reduce the possibility of false positives occurring, which causes unnecessary stress to parents and increases costs and the workloads of clinicians, and supports the delivery of the skills action plan of the Life Sciences Industrial Strategy.

Metrology Apprenticeships curriculum

A new curriculum for Metrology Technician Level 3 has been launched, enabling businesses to secure world-class measurement skills to unlock productivity and efficiency gains. Make UK, the manufacturers' organisation, has become the first training provider to license and roll it out. Following on from the Level 3 success, the NMS led the Metrology Trailblazer consortium of over 25 UK companies to develop a new higher Level 5 Apprenticeship Standard that sets out the knowledge, skills and behaviours required by Senior Metrology Technicians across a wide range of industries. This has now been approved for delivery by the Institute for Apprenticeships as part of UK government's ambitions to increase the number of quality apprenticeships.

"This new standard is a further stepping stone in our ambition to become a national champion for apprenticeships and we look forward to implementing and extending our metrology delivery capability with the support of NPL."

Stephen Mitchell, Director of Apprentices & Technology Training at EEF

New UK talent development initiative

The NMS is playing a key role in the new initiative CAMS-UK (Community for Analytical Measurement Science), an industrially-led membership network designed to bring cohesiveness to the chemical and bio-analytical measurement science community. It aims to develop a talent pool with industry-ready transferable skills, and facilitate access to measurement facilities infrastructure, training organisations and research across the UK. This supports the goals of the Life Sciences Industrial Strategy's skills agenda.

Postgraduate training in measurement science

The NMS is supporting nearly 200 postgraduates to gain advanced measurement skills, which includes industry co-funded studentships in collaboration with companies – such as Digital Surf, DSTL, Epigem, Element Materials Technology, Johnson Matthey, Keysight and Elekta – supporting the skills agendas of, for example, the Industrial Strategy and the Life Sciences Industrial Strategy.

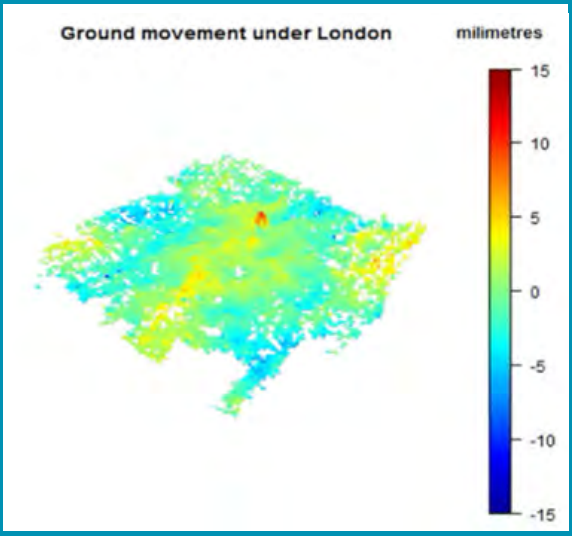
Providing confidence in the intelligent and effective use of data

The digital revolution has brought with it the ability to combine and manipulate huge quantities of data, generated by networks of sensors and instruments making more measurements than ever before. But more data doesn't necessarily mean more value.

The NMS is looking at the quality, reliability and integrity of data to ensure appropriate decisions are made based on them; it is an area of growth for the NMS. We must create the measurement framework required for traceability in data systems, thereby contributing to the Industrial Strategy's Grand Challenge of putting the UK at the forefront of the data revolution.

Satellite data analytics reveals ground movement

The NMS's data science capability has underpinned the European Space Agency PLIMM (satellite synthetic-aperture radar tracking of ground movement) collaborative project, which successfully demonstrated its service platform to industry and was showcased when Prince Andrew opened a new Science and Technology Facilities Council building. Ground movement is of particular interest to infrastructure and civil engineering contractors and the insurance sector. NPL is developing a new methodology for complex machine learning algorithms, including clustering techniques that will provide quality assurance for future data products using satellite data.



Supporting SMEs in digital manufacturing

The NMS's SME Manufacturer Measurement Network held its fifth event in Huddersfield with a focus on Digital Manufacturing. The event helped attendees, over 50 members from local businesses and academic institutions, learn about the current state of play in digital manufacturing. The Network is a northern hub supporting regional manufacturing SMEs to increase efficiency, reduce waste and improve product quality through access to expertise in measurement and product verification, addressing the skills agenda of the Industrial Strategy.

World-leading position in data confidence throughout the supply chain

The Digitally Enabled Supply Chain (DESC) aims to improve productivity using traceable measurement to build robust digital models of production processes and in-process measurements. The NMS's DESC activity has addressed productivity challenges in various companies, including in the food and drink, automotive and precision manufacturing sectors. This activity is closely aligned with the Made Smarter Review.

Analysis for Innovators

The NMS, in partnership with Innovate UK and the Science and Technology Facilities Council (STFC), funded the first Analysis for Innovators (A4I) programme to support innovative companies to overcome challenging measurement or analysis problems affecting innovation, productivity or product performance and thus their competitiveness. The A4I programme clearly supports delivery of the Industrial Strategy and its aim to improve productivity, and contributes to increasing R&D investment to 2.4% of GDP by 2027.

This programme enabled companies, including companies new to Innovate UK and the NMS, to access technical expertise and state-of-the-art facilities within the NMS laboratories and STFC to solve their measurement problems, with examples of highlights presented below.

Energy Technology Centre

Energy Technology Centre Ltd (ETC) provides water droplet erosion testing for wind turbine blades. The current approach involves stopping the test to take measurements. Through A4I, ETC explored new techniques for measuring material erosion throughout the testing process. The NMS identified an optical technique, combined it with a high-speed camera, and created software to interrogate the data. The initial feasibility study proved the concept, and ETC are now looking to adapt it for a wider range of blade surfaces. This could give ETC much greater insight into erosion mechanisms, creating competitive advantage for them, whilst helping the wind industry to better understand optimal design, material selection and coatings, thereby increasing lifetime and efficiency.

Adaptix Imaging

Adaptix Imaging is developing the core technology behind a low-cost portable device for 3D medical scans, offering a safer and cost-effective alternative to expensive computerised tomography. The innovation relies on a precisely-engineered grid of tiny X-ray emitters, which were not meeting high uniformity and durability requirements. Adaptix worked with the NMS to research the structure and chemistry of various materials and coatings which could address both problems, and identify causes of contamination in their manufacturing. Through the project they have improved design, material selection, manufacturing processes and product operating conditions. This has reduced development time, eliminated unproductive areas of research, and sped up time to market.

The Coconut Collaborative

The Coconut Collaborative, a UK manufacturer of coconut yogurt, worked with the NMS to develop a rapid and robust screening approach to detect rancidity in one of their raw products – coconut cream. This novel screening approach, which replaces the current manual 'taste test', will save an estimated £500k per year through reduced production and material charges.

AgPlus

AgPlus developed a portable diagnostic platform which can quickly identify a wide range of illnesses from a blood or saliva sample, allowing rapid point-of-care diagnosis. They had a problem of high failure rates in their electrode production. Through A4I, they carried out electrode measurements using a variety of advanced electrochemical and complementary analysis equipment. The research found the current printing thickness unsuitable, and identified the optimal thickness to reduce failure rates and allow them to move to mass production. It is anticipated that the product will soon increase the availability of rapid point-of-care diagnostics to clinics and hospitals, allowing earlier interventions to treat illness, and reduce patient anxiety associated with waiting for results.

"Working with the NMS gave us access to the latest chemical analysis technology which allowed us to solve a problem well beyond our capabilities and identify a solution. This overcame a major roadblock to manufacturing the final product on a commercial scale."

Tim Dwyer, Research and Development Director at AgPlus Diagnostics

Bramble Energy

Bramble Energy has created the world's first fuel cell which can be manufactured in established production facilities. To access lucrative new markets it also needed to prove that the design is durable, and a key aspect of this is its passivation layer, which protects components from the hostile cell environment. Through A4I, extensive analyses of passivation materials were carried out to understand degradation mechanisms, identifying materials to improve durability, as well as eliminating a contaminant discovered in their supply chain. This has improved durability, making the cell more competitive, and reducing time to market.

"The A4I project has been invaluable in unlocking world-leading facilities and expertise which would have otherwise been inaccessible to us."

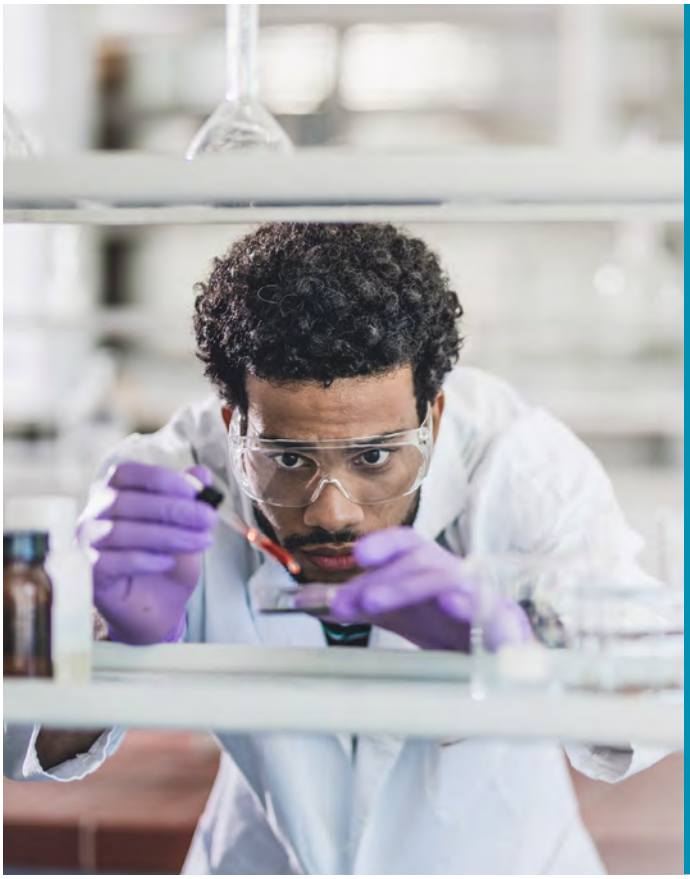
Erik Engebretsen, Head of Engineering at Bramble Energy

Sistemic

Sistemic worked with the NMS to validate data for regulatory product approval and allow them to meet new customer requirements and grow their business. The enhanced sensitivity and specificity of their novel assay will ensure that producers of stem cell therapy products that address currently unmet medical challenges can accurately assess contamination levels and ensure their safety, in compliance with the EC Regulation on Advanced Therapy Medicinal Products (No 1394/2007).

Future capability

The National Measurement System laboratories continue to invest in future capability to ensure the evolving measurement needs of the UK are addressed to support government priorities and innovation.



Virtual UK Centre for Engineering Biology, Metrology and Standards

Three NMS laboratories – NPL, LGC and NIBSC – and SynbiCITE, the Innovation and Knowledge Centre for Synthetic Biology, have established a £7M virtual UK Centre for Engineering Biology, Metrology and Standards. The Centre will develop reference materials and methods to improve the reproducibility of research results to support the conversion of innovation in synthetic biology into valuable products and services, helping to make the UK a global leader in the industrialisation of synthetic biology. Establishing industry-led measurements and standards will safeguard the quality and safety of products, and allow companies to maintain competitiveness and enhance innovation in fields such as gene, cell and regenerative therapies, as well as the discovery and manufacture of new antibiotics.

Advanced Quantum Metrology Laboratory

The Advanced Quantum Metrology Laboratory (AQML) will provide a centre for industry engineers, academic researchers and NMS scientists working in different aspects of quantum measurement. It will create a highly collaborative environment which will play an essential role in creating an innovative UK industry based on quantum technologies, identified as a core industrial challenge by the Industrial Strategy Challenge Fund (ISCF). It is due to be opened in 2019.

Advanced Multiphase Facility

NEL secured a £16M investment, with funding from Scottish Enterprise and NEL's parent company TÜV SÜD, to develop an Advanced Multiphase Facility (AMF), due to be opened in 2019. This world-leading facility will have the capability to evaluate large, high flow rate production systems at realistic subsea pressure conditions, contributing in particular to the oil and gas sector.

The AMF is the most important investment in the UK's National Flow Measurement Standards in the last 30 years. It will ensure the UK is at the leading edge of R&D in flow measurement in the next decade.

The National Measurement System laboratories

BEIS	**Office for Product Safety & Standards (Department for Business, Energy & Industrial Strategy)** www.gov.uk/government/organisations/office-for-product-safety-and-standards Email: OPSS.enquiries@beis.gov.uk Tel: 0121 345 1200 / 020 8943 7272	designated for legal metrology
LGC **NML**	**formerly Laboratory of the Government Chemist** **National Measurement Laboratory** www.lgcgroup.com/nml Email: measurement@lgcgroup.com Tel: 020 8943 7393	designated for chemical and biometrology
NEL	**National Engineering Laboratory** www.tuv-sud.co.uk/nel Email: info@tuvnel.com Tel: 01355 593700	designated for fluid flow metrology
NGML	**National Gear Metrology Laboratory** www.ncl.ac.uk/gears/services/metrology/index.htm Email: design.unit@ncl.ac.uk Tel: 0191 208 6192	designated for gears metrology
NIBSC	**National Institute for Biological Standards and Control** www.nibsc.org Email: enquiries@nibsc.org Tel: 01707 641000	designated for bioactivity metrology
NPL	**National Physical Laboratory** www.npl.co.uk email: communications@npl.co.uk Tel: 020 8977 3222	the UK's National Measurement Institute

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